State of Oregon
Department of Environmental Quality

STAFF REPORT

RECOMMENDED REMEDIAL ACTION

For

NU-WAY OIL SITE
PORTLAND, OREGON

Prepared By

OREGON DEPARTMENT OF ENVIORNMENTAL QUALITY
Northwest Region Office

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ACRONYMS

AOC: Area of Contamination
bgs: below ground surface
CEC: Chemicals of Ecological Concern
COC: Chemicals of Concern
COI: Chemicals of Interest
COPC: Chemicals of Potential Concern
cy: cubic yards
DCE: cis 1,2-dichloroethene
DDD: dichlorodiphenyltrichloroethane
DDE: dichlorodiphenyldichloroethane
DDT: dichlorodiphenyldichloroethene
DEQ: Department of Environmental Quality
EPA: United States Environmental Protection Agency
EES: Equitable Easement and Servitude
ELCR: Excess Lifetime Cancer Risk
EPC: Exposure Point Concentration
FS: Feasibility Study
HI: Hazard Index
IRM: Interim Remedial Measure
LNAPL: Light Non-Aqueous Phase Liquid
LOF: Locality of the facility
µg/L: micrograms per liter
mg/kg: milligrams per killigram
OAR: Oregon Administrative Rule
ORA: Oil Reprocessing Area
ORS: Oregon Revised Statute
PAHs: Polynuclear Aromatic Hydrocarbons
PCBs: Polychlorinated Biphenyls
RAOs: Remedial Action Objectives
RI: Remedial Investigation
RCRA: Resource Conservation and Recovery Act
SLVs: Screening Level Values
T&E: Threatened and Endangered
TPH: Total Petroleum Hydrocarbons
TCE: Trichloroethene
VOCs: Volatile Organic Compounds
VC: Vinyl Chloride

1. INTRODUCTION

1.1 INTRODUCTION

This document presents the recommended remedial action for the Nu-Way Oil site at 7039 Northeast 46th Avenue in Portland, Oregon which was developed in accordance with Oregon Revised Statutes (ORS) 465.200 et. seq. and Oregon Administrative Rules (OAR) Chapter 340, Division 122, Sections 010 through 115.

The recommended remedial action is based on the administrative record for this site. A copy of the Administrative Record Index is attached as Appendix A. This report summarizes the more detailed information contained in the following reports completed under the Orphan Site Program managed by Oregon Department of Environmental Quality (DEQ): Remedial Investigation (E&E 1994), Baseline Risk Assessment, including an update of the remedial investigation and both the human health and ecological risk assessments (E&E 2004), and the draft Feasibility Study Report (E&E 2004). The Feasibility Study (FS) was not finalized by DEQ. This Staff Report was prepared using portions of the draft FS and addresses deficiencies and data gaps of the draft FS through discussion and analysis.

1.2 SCOPE AND ROLE OF THE RECOMMENDED REMEDIAL ACTION

The recommended remedial action addresses the presence of metals, semi-volatile organics, petroleum hydrocarbons, and chlorinated volatile organics in contaminated groundwater, soil, sediment, and, potentially, air at the Nu-Way Oil site. The recommended remedial action consists of the following elements:

- Uplands and bank hot spot soil excavation,
- Contaminated Whitaker Slough sediment excavation to Columbia Slough baseline levels,
- Sediment excavation from the drainage ditch on the west side of the upland portion of the site,
- Bank stabilization,
- Placement of an upland soil cap,
- On- and Off-site disposal of excavated contaminated soil and sediment,
- Monitoring and further evaluation of the air pathway,
- Institutional and engineering controls,
- Groundwater monitoring,
- Periodic remedy review, and,
- Contingency measures.

2. SITE DESCRIPTION AND HISTORY

2.1 SITE DESCRIPTION AND LAND USE

The Nu-Way Oil site is located at 7039 Northeast 46th Avenue in the City of Portland in Multnomah County, Oregon in Section 18, Township 1 North, Range 1 East of the Willamette Baseline and Meridian (Figure 2-1). The site covers roughly 2.7 acres.

The west side of the site consists of a former lagoon area used for waste disposal when Nu-Way Oil was an operating facility. The east end of the site consists of a former oil reprocessing area (ORA). The north side of the site is a very steep, unstable embankment dropping to the Whitaker Slough. Evidence of instability includes trees falling across the slough and cracks in the bank. Two buildings remain on the site and the site is fenced except to the north adjacent to the Whitaker Slough. An east to west interceptor trench, installed in 1994 and 1995, is present on the property and extends along the north and northwest boundaries of the site. The trench includes eight recovery wells which are connected to an oil-water separator located in the north central portion of the site. The current layout of the property is presented in Figure 2-2 .

Residences, light industry, and warehouse facilities are located in the area surrounding the site. The site is bordered by the Whitaker Slough to the north; a residence to the east; RCI Sheet Metal to the southeast; and Halton Equipment Company, a heavy equipment retailer, to the west. Approximately one-half of the site, where the former lagoon was located, was excavated in 1996 and backfilled with gravel. The remaining half of the site consists of unpaved soil.

2.2 PHYSICAL SETTING

2.2.1 Climate

Portland receives approximately 39 inches of precipitation annually. The majority of the precipitation falls in the late fall and winter months, with monthly totals ranging from 0.28 inches in July to 6.91 inches in December. Summer temperatures average 65°F and the winter temperatures average 40°F.

2.2.2 Geology

The site is located on the flat flood plain bordering the south side of the Whitaker arm of the Columbia Slough. Two main stratigraphic units have been encountered during investigations at the property; an upper, fine-grained unit and a lower coarse-grained unit. The upper unit is composed of discontinuous layers of silt and clay to a depth of approximately 25 feet below ground surface (bgs) near the north end of the site and about 20 feet bgs near the southern end. The material is generally gray, contains occasional woody debris, and exhibits some orange mottling near the surface in undisturbed sections.

The lower, coarse-grained unit is composed of fine basaltic gravels in a sandy or silty matrix. Occasional fine sand sections up to a few feet in thickness are seen, especially near the top of the unit. Figure 2-3 shows the cross-section locations for Figures 2-4 and 2-5.

2.2.3 Hydrogeology

In both the upper fine-grained and lower coarse grained units groundwater flow is toward the west or slightly southwest. In the upper unit the water table shows about a two foot drop from the east side to the west side of the site. In the lower unit the gradient is much flatter, with only about half a foot of drop from east to west on the site.

The water level of Whitaker Slough is artificially controlled through a series of levees and pump stations operated by the Multnomah County Drainage District. The Whitaker Slough is used for storage of stormwater runoff throughout the area. Water levels in the Slough can vary by 3 or 4 feet depending on the frequency of pumping and the time of year. The slightly southwest groundwater gradient that is sometimes seen suggests that, at least periodically, the Slough recharges groundwater under the site.

2.2.4 Surface Water and Stormwater Features

The Whitaker Slough is located on the north side of the Nu-Way Oil site. Surface water runoff from the site and surrounding area is collected in storm drains that discharge to the Whitaker Slough via infiltration and a pipeline located on the west side of the Nu-Way site. Surface runoff in the area immediately around the site drains to the Whitaker Slough and then to the main stem of the Columbia Slough. The Whitaker Slough joins the main stem of the Columbia Slough approximately 1500 feet to the west of the site.

2.2.5 Land Use

The Nu-Way site is vacant. The current and reasonably likely future land use designation for the Nu-Way Oil site is industrial sanctuary, as zoned by the City of Portland, and no change in zoning is anticipated. However, to the east of the Nu-Way site is a residence and the land directly across Whitaker Slough from the Nu-Way site is zoned residential. Use regulations for the General Industrial 2 zone prohibit the construction of new residences. Therefore, it is anticipated that no new residences will be constructed within the locality of the Nu-Way site. Land use designations for property to the west and south of the site include industrial uses.

2.2.6 Groundwater and Surface Water Uses

OAR 3401-122-115(9) defines beneficial uses of water as any current or reasonably likely future beneficial use of groundwater or surface water by humans or ecological receptors. The only use of groundwater identified within a 0.5 mile radius of the Nu-Way site was one irrigation well approximately 0.5 mile south and upgradient of the site. Property owners adjacent to Nu-Way along Northeast 46th Avenue receive potable water from the City of Portland Water Bureau. The AB Finishing site on Northwest 46th at Columbia Boulevard has an industrial process well. The zone of influence of this well does not impact the Nu-Way Oil site.

Groundwater at the site is hydraulically connected to the Whitaker Slough. Use of the Whitaker Slough adjacent to the Nu-Way site for swimming and fishing is not likely to occur because of the steep embankment. Fishing has been observed in parts of Columbia Slough near Nu-Way, particularly from bridges over the slough. Therefore, it is possible that anglers may catch and eat fish from Whitaker

Slough and may be exposed to site-related contamination in these fish. Boating is a general recreation use of the Columbia Slough.

2.2.7 Locality of the Facility

In the uplands the locality of the facility (LOF) includes the following: 1) the entire Nu-Way Oil property prior to 1988, 2) the footprint of the subsurface soil impacted with residual light non-aqueous phase liquids (LNAPL) on the adjacent properties to the west, east and south, and 3) locations where contaminant transport via groundwater might occur. For the Whitaker Slough, early remedial investigation data collected down the Whitaker Slough to the confluence of the main stem of the Columbia Slough show concentrations above the baseline concentrations calculated for the Columbia Slough (DEQ 2002a and DEQ 2005b). This suggests that the Nu-Way Oil site may be a contributor to contaminants in the slough downstream of the Nu-Way Oil site and therefore the LOF includes the Whitaker Slough adjacent to the Nu-Way Oil site and is estimated to end at the confluence with the main stem of the Columbia Slough. Impacts to the main stem are also possible but have not been investigated.

2.3 SITE HISTORY

The Nu-Way Oil Company operated a used oil re-refining facility at the site from 1935 to 1987. The re-refining process involved the removal of water, debris, and particles from the oil by filtration and dewatering, and the removal of metals, salts, aromatics, and asphaltics by precipitation with sulfuric acid. Finally, mercaptans and other contaminants were removed by filtration with clay. The acid sludge, wastewater, and spent clay filtrate were disposed of in the unlined lagoon located in the west portion of the site. According to the site owner, waste was directed into the lagoon across the ground surface via trenches and berms instead of pipes; therefore, oil waste inundated site soil. When the facility was shut down in 1987, the lagoon was covered with spent clay, site soil, and demolition debris. Figure 2-6 shows the approximate locations of the site features prior to 1988.

The United States Environmental Protection Agency completed initial investigations on the site in 1988 and referred the site to Oregon (EPA 1986 and EPA 1988). In 1989, Oregon DEQ initiated negotiations with Mr. Delton Geary, the property owner at the time regarding implementing a remedial investigation at the site. Mr. Geary submitted documentation regarding his ability to pay for the investigation. Mr. Geary was required to submit monthly payments to contribute to the investigation but the site was declared an Orphan Site and all the subsequent investigations were implemented under the Orphan Site Program. Mr. Geary subsequently transferred a portion of the property to RCI Sheet Metal, Inc which continues to own that portion of the property.

2.4 ENVIRONMENTAL INVESTIGATIONS

The following documents contain results from Nu-Way environmental sampling performed by Oregon DEQ:

- *Nu-Way Oil Remedial Investigation/Removal Assessment* (Parametrix 1993)
- Memorandum from Ken Cameron to Bill Dana describing soil sampling (DEQ) 1994
- *Interim Removal Action Measure Report* (E&E 1995a)
- *Final Interim Removal Action Measure Report*, Whitaker Slough (E&E 1995b)
- *Supplemental Lagoon Investigation Report* (E&E 1996)
- *Removal Action Summary Report* (E&E 1997)
- *Baseline Risk Assessment, Nu-Way Oil Company, Portland, Oregon* (E&E 1998)

- *Baseline Risk Assessment Addendum, Nu-Way Oil Company, Portland, Oregon* (E&E 1999a)
- *Supplemental Remedial Investigation Push Probe Drilling and Sampling Results at the Nu-Way Oil Site* (E&E 1999b)
- *Supplemental Remedial Investigation, Oil Reprocessing Area Investigation Report* (E&E 1999c)
- *Data Report for Whitaker Slough Bank Sampling* (E&E 2000a)
- *Feasibility Study Data Gap Investigation Report* (E&E 2000b)
- *Internal Memorandum from Debbie Bailey to Nu-Way Oil File on October 17 and 18 Push-Probe Investigation* (DEQ 2001a)
- *Final Soil and Groundwater Report* (E&E 2003a)
- *Final Storm Drain System Evaluation and Sampling Report* (E&E 2003b)

Summaries of the investigations documented in the reports listed above are presented in the Final Baseline Risk Assessment document (E&E 2004a). The Baseline Risk Assessment was completed in January 2004. The Draft Feasibility Study was submitted to DEQ in August 2004. In August 2005 E&E prepared a technical memorandum to supplement the draft FS (E&E 2005). In August 2005 DEQ prepared a technical memorandum to summarize derivation of the cleanup levels and hot spot levels for the site (DEQ 2005a).

2.5 INTERIM REMEDIAL MEASURES (IRM)

Three interim actions, described below, were completed at the site.

2.5.1 1993 IRM

In 1993 several tasks were completed at the site. A leaking aboveground storage tank was removed. The former lagoon area was capped with a 200-foot by 200-foot synthetic liner in order to prevent stormwater infiltration, direct contact with exposed wastes, and production of contaminated surface water runoff. In addition a drainage ditch was constructed on the south side of the former lagoon area to collect and remove surface water runoff. This ditch was connected to the stormwater drainage ditch along the west side of the site.

2.5.2 Interceptor Trench

In 1994 and 1995 an east to west interceptor trench was constructed in two phases along the northern boundary of the site near the Whitaker Slough: 175 feet in 1994 and an additional 194 feet in 1995. Recovery wells, piping and storage tanks were installed to allow active recovery measures. Although the equipment remains on-site, active recovery has not occurred because very little oil has migrated into the trench. The interceptor trench is 18 feet deep and is shown in Figures 2-3 and 2.5.

2.5.3 Lagoon Area Excavation

In November 1996 approximately 10,500 tons of Resource Conservation and Recovery (RCRA) contaminated material and 2,100 tons of non RCRA-contaminated material were excavated from the former lagoon area. The action effectively eliminated the immediate threat of direct human contact with toxic and corrosive soil previously present in the former lagoon area. The excavated area was backfilled with gravel and subsequently was graded. The removal action also eliminated a large portion of the sludge in the former lagoon, a major source of groundwater contamination at the site.

Following the removal action at the former lagoon area, contamination remained on site in several areas, including contamination below the excavation depth of the removal action in the former lagoon area, the former oil reprocessing area, the embankments of the Whitaker Slough, and along the fence line to the south and west of the former lagoon area. Contamination also remained in the Whitaker Slough sediment.

3. RESULTS OF INVESTIGATION(S)

3.1 NATURE AND EXTENT OF CONTAMINATION

Characterization of the nature and extent of contamination at the Nu-Way Oil site is presented in the documents listed in Section 2.4. The following sections provide a summary of the nature and extent of contamination in soil, groundwater, and sediment.

3.1.1 Surface Soil

During the remedial investigation (RI) for the Nu-Way Oil project, surface soil contamination was observed on Nu-Way property and the properties bordering the Nu-Way property to the south, east, and west (i.e., the Geary, Ellett, Halton, and RCI Sheet Metal properties) (Figure 3-1). Metals, pesticides, polynuclear aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPH), polychlorinated biphenyls (PCBs) and volatile organic compounds (VOCs) were found in upland surface soils. Arsenic, lead, TPH, and PCBs, however, were the contaminants of widest distribution. The maximum concentrations found in surface soil on the Nu-Way property are 42.9 milligrams per kilogram (mg/kg) of arsenic, 24,300 mg/kg of lead, 310 mg/kg of PCBs, and 87,000 mg/kg of TPH. The second highest concentrations are 22, 14,400, 29, and 29,000 mg/kg for arsenic, lead, PCBs and TPH, respectively. Surface soil on the Nu-Way property is generally impacted by site contaminants, except in the former lagoon area. In 1996, the lagoon contents and soils were removed down to the water table in some locations and the area backfilled with clean gravel. Other contaminants found at the site in upland soils included several metals, PAHs, and pesticides. Other contaminants found in bank soils included chromium, five pesticides, and three PAHs (pyrene, chrysene, and benz(a)anthracene).

The extent of off-site surface soil contamination has been sufficiently delineated. Fifteen surface soil samples were collected from the off-site industrial property and 18 from the off-site residential property. Some limited surface soil contamination that could be attributable to the Nu-Way activities is on all adjacent neighboring properties. In the samples from the Geary property, lead was found at 190 and 225 mg/kg, PCBs at 2.28 mg/kg, and TPH at 1,420 mg/kg. In the four samples from the RCI Sheet Metal property, lead was detected between 7.06 and 193 mg/kg, and TPH between 269 and 1,231 mg/kg. PCBs were not detected.

In 10 samples collected from the Halton property, lead was detected from 6.36 to 4,131 mg/kg. In seven of the 10 samples, PCBs were not detected. In the remaining samples the maximum PCB concentration was 2.7 mg/kg. TPH ranged from 93 to 28,900 mg/kg in the samples from the Halton property. The Halton property between the Nu-Way property boundary and the Halton fence is the most impacted off-site surface soil area. The surface soil investigation was not extended past the current fence line on the Halton property. Further surface soil delineation on the Halton property was not performed because the Halton property beyond the property fence is at a higher elevation due to historical filling performed by the Halton Company. Therefore, results from surface soil sampling would not be representative of Nu-Way contamination.

Eighteen samples were collected from the Ellett residential property. The two highest lead concentrations were 1,780 mg/kg (BH-11) and 479 mg/kg (BH-12). The remaining sampling locations ranged in lead concentrations from 4.15 to 327 mg/kg. PCBs were detected in two samples at 0.234 and 0.147 mg/kg. In the 10 samples analyzed for TPH, the concentration ranged from 74 to 2,250 mg/kg. The samples collected from the Ellett property provided an adequate delineation of that property. The areal extent of the immediate area around the high lead concentration found at BH-11 and BH-12 may have to be further evaluated during the remedial action.

3.1.2 Subsurface Soil

Metals, pesticides, VOCs, PAHs, PCBs and TPH were detected in subsurface soils at the Nu-Way site. Lead, PCBs, and TPH were the contaminants of widest distribution. Figure 3-2 shows sampling locations for subsurface soils. Elevated levels of lead and TPH are present in on-site and off-site subsurface soils. Elevated levels of TPH are present as free product identified as a residual light non-aqueous phase liquid (LNAPL) at the Nu-Way site and neighboring properties (Halton, Geary, Kuhnau, and RCI Sheet Metal) at varying depths. The area impacted by residual LNAPL has also been referred to as the "Smear Zone" in earlier documentation on the site. The highest concentration of lead in subsurface soil found on site was 8,900 mg/kg at 4 feet bgs in GP2, and the highest concentration of lead off-site was 321 mg/kg in BH-3 at 4 feet bgs on the Halton property. The extent of subsurface soil contamination from the Nu-Way activities is defined by the extent of the residual LNAPL zone.

The extent and thickness of subsurface residual LNAPL contamination attributable to Nu-Way Oil operations is presented in Figure 3-3. Figure 3-3 is a conservative estimate of the extent as the boundary is placed where the LNAPL was not detected so the actual boundary is inside the line. In some locations the thickness is greater than 10 feet. In 1994 and 1995 an interceptor trench was installed on the north side of the property to capture any LNAPL that might migrate to the Whitaker Slough. Very minor quantities of LNAPL have entered the trench. The recovery system has not been activated to remove LNAPL from the trench. Based on a ten-year monitoring history of the trench, the LNAPL does not appear to be mobile. Analysis of the residual LNAPL on-site in subsurface soil has shown that the volatile fraction is essentially no longer present and the heavy hydrocarbon chains remain.

Total VOCs, both chlorinated and non-chlorinated, were detected at low microgram-per-kilogram (µg/kg) levels across the Nu-Way site and at off-site locations. Total VOCs are present in subsurface soil at the Ellett residence at a maximum concentration of 10,510 µg/kg at 8.5 feet bgs (BH-12). However, no chlorinated volatiles were detected at that location. Total VOCs in subsurface soil extend west of the Nu-Way site onto Halton property (BH-3 at 4 feet bgs).

Trichloroethene (TCE) was detected in subsurface soils on the Nu-Way site and at neighboring properties. In subsurface soils, TCE was detected at only two push-probe locations during the 2002 site investigation (E&E 2003a). Boring BH-1 at 9.5 feet bgs, which is located on the Nu-Way property, exhibited a TCE concentration of 0.344 mg/kg. Boring BH-20, which is located on the Geary property, exhibited a TCE concentration of 0.0131 mg/kg at 21 feet bgs. Additionally, from the 1993 RI/removal assessment (Parametrix 1993), sample MC-3, located on the Nu-Way site, exhibited a TCE concentration of 0.12 mg/kg at 8 feet bgs.

3.1.3 Sediment

Metals, PCBs, TPH, PAHs, and pesticides were detected in sediment samples in the Whitaker Slough adjacent to the Nu-Way site. The highest concentrations of lead (35,300 mg/kg-dry at SD-20), PCBs

(1,516J µg/kg at SD-02), and TPH (5,960 mg/kg-dry) are present near two outfalls (one 42 inch pipe and one 18 inch pipe) located in the northwestern corner of the site. Sheen attributable to petroleum hydrocarbons has also been observed during sampling events in the sediments adjacent to the site. Several PAHs were found in sediment adjacent to the Nu-Way site. However, chrysene, pyrene and benz(a)anthracene were the only PAHs also found in bank soils. Lead and TPH concentrations decrease downstream of the site. Maximum concentrations of DDE, DDT, dieldrin and heptachlor were above toxicity screening values in bank soils.

The downstream extent of sediment contamination attributable to the site cannot be reliably estimated due to the potential contribution of other sources including two stormwater outfalls east of the site, and other outfalls between the site and the confluence of Whitaker Slough and the main stem of the Columbia Slough downstream of the site. In addition, results from upstream sediment investigations suggest that other sources of contamination are present upstream of Nu-Way Oil.

An investigation was completed in 2002 and 2003 around the two outfalls on the west side of the investigation area and the drainage ditch and 18 inch conveyance pipe. Stormwater samples collected in 2003 from the two outfalls suggest that low levels of lead and TPH continue to enter Whitaker Slough during storm events. Samples collected from the drainage ditch (SD18, SD24, SD25 and SD26) and the 18 inch pipe bedding material indicate that sediments from the drainage ditch may contribute to Whitaker Slough sediment contamination during storm events. The highest concentration in the drainage ditch investigation was found at SD18 (80 mg/kg lead and 28 mg/kg PCBs). The lead concentrations in SD24, SD25, and SD26 were relatively consistent between 37 and 44 mg/kg suggesting a background concentration above natural soil background of 17 mg/kg.

Figure 3-4 presents sampling locations for the October 2002 and January 2003 Whitaker Slough and the drainage ditch sampling events. Sampling locations and data for earlier sediment sampling events can be found in the Baseline Risk Assessment (E&E 2004a).

3.1.4 Groundwater

Metals, VOCs, and TPH have been detected in groundwater at the Nu-Way site. Samples were collected from monitoring wells, recovery wells, and from temporary boreholes.

Total metals results from on-site monitoring wells suggested the potential for migration of metals from groundwater to surface water, so five temporary well points were installed along the toe of the Nu-Way Oil embankment adjacent to the Whitaker Slough. Analysis for total and dissolved metals was performed for lead, cadmium, and barium. The only analyte in groundwater that does not meet acceptable ecological screening levels is total lead. Total lead concentrations were above the ambient water quality criteria in the two sampling locations at the western end of the site. Lead and cadmium were not detected in the dissolved fraction. Barium was detected at concentrations ranging from 9.4 to 15.2 micrograms per liter (µg/L) which exceeds ambient water quality criteria. However, barium was determined not to be a site issue because the surface water background concentration range for barium in the Columbia River system has been identified as 1 to 30 µg/L (USGS 1996). The concentrations in groundwater at the Nu-Way Oil site are within the background range so barium is not considered a chemical of concern.

Total VOCs (chlorinated and non-chlorinated volatiles) were detected at most of the grab groundwater sample locations, with maximum total VOCs detected in BH-24 on the Ellett property. The monitoring wells mainly define the on-site groundwater contamination, except for MW-4 and MW-13, which are on the Halton property. Total VOCs have been detected in all the Nu-Way investigation monitoring wells, with the exception of MW-16, which is located along the northwest portion of the site. Figure 3-5 presents the monitoring well, borehole and recovery well locations for the site and provides data on total VOCs for March 2002.

The highest concentration of diesel-range petroleum hydrocarbons on the Nu-Way property is at MW-15. The highest concentrations of total VOCs are present in the northeast corner of the Nu-Way investigation area, around MW-12, MW-15, and MW-20. The highest concentrations of chlorinated VOCs on site are present in BH-1 in the southwest corner, and MW-20 at the eastern boundary of the Nu-Way site. The distribution of chlorinated VOCs on site potentially suggests that more than one source area is present in the investigation area.

The groundwater flow direction is to the west in the shallow groundwater and northwest in the deep groundwater. In the shallow groundwater, cis-1,2-dichloroethylene (DCE) was observed in BH-22 at 3.38 µg/L, which suggests that contamination from the Nu-Way property may have impacted the off-site shallow groundwater zone on the Halton property.

Regarding the other off-site industrial properties that were investigated during the Nu-Way investigation, only borehole data are available for review. The predominant VOCs found in groundwater were the chlorinated VOCs, with DCE being the predominant chlorinated VOC. BH-28 and BH-31 were outside the residual LNAPL area, with low levels of total VOCs detected.

The total VOCs and total aliphatic chlorinated VOCs on the Ellett property varied across the borehole locations, suggesting that there may be more than one source of contamination. At BH-21 on the Ellett property, TCE was detected at 527 µg/L. At BH-30, TCE was detected at 382 µg/L and DCE at 101 µg/L. The source of contamination at these locations is assumed to be upgradient of the contamination from Nu-Way.

Concentrations of contaminants in groundwater at the Nu-Way site are not expected to increase in the future for the following reasons: 1) the contamination at the Nu-Way site has been present for many years starting in the 1930s, 2) the area with the highest concentrations on site, the former lagoon area, was remediated in 1996 removing a significant amount of contaminant mass from the site, 3) observations of groundwater quality in the interceptor trench, installed to control migration of LNAPL to the Whitaker Slough, suggest that very little, if any, LNAPL is migrating into the trench, and 4) the subsurface soils are silt and clay down to 18 feet, restricting the partitioning from the soils to groundwater.

3.2 BASELINE RISK ASSESSEMENTS

Baseline human health and ecological risk assessments were performed in accordance with OAR 340-122-0080 and -0084 to evaluate the potential risks to human health and the environment and the need for remedial action, or no action, at the site. The final baseline RA (E & E 2004) included an updated baseline human health risk assessment (HHRA) and Level II screening ecological risk assessment (ERA), and followed previous RAs, including the initial baseline RA (E&E 1998b) and baseline RA addendum (E & E 1998a). A summary of the human health and ecological risk assessments is provided in the following sections.

3.2.1 Human Health Risk Assessment

The Baseline HHRA was performed in accordance with the EPA's Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (1989c, 1991, 2002), DEQ's Guidance for the Conduct of Deterministic Human Health Risk Assessments (DEQ 2000), DEQ's Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites (DEQ 2003), and other relevant guidance documents. The human health risk assessment included an evaluation of the chemicals found at the site to 1) determine which are the chemicals of potential concern and 2) to perform the following: a toxicity assessment, an exposure assessment, risk characterization, and an uncertainty assessment.

3.2.1.1 Chemicals of Potential Concern (COPCs)

The preliminary screening of chemicals of interest (COIs) was completed as allowed under OAR 340-122-0080(5) and DEQ Guidance for Conduct of Deterministic Human Health Risk Assessments (DEQ, 2000) and was based on frequency of detection, background and concentration-risk. The soil, sediment and groundwater analytical data from investigations conducted from 1993 through early 2003 were screened to determine which COIs to retain as COPCs. COIs were designated as COPCs based on:

Frequency of Detection – COIs that were detected in less than 5% of the samples site-wide for a given media were not selected as COPCs. Detection limits did exceed screening levels for TCE and vinyl chloride (VC) in some soil samples. As a result, though VC (a degradation product of TCE) was not detected in any of the soil samples it was retained as a COPC.

Background Concentrations – Inorganic (naturally-occurring metals) COIs that were detected at a maximum concentration less than the established background value were not selected as COPCs. No metals were excluded as COPCs in soil due to background concentrations.

Concentration-Risk Screen – COIs that were detected in at least 5% of either soil or groundwater samples were screened against risk-based concentrations (RBCs) for soil and groundwater. Because only fish consumption was evaluated as an exposure pathway for the Whitaker Slough, only bioaccumulative COPCs in sediment (i.e., PCBs) were retained as COPCs. The following describes the concentration risk screening for soil and groundwater samples.

For COPCs detected in more than 5% of the samples site-wide, the maximum detected concentration was compared to RBCs derived from EPA Region 9 preliminary remediation goals (PRGs) for residential surface soil and residential RBCs for vapor intrusion into indoor air and volatilization to outdoor air based on DEQ (2003) guidelines revised to include additional chemicals and current DEQ decisions regarding exposure factor values. It was assumed that the RBCs based on a residential scenario would be generally protective of workers (occupational, excavation, and construction) and trespassers. Although the residential exposure to indoor and outdoor vapors is typically assumed to be exclusionary (i.e., the resident is exposed to either outdoor *or* indoor air), the risk ratios for exposure to both vapors in indoor and outdoor air were summed in order to be conservative in the screening procedure.

The maximum detected concentration of each COI was divided by the respective RBCs then each quotient was summed to generate a risk ratio for each COI. If a risk ratio was greater than one, then the COI was retained as a COPC. In addition, the risk ratio for each COI in soil and groundwater was compared to the value of one divided by the total number of COIs to assess potential cumulative effects. If a risk ratio was greater than one divided by the total number of COIs, then the COI was retained as a COPC. Next, the risk ratios for each COI in soil and groundwater were summed to generate a total risk ratio for each COI. If a total risk ratio was greater than one, then the COI was retained as a COPC.

Sediment contaminant concentrations were screened against DEQ's draft bioaccumulative screening levels for the Columbia Slough (DEQ 2002a and DEQ 2005b). PAHs were screened out because PAHs were not detected in fish tissue during the Columbia Slough Screening Level Risk Assessment (Parametrix 1995). TPH concentrations were screened against RBCs generated using DEQ's Risk-Based Decisions Making for Remediation of Petroleum Contaminated Sites (2003).

3.2.1.2 Exposure Assessment

The exposure assessment evaluated current or potential future exposure scenarios whereby humans might be exposed to contaminants in affected media (e.g., soil, groundwater, sediment, or air). The exposure pathways quantitatively evaluated in the human health risk assessment are shown in Figure 3-6 which presents the conceptual human health exposure model. The human receptors evaluated in the risk assessment included current and future on-site and off-site industrial workers, current and future off-site residents, current and future trespassers and future excavation and construction workers. The principal exposure routes include incidental ingestion and dermal contact with soil and sediment, and consumption of fish caught within the locality of the facility.

The exposure point concentration (EPC) is the representative concentration of a contaminant to which a receptor could be exposed at the site. Human health EPCs for each COPC in each medium were calculated for the Nu-Way Oil site and the conclusions presented in the risk assessment. EPCs were used to calculate the daily intake of a chemical, or dose, expressed as milligrams of chemical per kilogram body weight per day (mg/kg/day). EPCs for site contaminants are presented in the Baseline Risk Assessment (E&E 2004a) and summarized in DEQ's technical memorandum summarizing the deriviation of the cleanup levels (DEQ 2005a).

3.2.1.3 Toxicity Assessment

For the baseline risk assessment, human health effects were divided into two groups: non-carcinogens and carcinogens. The division is based on the mechanism of action associated with the COPCs. Toxicity factors for the assessment were obtained from EPA's Integrated Risk Information System (IRIS) and/or EPA's Health Effects Summary Tables (HEAST).

A reference dose, or RfD, is the toxicity value used in evaluating non-carcinogenic effects resulting from exposure to contaminants. The RfD is the estimate of a daily exposure for a human that is unlikely to produce an appreciable risk or adverse effect during an exposure period. For carcinogens, a slope factor (SF) is used to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a potential carcinogen.

3.2.1.4 Risk Characterization

The calculated intake of a chemical divided by its reference dose is called the hazard quotient (HQ). The sum of the individual chemical HQs for each pathway at the site is a hazard index (HI). A hazard index greater than one (1) suggests that an adverse effect may occur to exposed individuals. DEQ's limit for acceptable risk to non-carcinogens is an HI of 1.

Excess lifetime cancer risk (ELCR) is calculated by multiplying the intake of a carcinogenic chemical by its slope factor. The risk is expressed as a probability (for example, 3×10^{-6} means an increase in cancer risk of three in one million). DEQ's acceptable risk level for individual chemicals is an excess lifetime cancer risk of 1×10^{-6}. For the cumulative risk resulting from summing the risks of more than one carcinogen at a site, the acceptable risk level is 1×10^{-5}. A summary of the risk assessment results is presented below:

The Baseline HHRA evaluated risks associated with exposure to contaminants under four scenarios within the locality of the Nu-Way facility: on-site, the surrounding off-site industrial property, a neighboring residential property, and the Whitaker Slough. Human health risks were calculated for occupational workers, residents, adult and child trespassers, excavation workers, and construction workers. Risks for the occupational workers and the residents were also calculated assuming the significant re-grading of property and subsequent direct exposure to subsurface soils. From these risk calculations, chemicals of concern (COCs) were identified. In addition to specific chemicals, petroleum hydrocarbons are present in subsurface soils on site and in off-site residential and industrial areas and were also evaluated. The risk from exposure to the residual LNAPL was not quantified, but was assumed to result in unacceptable human health risks.

The following lists COCs for each of the four exposure settings.

On-site Industrial Property

COCs identified for the on-site property at Nu-Way include arsenic, lead, and PCBs in surface soils; PCBs, TCE, lead and TPH in subsurface soils; and VC and TCE in groundwater. The majority of the detected concentrations of arsenic were within the range of natural background concentrations. The 1998 Baseline Risk Assessment (E & E 1998a) identified the highest concentrations of arsenic as possibly representing contamination from historic operations at the Nu-Way site. The background concentration of arsenic is listed by the DEQ (2002b) as 7 mg/kg. Arsenic is identified as a COC in soil at concentrations above this background level. It is also important to note that TCE concentrations in subsurface soils and VC concentrations in groundwater collected on-site are mostly non-detect.

For on-site industrial conditions, the cumulative excess lifetime cancer risk (ELCR) to industrial workers from on-site surface soil is 8×10^{-6}, with equal contributions from arsenic and PCBs. There is also unacceptable risk from lead in surface soil. In subsurface soil, the ELCR is slightly higher at 1×10^{-5}, with the major contribution to risk from PCBs. Vinyl chloride in groundwater resulted in an ELCR of 5×10^{-6} even though vinyl chloride was not detected in most samples.

For onsite construction workers, there was unacceptable risk to lead in surface soil, and PCBs in subsurface soil (hazard quotient of 4). The ELCR from groundwater exposure to construction workers in an excavation was 2×10^{-5}, with equal contributions from TCE and vinyl chloride. Lead concentrations were also considered unacceptable to onsite excavation workers and trespassers. The risk from direct contact with separate phase petroleum hydrocarbons (in the residual LNAPL) in subsurface soil was not quantified, but was assumed to be unacceptable.

Off-site Industrial Property

COCs identified for the off-site industrial property surrounding the Nu-Way site include lead, TPH, and PCBs in surface soil. Lead and TPH were identified as COCs on the Halton property. PCBs were identified as COCs on the Geary property.

PCBs concentrations in surface soil resulted in an ELCR to industrial workers of 2×10^{-6}. Concentrations of lead in surface soil were unacceptable to industrial workers, construction workers, excavation workers, and trespassers. Concentrations of TPH in surface soil resulted in a hazard quotient of 2 for construction workers. In addition, the risk from direct contact with separate phase petroleum hydrocarbons (in the residual LNAPL) in subsurface soil was not quantified, but was assumed to be unacceptable.

Residential Property

COCs identified for the neighboring property include lead in surface soil, TPH in subsurface soil, and TCE in groundwater.

Concentrations of lead in surface soil were unacceptable to residents, as well as to construction workers, excavation workers, and trespassers on residential property. TCE in groundwater resulted in unacceptable risk from volatilization to indoor air (ELCR = 5 x 10^{-5}) for residents, and also unacceptable risk from volatilization to air in an excavation for short-term excavation workers (ELCR = 4 x10^{-6}) and construction workers working in an excavation (ELCR = 4 x 10^{-6}). The risk from direct contact with separate phase petroleum hydrocarbons (in the residual LNAPL) in subsurface soil was not quantified, but was assumed to be unacceptable.

Whitaker Slough
COCs identified in the sediment samples from the Whitaker Slough samples include PCBs and lead. COCs identified in Whitaker Slough bank soils include PCBs and lead.

PCB concentrations in slough sediment resulted in an ELCR for recreational anglers (through bioaccumulation into fish) of 7 x 10^{-5}. Assuming potential transport of bank soils into the slough, the potential future PCB risk to anglers was also unacceptable (ELCR = 6 x 10^{-4}). Lead was also considered present at unacceptable concentrations in both sediment and bank soils.

Tables presenting the calculated risk for each exposure scenario for the project and an explanation of how the risks were calculated are presented in DEQ’s 2005 technical memorandum (DEQ 2005a).

3.2.1.5 Uncertainty Evaluation

Uncertainties identified in this evaluation are associated with site characterization, selection of site data used in calculating chemical intake, estimation of potential chemical intake levels, toxicity parameters, and risk characterization. A detailed discussion of uncertainty is presented in Section 3.2.5 of the Baseline Risk Assessment (E&E 2004a). Most of the assumptions used in the risk assessment are conservative and would tend to overestimate the risk to human health. The following are some examples of uncertainty that may result in over or underestimation of the risk:

- The principal uncertainty regarding the exposure estimation calculations is associated with the selection of appropriate parameter values. The use of RME exposure parameters is likely to overestimate potential exposure.
- Exposure parameters used in calculating the exposure estimates were obtained principally from EPA guidance. These values are intentionally conservative and likely overestimate actual exposure.
- The modeling of vapors from groundwater to subsurface soil to indoor and outdoor air was based on the assumption that chemicals dissolved in groundwater volatilize to the air pathway. Of the data used to calculate EPCs, some of the samples were collected from the residual LNAPL, where oil exists in a separate phase. The transport models used in the exposure assessment do not adequately take into account the effects of a separate oil phase, particularly the role of hydrocarbons in accelerating biodegradation of chlorinated volatiles.
- A degree of uncertainty is present when predicting any type of future conditions, including land and water uses.
- There is uncertainty in the application of the BSAF for modeling PCB concentrations in sediment to fish. The approach greatly underplays the complexity of the processes transferring contaminants from aquatic ecosystems to aquatic organisms.

3.2.2 Ecological Risk Assessment

This section presents the ERA, which includes a Level I Scoping ERA for the upland portion of the site and the Whitaker Slough, and the Level II Screening ERA for the Whitaker Slough. The ERA was completed in accordance with DEQ's (2001b) *Guidance for Ecological Risk Assessment*. The ecological risk assessment (ERA) is a process of determining whether site-related chemicals may affect ecological receptors. In Oregon the ERA consists of different levels of assessment: Level 1 Scoping, Level II Screening, and Level III Baseline. For the Nu-Way Oil site both the Level I and Level II assessments were performed. The Level II process included problem formulation, exposure assessment, ecological effects (toxicity) assessment and risk characterization. This section summarizes the results of the Level I and Level II ERA for the site.

The conclusions of the Level 1 assessment were that the potentially complete exposure pathways currently include:

- Whitaker Slough bank soil to terrestrial receptors inhabiting the site;
- Erosion of Whitaker Slough bank soil and upland soils to the Whitaker Slough;
- Groundwater migration to the Whitaker Slough; and
- Sediment to aquatic receptors in the Whitaker Slough.

3.2.2.1 Problem Formulation

The boundaries of the site include both the Whitaker Slough and uplands soils. The Whitaker Slough represents ecologically important aquatic habitat. The uplands soils represent a potentially significant ecological habitat if the site is not developed.

The conceptual ecological exposure model (Figure 3-7) identified the following ecological indicator communities of concern and their exposure routes:

- Terrestrial birds and mammals that may be exposed to COIs in Whitaker Slough water via ingestion and inhalation.
- Aquatic life, semi-aquatic birds and mammals that may be exposed to COIs in the Whitaker Slough surface water, sediment, and aquatic organisms via ingestion and direct contact.
- Benthic invertebrates exposed to COIs in sediment and associated pore water via ingestion and direct contact.

Based on the ecological receptors the ecological assessment endpoints identified for the ecological risk assessment were:

- Protection of piscivorous birds from reproductive impairment associated with exposure to PCBs;
- Protection of piscivorous mammals from reproductive impairment associated with exposure to PCBs; and
- Maintenance of a healthy population of benthic organisms in the Whitaker Slough not affected by lead, PCBs, PAHs, and petroleum hydrocarbons.

The following elements were included in the ecological risk assessment:

- Measured concentration of COIs in groundwater,
- Predicted (modeled) future concentrations of COIs at the groundwater to surface water interface, and,

- Ecological toxicity data available in published literature.

3.2.2.2 Contaminants of Potential Ecological Concern

The following Level II ecological screening evaluations were performed:

- Upland soil and slough bank soil – terrestrial
- Whitaker Slough bank soil – aquatic
- Whitaker Slough sediment – aquatic
- Groundwater (migrating to surface water) – aquatic

Exposure point concentrations of COIs were compared with default screening values (and background levels for inorganics) according to DEQ guidance (2001b). On the basis of the Level II screening, the following chemicals of potential ecological concern (CPECs) were identified:

- Upland soil: metals, pesticides, and PCBs
- Whitaker Slough bank soil: metals, pesticides, PAHs, and PCBs
- Whitaker Slough sediment: PCBs, PAHs, lead, and petroleum hydrocarbons
- Groundwater: lead, barium, and petroleum product.

The Level II screening was extended with a site-specific evaluation of potential impacts to the great blue heron and river otter from dietary exposure to PCBs.

3.2.2.3 Exposure Assessment

The detection of high levels of lead and low levels of PCBs in sediment adjacent to the site confirms the migration of site-related contamination into the Whitaker Slough. Benthic organisms and other aquatic wildlife are potentially directly exposed to site-related lead, PCBs, PAHs and petroleum product in sediment. Piscivorous birds and mammals may also be potentially exposed to PCBs in the food chain through bioaccumulation. Terrestrial receptors may be exposed to high levels of lead, cadmium, chromium, 4,4-DDD, 4,4-DDT, and PCBs in upland soils and lead and 4,4-DDT in Whitaker Slough bank soils.

Shallow groundwater underlying the site flows in a westerly direction and deeper groundwater flows in a northwesterly direction. Groundwater recharge to the Whitaker Slough may be a CPEC migration exposure pathway. Surface water run-off and soil erosion from the site to the Whitaker Slough and soil erosion from slough banks to surface water and sediment are complete migration pathways for CPECs. CPECs migrating to the Whitaker Slough may be found in slough sediment and surface water. Soil erosion from the Whitaker Slough south bank to the Whitaker Slough surface water and sediments is an additional exposure pathway.

3.2.2.4 Toxicity Assessment

The primary chemicals of ecological concern (CECs) are PCBs, lead, PAHs, and pesticides, all of which were found to be at concentrations above the screening levels for freshwater sediment. Lead was also found to be above the bioaccumulation screening levels for the Columbia Slough (DEQ 2002a and DEQ 2005b). Petroleum hydrocarbons were found at concentrations that produce sheen in water and are therefore also CECs.

The primary toxic effect of PCBs is on reproduction in animals. Mink are especially susceptible to PCB toxicity. Other toxic endpoints include developmental effects and cancer. PCBs are known to induce hepatic microsomal activity of the mixed-function oxidase (MFO) system. The PCB congeners most similar in structure to 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (which also acts by MFO induction) are the most toxic.

Lead inhibits the activities of various important enzyme systems. Adverse effects have been seen on blood, brain and nervous systems, reproduction, and survival.

Most petroleum constituents are relatively non-persistent, and petroleum hydrocarbons do not tend to biomagnify through food webs. At high exposure levels, conventional toxic effects may be less important than the effects of the physical properties of oils coating plants and animals and coating and saturating soil and sediments. In addition, some components of petroleum hydrocarbons, such as PAHs and heterocyclic compounds, are moderately toxic and persistent and can accumulate to hazardous levels. PAH toxicity results from interferences with cellular membrane function and enzyme systems associated with membranes. Reactive metabolites of PAHs, such as epoxides and dihydodiols, can bind to cellular proteins and DNA, leading to mutations, developmental malformations, tumors, and cancer.

Organochlorine pesticides (e.g., DDT, dieldrin, heptachlor) are neuroactive agents. They act by binding to cellular molecules, and adversely affecting ion permeability or nerve receptors. From an ecological risk standpoint, however, the main concern is the persistence of organochlorine pesticides, and their ability to substantially biomagnify in the food web. The primary impacts are to birds, with the main effects being embryotoxicity, eggshell thinning, and other effects resulting in reduced reproduction. DDT, dieldrin, and heptachlor are also considered carcinogens in animals, and suspected carcinogens in humans.

3.2.2.5 ERA Uncertainties

The ERA combines and integrates information developed in the CPEC process, as well as, the exposure and toxicity assessments. There are uncertainties with each of these aspects of the ERA that also affect the degree of confidence in the ERA results.

- Use of models may not be accurate to estimate transport and environmental fate of CPECs in the environment and subsequent uptake by ecological receptors. The effect of this uncertainty on the result of the risk characterization varies.
- The great blue heron and river otter were chosen as representative measurement species. However, they may not be the most sensitive to particular CPECs; consequently risks may be underestimated.
- The bioavailability of a chemical depends on the physiological and biochemical processes involved in the absorption, metabolism, and excretion of a substance. The bioavailability of most chemicals in most environmental media is less than 100%. Consequently, the amount of a CPEC to which a receptor is exposed is likely to be less than the amount assumed in this ERA.
- Measurement receptors will likely eat more than one food item (i.e., fish).
- A measurement receptor may metabolize or eliminate a CPEC, reducing the availability of the CPEC.
- Total metal concentrations in groundwater were compared to surface water benchmarks though the transport of total metals through groundwater to surface water is not fully understood.

3.2.2.6 ERA Conclusions

Lead, PAHs, PCBs, and pesticides are present in Whitaker Slough sediments and bank soils that may lead to adverse effects to benthic organisms. Although not evaluated quantitatively in this ERA, petroleum hydrocarbons in sediments may also impact benthic organisms. Dietary modeling of PCBs in sediment determined that potential adverse effects to the great blue heron and river otter are not likely based upon comparison to LOAELs and the relative size of the feeding area compared to the impacted area. Lead, chromium, and PCBs are present in the bank soils of the Whitaker Slough along the northern perimeter of the site at levels exceeding DEQ Level II Ecological SLVs for terrestrial receptors. Chromium, however, is below the soil background concentration. Other inorganics were either below background or DEQ Level II Ecological SLVs. Erosion of Whitaker Slough bank soils may impact receptors in Whitaker Slough due to contamination of pesticides (DDE, DDT, and dieldrin), PAHs (pyrene, chrysene, and benz(a)anthracene), lead, and PCBs.

The uplands soils were not carried forward into the Level II assessment because it was assumed that development would affect the available habitat on the site. However, lead, cadmium, chromium, PAHs, pesticides, and PCBs are present in upland soils at concentrations exceeding background and DEQ Level II Ecological SLVs for terrestrial receptors. If development does not occur on site, or the site is not capped and significant ecological habitat is present in the future, there is a potential for adverse effects to terrestrial ecological receptors.

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4. REMEDIAL ACTION OBJECTIVES

This section describes the remedial action objectives and associated cleanup and hot spot levels derived for the site based on the beneficial land and water uses and potential exposure pathways identified in the risk assessment. This section also presents the estimated volumes for the contaminated media used in the remedial alternatives development summarized in Section 5.

4.1 REMEDIAL ACTION OBJECTIVES

The following site-specific remedial action objectives (RAOs) were developed for soil, groundwater, sediment and air for the purpose of achieving protection of human health and the environment, as required by OAR 340-122-040:

4.1.1 Soil

1. Prevent human exposure to COCs in surface and subsurface soil by direct contact, incidental ingestion, and inhalation for on-site and off-site workers and construction workers, off-site residents, and trespassers that would result in unacceptable excess lifetime cancer risk (ELCR) greater than 1 x 10^{-6} for individual chemicals, 1 x 10^{-5} cumulative risk for each pathway, and an HI greater than 1, or a blood lead level of more than 10 micrograms per deciliter (µg/dL).
2. Prevent human exposure to the residual LNAPL in subsurface soil in on-site and off-site industrial and residential areas.
3. Prevent ecological receptor exposure to CECs in upland soil and Whitaker Slough bank soil that would result in unacceptable risk for individual T&E species and populations of non-T&E species.
4. Treat hot spots of COCs in soil to be protective of human health and beneficial use of groundwater and surface water by reducing their concentration, volume, or mobility.

4.1.2 Groundwater

1. Prevent human exposure to COCs in groundwater by direct contact, incidental ingestion, and inhalation for on-site and off-site workers and construction workers, off-site residents, and trespassers that would result in unacceptable ELCR greater than 1 x 10^{-6} for individual chemicals, 1 x 10^{-5} cumulative risk for each pathway, and an HI greater than 1.

2. Prevent migration of CECs in groundwater to surface water in Whitaker Slough that would result in unacceptable risk to individual T&E species and populations on non-T&E species.

4.1.3 Air

1. Prevent human inhalation exposure to COCs that volatilize from soil and groundwater and migrate to indoor/outdoor air that would result in unacceptable ELCR greater than $1x10^{-6}$ for individual chemicals, 1×10^{-5} cumulative risk for each pathway, or an HI greater than 1.

4.1.4 Sediment

1. Reduce the COCs and CECs concentrations in the Whitaker Slough to Columbia Slough baseline levels.

2. Prevent ecological receptor exposure to sheen, as such exposure results in an unacceptable risk to ecological receptors.

3. Prevent erosion of Whitaker Slough bank soils into the slough that would result in an unacceptable risk of exposure for ecological receptors.

4.2 SUMMARY OF CLEANUP AND HOT SPOT LEVELS

This section summarizes the development of cleanup levels for soil, sediment and groundwater. The cleanup levels and hot spot levels for the site were derived from the conclusions in the risk assessment and using DEQ guidance for identification of hot spots. DEQ's technical memorandum (DEQ 2005a) presents a summary of the exposure point concentrations calculated for the site, the risk associated with those concentrations, and the cleanup levels derived for the site. The following is a summary of the derivation of the cleanup levels and hot spot levels. Tables 4-1 and 4-2 also provide a summary of the specific cleanup and hot spot levels derived for human receptors and ecological receptors, respectively.

4.2.1 Human Receptors

4.2.1.1 Soil

Site specific cleanup levels were calculated for both industrial and residential properties using the risk associated with the exposure point concentration for a chemical and determining what concentration represents an ELCR of 1×10^{-6} or a hazard index of 1. For arsenic, the background concentration was used as the cleanup level in accordance with the cleanup rules because the site specific cleanup level is below background. The hot spot determination for upland soils and bank soils at the site included an evaluation of "highly concentrated", "highly mobile", and "not reliably containable", consistent with OAR 340-122-00115(31)(b). Highly concentrated hot spot levels are defined as risk-based concentrations corresponding to 100 times the acceptable excess lifetime cancer risk for human exposure to individual carcinogen (which is equal to 1×10^{-4} risk level) or 10 times the acceptable ELCR level for human exposure to each individual noncarcinogen. The analysis for "highly mobile" and "not reliably containable" hot spots was also performed. The residual LNAPL in subsurface soil was not identified as a highly mobile or not reliably containable hot spot because the residual LNAPL concentrations are below the residual saturation concentration for fuel oils in silt and sand (Brost and DeVaull 2000) and the LNAPL has not been shown to be mobile enough to migrate into the slough.

4.2.1.2 Sediment

The exposure pathway with unacceptable risk is recreational fisherman (anglers) indirect exposure through fish consumption as a result of bioaccumulation of contaminants present in the sediment. However, the site-specific cleanup level in Whitaker Slough sediment was derived based on the Columbia Slough baseline levels established in DEQ 2002a and DEQ 2005b because the baseline levels are above the site-specific cleanup levels. The PCB hot spot concentration was calculated using 100 times the risk based concentration. The lead hot spot concentration was set at the same level as the target cleanup level because 10 times the risk based concentration is still below the Columbia Slough baseline level.

4.2.1.3 Groundwater

Site-specific cleanup levels were derived for groundwater based on contaminant migration from groundwater into indoor air. The cleanup level concentration in groundwater is the concentration above which there is the potential for exceedances of the indoor air acceptable concentrations if contaminants in groundwater migrate into an excavation or into indoor air.

4.2.2 Ecological Receptors

4.2.2.1 Soil

No threatened and endangered species are expected to have significant exposure to site-related chemicals in soil at the site. Consistent with DEQ guidance, chemical-specific cleanup levels for ecological receptors were set at five times the most stringent (lowest Level II Ecological Screening Level Value (SLV) or the population level screening level value for plants, invertebrates, birds, or mammals. For chromium, the value of five times the most stringent SLV was lower than the background concentrations, so the background concentration was used as the cleanup level. The hot spot determination for upland soils and bank soils at the site included an evaluation of “highly concentrated”, “highly mobile”, and “not reliably containable”, consistent with OAR 340-122-00115(31)(b). Hot spot concentrations for ecological receptors were set at ten times the cleanup level, consistent with DEQ guidance.

4.2.2.2 Sediment

No threatened and endangered species were identified for the Whitaker Slough. Although risk-based concentrations were derived for the project, the site-specific cleanup levels were based on the Columbia Slough baseline levels presented in DEQ 2002a and DEQ 2005b. The baseline levels were used because the freshwater sediment guidelines concentrations are below the baseline levels. In addition, sediment that, when disturbed, forms sheen, is assumed to be an exceedance of the target cleanup level due to potential adverse effects on aquatic organisms from physical contact. Hot spot concentrations, calculated at 10 times the risk-based concentrations, were also set at the baseline concentrations.

4.2.2.3 Groundwater

The groundwater cleanup levels were based on migration of groundwater to surface water. The ambient water quality criteria for lead is used as the cleanup level for groundwater. In addition, sheen in surface water is used as the cleanup level for petroleum hydrocarbons that might migrate from groundwater to surface water.

4.3 EXTENT OF CONTAMINATION BASED ON CLEANUP AND HOT SPOT LEVELS

This section presents the extent of contamination for soil, groundwater, and sediment, based on the site cleanup and hot spot levels developed in the previous sections. See Table 4-3 for a summary of the soil and sediment volumes used to evaluate the alternatives for the site. E&E's technical memorandum provides more detailed support of the information on the table (E&E 2005).

4.3.1 Soil

Surface soils are considered from the ground surface to 3 feet bgs. Most of the surface soil samples collected within the former oil reprocessing area (ORA), along the south bank of Whitaker Slough, and along the site perimeter exceeded cleanup levels for lead and/or PCBs. The estimated extent of surface soil exceeding cleanup levels is presented in Figure 4-1. Hot spot level exceedances occurred mainly along the south bank of Whitaker Slough. Most of the samples along the south bank of the slough exceeded the hot spot levels for PCBs and lead. Note, however, that the hot spot level for bank soils is much lower than that for on-site and off-site upland surface soils because the hot spot levels for bank soils are based on protection of human health through fish consumption and receptors in the slough and hot spot levels for upland soils are based on protection of human health through uplands human health exposure scenarios. The estimated extent of surface soil exceeding hot spot levels is also presented in Figure 4-1.

Subsurface soil samples were collected from 3 to 21 feet bgs. Two subsurface samples in the former ORA (S51 at 5 feet BGS and GP-7(01) at 4 feet bgs) exceeded the cleanup level for lead. Only one subsurface soil sample exceeded the hot spot level action level for lead (GP2 at 4 feet bgs). PCB cleanup level exceedances occurred in four subsurface samples, all located in the former ORA. Two samples collected in the former ORA exceeded the cleanup level for TCE (MC-4 at 8 feet bgs and ORA-5 at 3 feet bgs). No subsurface soil samples analyzed for PCBs and TCE exceeded the hot spot levels for the site.

<u>Cleanup Level Volumes</u>: The estimated volume of upland surface soils exceeding cleanup levels is 2,950 cubic yards (cy) while the estimated volume of subsurface soil exceeding the cleanup level is 180 cy. The estimated volume of bank soils exceeding cleanup levels is 840 cy.

<u>Hot Spot Level Volumes</u>: The estimated volume of hot spot bank soils is 640 cy (Areas HS1, HS2, HS3, and HS4). The upland surface soil hot spot volume was estimated to be 110 cy and is defined by four areas within the former ORA (Areas HS5, HS6, HS7, and HS8). The only subsurface hot spot exceedance (HS1') was identified at sample location GP2 at four feet. The estimated subsurface hot spot volume is 20 cy.

<u>Volume of soil with Residual LNAPL:</u> The volume of subsurface soil impacted by the residual LNAPL is estimated to be 33,350 cy (Figure 4-2). In addition, in order to access the impacted soil in some locations, non-impacted soils on the surface would have to be removed. None of these soils exceed the hot spots concentrations for residual LNAPL.

4.3.2 Groundwater

The two pathways considered complete in the risk assessment were the groundwater to surface water pathway and the air pathway (volatilization of contaminants from groundwater to indoor and outdoor air). For the groundwater hot spot evaluation, the potential was evaluated for contaminant migration from groundwater to cause a significant adverse effect on beneficial uses of the Whitaker Slough. Results of the groundwater samples collected from temporary well points located immediately adjacent to the Whitaker Slough were compared to DEQ ambient water quality criteria (AWQC) and DEQ's Screening Level Values (SLVs). Total lead was the only contaminant that exceeded AWQCs and background levels; however, the groundwater samples were collected from areas of lead-impacted soils/sediment and may not be representative of actual groundwater concentrations due to the entrainment of suspended soil particulates in the groundwater samples. A groundwater monitoring program will be implemented to confirm that the groundwater to surface water migration pathway is not of concern.

For the air pathway, TCE and VC exceed RBCs for vapor intrusion in the ORA and adjacent property to the west. The RBCs were developed through modeling vapor transport from groundwater, which did not consider attenuation of vapor transport from the residual LNAPL zone that exists in these areas. The pathway will be further evaluated to determine whether vapor controls are necessary for any future buildings constructed in these areas.

In conclusion, based on this presentation, no hot spot or cleanup level volumes were estimated for groundwater. The groundwater pathway will be addressed through groundwater sampling for the groundwater to surface water pathway. The air pathway will be addressed through monitoring groundwater and/or soil vapor as well.

4.3.3 Sediment

Whitaker Slough Sediments

Most of the samples collected from Whitaker Slough, upstream and downstream of the site, exceeded the human health fish consumption hot spot level for lead. Therefore, some of the contamination does not appear to be site related. The presence of residual TPH contamination in sediment, as evidenced by sheen when the sediment is disturbed, is considered a reliable indicator for sediment contamination attributable to the NuWay Oil site. The TPH-impacted sediments are located adjacent to the site and extend approximately 150 feet downstream of the site. The aerial extent of sediment contamination is 26, 000 square feet, and the estimated volume is 1,650 cy.

The Nu Way Oil site likely contributed to sediment contamination beyond the sediment remediation area. However, considering the ambient background in the Columbia Slough and concentrations upstream from Nu-Way Oil and the presence of other stormwater outfalls downstream of the site, other sources of contamination have likely contributed to the downstream contamination. Sediment sampling was conducted in 2002 and 2003 to identify the current extent of contamination above the baseline concentrations in the Whitaker Slough and readily attributable to the Nu-Way Oil site. Only the currently identified exceedances of the Columbia Slough baseline levels will be addressed in the recommended remedy presented in this document. See Sections 5.1.2 and 8.2.1 for further explanation.

Drainage Ditch Sediments

Sediment contamination that exceeds the target cleanup levels is present in the drainage ditch at the entry point to the buried stormwater pipe and at upstream sampling locations (see Figure 4-3). The source of the contamination for these locations may not be attributable to Nu-Way or it may be one of several sources including runoff from the city streets and runoff from adjacent properties. The localized area around the entry to the pipe (SD18 area) which is most likely attributable to the Nu-Way Oil would be addressed through the proposed action. The aerial extent of that sediment is estimated at 400 square feet (to approximately 20 feet south of SD18). The estimated volume of sediment is 400 cubic feet or 15 yd^3.

4.4 APPLICABLE LAWS AND STANDARDS

The recommended remedy will comply with all applicable federal and state laws and standards as described below:

Oregon Hazardous Waste Management Act (ORS 466) - This act and its implementing administrative regulations (OAR 340-100-0001 *et seq*.) govern the generation, transportation, treatment, storage, and disposal of hazardous wastes. These rules may have applicability at the site if remedial actions generate characteristic or listed hazardous wastes (including environmental media such as contaminated soils and/or groundwater). The act incorporates the requirements of the federal Resource Conservation and Recovery Act (RCRA) program.

The soil and sediment contamination to be addressed is not associated with any known releases of hazardous wastes as defined under RCRA. Leaching tests have been completed on the sediments in place in the Whitaker Slough and ORA soils and the material did not exceed the applicable criteria for a characteristic hazardous waste.

Area of Contamination (AOC) Policy. The AOC policy was first articulated in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (see 53 FR 51444 for discussion in proposed NCP preamble; and 55 FR 8758-8760, March 8, 1990, for final NCP preamble discussion). In the AOC policy, EPA interprets RCRA to allow certain discrete areas of generally dispersed contamination to be considered RCRA units. Because an AOC is equated to a RCRA land-based unit, consolidation and in-situ treatment of hazardous waste within the AOC do not create a new point of hazardous waste generation for purposes of RCRA. This interpretation allows wastes to be consolidated or treated in-situ within an AOC without triggering land disposal restrictions or minimum technology requirements. The AOC interpretation may be applied to any hazardous remediation waste that is in or on the land.

Toxic Substances Control Act (40 CFR 750 and 761, OAR 340-110, OAR 340-108). The toxic substances control act (TSCA) addresses the manufacturing, processing, distribution in commerce, use, cleanup, storage, and disposal of PCBs. Due to the presence of PCBs in soils and sediments at the Nu-Way Oil site, TSCA rules are applicable to remedial actions involving soils and sediments contaminated with PCBs. PCB contamination below 50 ppm is not regulated by TSCA, except under special circumstances. Contaminated media containing greater than 50 ppm of PCBs may require treatment by incineration or another equivalent method, or placement in a TSCA-approved chemical waste landfill.

Oregon Solid Waste Management (ORS 459 and OAR 340-093 and 340-095) – This statute and implementing rules govern the management of solid wastes, including the permitting of disposal sites, and are applicable to the off-site management and disposal of the contaminated soils and dredged sediments.

Off-site disposal of the excavated soil and sediment will comply with the applicable solid waste regulations.

Oregon Water Quality Standards (ORS 468B and OAR 34-041). These standards protect aquatic life and public health, and are applicable to the Nu-Way Oil site for any discharges to the Whitaker Slough from shallow groundwater or overland flow of stormwater.

Oregon Water Pollution Control Act (ORS 468B and OAR 340-045). This act and the implementing administrative rules govern discharge of pollutants to surface waters. The act incorporates the federal Clean Water Act (CWA) programs, including the NPDES permitting system.

Oregon Groundwater Quality Protection Act (ORS 468B and OAR 340-040). This act and the implementing administrative rules constitute Oregon's groundwater protection program. The program incorporates the federal Safe Drinking Water Act requirements and maximum contaminant level (MCL) standards. The groundwater protection program policy states that the rules are not to be used as cleanup standards, but they may be used to evaluate non-degradation of existing groundwater resources and may be considered for remedial actions that include the use of underground injection control (UIC) systems for treated groundwater or storm water disposal.

Removal or Fill Permits for Work in Whitaker Slough. Section 404 of the Federal Clean Water Act (CWA) requires approval before discharge of dredged or fill material into waters of the United States, including wetlands. The United States Army Corps of Engineers (USACE). has the authority for issuing permits under this section. A USACE permit may be issued only after the proposed discharge is reviewed and measured against the requirements of the CWA, including Section 404(B)(1) guidelines implemented by EPA (40 CFR § 230). A similar permitting requirement exists under the Oregon fill and removal law, ORS 196.800 to 196.990, which is enforced by the Oregon Department of State Lands (DSL). USACE and DSL have developed a joint permit application for construction, excavation, and filling in Oregon's waters, which may include streams, rivers, lakes, or wetlands.

Section 401 of the CWA requires that any applicant for a federal license or permit to conduct any activity that may result in a discharge to waters of the state must provide the licensing or permitting agency with a certification from DEQ stating that the activity complies with water quality requirements and standards. USACE coordinates with DEQ on water-quality-related permitting conditions.

Submersible and Submerged Lands (ORS 274). The State of Oregon owns the sediment in the Whitaker Slough. Access for dredging is obtained under these statutes.

Oregon Occupational Safety and Health Code (OAR 347). These codes, analogous to the federal Occupational Safety and Health Administration codes, contain health and safety requirements that must be met during implementation of any remedial action. These standards are intended to protect construction and utility workers at the site.

City of Portland permits/regulations - The substantive requirements of local permits and regulations will be complied with including, but not limited to preparation of a grading plan, an erosion plan and traffic plan. The remedial actions at the site will also meet the applicable, substantive requirements of the City Code Chapter 33.430 for Environmental Zones. The City of Portland Office of Planning and Development Review (OPDR)/National Flood Insurance Program regulates structures and property impacts for activities in the flood plain and floodway. OPDR administers the permitting in consultation with the Federal Emergency Management Agency (FEMA). The City would be involved in the evaluation of the floodway encroachment analysis. The Multnomah County Drainage District (MCDD), which is responsible for flood control in flood plains designated by FEMA, would likely consult on any project that impacts water flow and/or water quality in the Whitaker Slough.

5. DESCRIPTION OF REMEDIAL ACTION ALTERNATIVES

This section provides a description of the remedial action alternatives considered for the Nu-Way Oil site. Prior to development of the remedial action alternatives general response actions (GRAs) and remedial technologies were screened. This process is presented in the draft FS. The GRAs included no action, engineering and institutional controls, on- or off-site treatment, excavation and off-site disposal without treatment, and any combination of the preceding actions as appropriate. Several remedial technologies were evaluated for each of the media for each of the GRAs separately. Viable response actions and technologies that can meet the RAOs were assembled into remedial action alternatives. Each set of alternatives includes the no-action alternative, which provides a baseline for comparison to other alternatives. Section 7 evaluates the alternatives individually against the balancing factors.

5.1 REMEDIAL ALTERNATIVE DEVELOPMENT SCREENING

This section discusses the development of remedial alternatives for the site, and supplements the discussion in the draft FS. The presentation in the draft FS has been modified by DEQ to streamline the presentation of alternatives and to consider additional alternatives.

5.1.1 Soil Alternatives Screening

Due to the large volume (approximately 33,500 cubic yards) of soil contaminated with the residual LNAPL in the subsurface soil on the property and the observation that the residual LNAPL does not appear to be mobile, remediation of all the contaminated soils was not considered feasible and was screened out as a potential remedial alternative. With the exception of one alternative that considers removal of only surface soil contamination to risk-based concentrations and includes institutional controls for management of the subsurface LNAPL, remedial alternatives in the FS were limited to treatment of hot spots of contamination and implementation of engineering controls (cap) to address residual subsurface contamination above the RBCs.

EPA has issued a policy for management of remediation wastes in designated areas termed Areas of Contamination (AOC). Pursuant to this policy DEQ is defining the Nu-Way Oil site as a single AOC. The AOC allows DEQ to consolidate and manage soil and sediment for the purpose of development of protective and cost-effective remediation alternatives for the site. Under this approach, a remedial alternative could be developed that involved consolidation of soil excavated from the bank and the sediment from the Whitaker Slough within the AOC and placement in the former lagoon area. The lagoon is located in the uplands portion of the property. Soil human health hot spot concentrations for the uplands area and other applicable criteria were identified as the on-site disposal criteria (i.e., the concentrations below which on-site disposal can occur) since the soils in place on-site below these concentrations do not have to be excavated as long as a cap is placed on the site. Uplands terrestrial ecological hot spots were not selected for the disposal criteria because for alternatives considering on-site disposal, it is assumed that a cap will be placed on the site and that development will occur that will affect the viability of terrestrial habitat at the site.

The upland human health hot spot concentration for surface soil is 8000 mg/kg for lead and 170 mg/kg for arsenic. For PCBs, the Toxic Substance Control Act (TSCA) cleanup level of 50 ppm was specified based on consideration of ARARs rather than the upland hot spot concentration of 140 mg/kg as additional TSCA requirements might be triggered. Concentrations of 50 ppm PCBs and above are regulated as TSCA waste. A TPH risk-based concentration was not established for the upland on-site industrial exposure pathways because TPH fractionation analysis did not show an unacceptable risk for the direct contact pathways. A TPH concentration was not established for migration to groundwater because the residual LNAPL on site does not appear to be mobile. The on-site disposal criterion for TPH was selected using the data presented in Brost and DeVaull (2000) where non-aqueous phase liquid (NAPL) mobility limits in soil are presented for several types of NAPL. For fuel oils in silt to fine sand the concentration presented is 51,429 mg/kg. TPH at concentrations below the mobility limit should be acceptable for disposal on site as they are not expected to mobilize. In addition, the sediments are fine silt and TPH would not be expected to mobilize towards the slough from the sediment that would be placed in the former lagoon area. The TPH on-site disposal criterion was set at 50,000 mg/kg. The on-site disposal criteria for the Nu-Way site are presented in Table 5-1.

5.1.2 Sediment Alternative Screening

The draft FS included evaluation of three sediment alternatives: no action, selective dredging and capping, and dredging. The no action alternative is not protective and does not meet RAOS for sediments. Capping is not feasible in the Whitaker Slough because the cap material would impede flood control and limit future flood control dredging activities. The dredging only alternative is the only feasible alternative that is effective, reliable and cost-reasonable. Dredging is therefore included as a common element to the alternatives for simplicity. The dredging alternative however would not achieve the acceptable risk levels for fish consumption. For sediment the recommended alternative would propose dredging sediment to the Columbia Slough baseline concentration which is not a risk-based concentration but an urban background number. The Nu-Way site would then meet Tier 1 cleanup levels as defined in the Columbia Slough Sediment Record of Decision (DEQ 2005b). It is anticipated that once the primary source is remediated, sediment concentration will decline through natural recovery processes in the sediment. Sediment in this area will continue to be monitored as part of the long-term monitoring plan for the slough that is being implemented by the City of Portland.

5.2 COMMON REMEDIAL COMPONENTS

Some components of the recommended remedial action will be common to all alternatives considered. This includes groundwater monitoring, air pathway evaluation, bank stabilization, building demolition, Whitaker Slough and drainage ditch dredging and disposal and institutional controls. These components are briefly discussed below prior to presentation of the alternatives.

5.2.1 Groundwater Monitoring

Groundwater monitoring is required to address several assumptions. Monitoring groundwater in the recovery trench will help to confirm the assumption that residual LNAPL is not mobile on-site and will not migrate into the Whitaker Slough. Monitoring groundwater on-site for chlorinated volatile organics will help to verify assumptions with respect to general groundwater contamination and to provide data for the exit strategy for any active remedy or institutional control. Monitoring groundwater will help to confirm that dissolved metals concentrations remain at acceptable concentrations to meet the RAOs for the site.

5.2.2 Air Pathway Evaluation

During remedial design, monitoring will be performed to evaluate the risk assessment conclusions regarding the indoor air pathway. Monitoring might include soil gas sampling or additional groundwater monitoring and modeling.

5.2.3 Bank Stabilization

As discussed in Section 2.1, the Nu-Way Oil bank to the slough is very steep and has evidence of slides. There is a significant potential for failure of the bank resulting in soil contamination sliding into Whitaker Slough. A bank failure could also impact the interceptor trench. Each of the remedial alternatives therefore, includes re-contouring the existing bank and capping to prevent soil contamination from entering the slough from the upland area. To stabilize the bank, approximately 2,500 cubic yards of soil would be excavated to permit the contouring of the bank to a slope of 1.5:1 horizontal to vertical. The bank would be capped following installation of a rock toe and sequential placement of approximately 1600 cubic yards clean soil cap in lifts and geogrids. Native vegetation would be planted following cap placement to enhance the riparian habitat and prevent cap erosion. Figure 5-1 presents the conceptual design for bank stabilization. During bank stabilization three to four monitoring wells will have to be abandoned. Table 5-2 presents the cost summary for bank stabilization.

5.2.4 Institutional Controls

Institutional controls will be required for the remedy at the Nu-Way Oil site regardless of which alternative is selected because contamination will remain on site. Elevated levels of TPH in subsurface soil, identified as a residual LNAPL, are present at the Nu-Way site and neighbouring properties (Halton, Geary, Kuhnau, and RCI Sheet Metal) at varying degrees. An easement and equitable servitude (EES) would be implemented for the Nu-Way Oil site and adjacent properties with residual LNAPL or surface soil contamination. The EES will include restrictions on groundwater use, restrictions on excavations within the capped area or where residual LNAPL is present without worker health and safety requirements, and maintenance requirements for the soil cap, where applicable. The owners of the Nu-Way property will grant DEQ an easement to implement the institutional controls of the Record of Decision for the property. Institutional controls on neighbouring properties will be negotiated with the property owners.

5.2.5 Building Demolition

The two buildings on the property will have to be removed during implementation of the remedy regardless of what soil alternative is selected. The materials from the buildings will be analyzed to determine the appropriate disposal location for the materials.

5.2.6 Whitaker Slough/Drainage Ditch Sediment Dredging and Disposal

Each of the alternatives evaluated below would include removal of sediment from Whitaker Slough and from the uplands drainage ditch on the site. The estimated area of the Whitaker Slough sediments that will be dredged is 26,000 square feet in size. The dredging depth would be 1.5 feet below the current sediment surface. Selective dredging to deeper depths would be conducted in five areas (SD-1 to 3 feet, SD10 to 7 feet, SD15 to 4 feet, SD20 to 3 feet and SD21 to 6 feet) that exceed cleanup and hot spot concentrations. These deeper excavations would be allowed to fill through natural sedimentation processes. The total estimated volume of Whitaker Slough sediments is 1,650 cy.

Dredging of sediment would be completed using barge mounted excavators with either a standard bucket or clamshell or an alternative method developed during remedial design (Note: According to the Multnomah County Drainage District [MCDD], the completion depth will be at the ideal channel depth of approximately 5 feet national Geodetic Vertical Datum [NGVD] to allow for proper channel flow and flood control management). Silt fences would be installed during dredging operations to prevent suspended transport outside of the work zone. MCDD will be asked to pump down the slough water elevation as well during the dredging activity.

Dredged Whitaker Slough sediments would be transferred to the upland area of the site for de-watering and characterization for disposal. Excavated sediment will be managed in the same manner as in the recommended soil management alternative. Water recovered from the sediment would be treated and either land applied or discharged to surface water in accordance with discharge limits established by DEQ’s Water Quality Program.

The drainage ditch along the southwest side of the property is contaminated with site contaminants. Capping of the sediment is not an option because the ditch is used for storm water management and the elevation of the ditch bottom can not be raised. This limits the options available for managing the contamination to excavation, removal and backfilling. Sediment will be removed from the bed of the drainage ditch in the vicinity of the entry to the buried stormwater pipe on the west side of the site. The excavation depth will be one foot and the excavation will end approximately 20 feet south of the buried pipe. Sediment excavation from the ditch further south will not be performed because the lead concentrations are all above the risk-based concentration suggesting that there are sources other than Nu-Way Oil for the contamination. Clean sand and gravel would be placed as backfill. Management of the sediment will be consistent with management of soil in the selected remedial alternative. The estimated volume of drainage ditch sediments is 15 cy.

Sediment contamination was found in samples collected in the ditch south of the Nu-Way Oil property boundary. The contamination is not attributable to Nu-Way Oil as the location is upstream of the site and would be considered a background sample. Coordination with property owners and the City of Portland to address upstream contamination and storm water contamination that might recontaminate the drainage ditch and perhaps the Whitaker Slough should be accomplished. However, implementation of the Nu-Way Oil remedy will not be dependent upon successful completion of that coordination.

5.3 REMEDIAL ALTERNATIVES

This section presents four alternatives. Each alternative, except the no action alternative, is intended to meet all the applicable RAOs.

5.3.1 Alternative 1: No Action

This alternative would involve no new remedial actions and would leave all soil contaminants in place. No system maintenance would be associated with this alternative. Neither institutional controls nor site monitoring would be implemented. Long-term human health and environmental risks for the site essentially would be the same as those identified in the baseline RA. This alternative is included to provide a basis of comparison for the remaining alternatives.

5.3.2 Alternative 2: Excavation of Soils above Hot Spot Levels and Sediments above Baseline Levels, Off-Site Disposal, and Institutional/Engineering Controls (Cap)

Alternative 2 would include soil excavation, sediment dredging, off-site disposal of hot spot uplands and bank soils and sediments, bank stabilization, placement of a permeable cap, monitoring, building demolition, and institutional and engineering controls.

The following estimated volumes of soils would be excavated, profiled, and transported off-site for treatment and/or disposal: 130 cy of uplands hot spot soils, 20 cy of off-site soil above residential and industrial risk-based concentrations, and 640 cy of bank soils above the bank hot spot concentrations. None of the bank soils exceed uplands hot spot levels so once they are moved from the bank they are no longer considered hot spots. However, in this alternative they are disposed of off-site. The 130 cubic yards of soil at concentrations above the uplands hot spot concentrations would be treated through solidification and/or stabilization prior to disposal in a Subtitle C landfill. The remaining 660 cubic yards of soil would be disposed in a Subtitle D landfill without treatment (as long as the requirements of the landfill operator are met).

The following estimated volumes of sediment will be dredged, as described in Section 5.2.6, profiled, and transported off-site for treatment and/or disposal: 1,650 cy of Whitaker Slough sediment exceeding Columbia Slough baseline levels, 40 cy of Whitaker Slough sediment exceeding the on-site disposal criteria, and 15 cy of drainage ditch sediment. The sediments will be dewatered on-site. The water will be treated, as necessary to permit either land application or discharge to surface water. The 1,610 cy of contaminated, dewatered sediment and 15 cy of drainage ditch sediment will be disposed of off-site in a Subtitle D facility without treatment. The 40 cy will be treated, if required by the land disposal restrictions, prior to off-site disposal.

For bank stabilization, an additional 1860 cy of soil would be excavated from the bank to re-engineer a stable bank for capping. Since these soils are assumed to be contaminated below the on-site disposal criteria they would be disposed of on-site in the former lagoon area. They will not be sampled unless visual contamination is observed. If visual contamination is observed, the soils will be sampled and analyzed to ensure that the soils are at concentrations below the on-site disposal criteria. The gravel in the former lagoon would be removed to permit on-site disposal. Excavated upland areas would be backfilled with clean gravel excavated from the former lagoon. Approximately 1600 cubic yards of clean soil would be placed in the bank for re-engineering the slope.

In addition to the above, a two foot permeable soil cap would be placed over the entire uplands area except for the area that has already been capped with asphalt in the southeastern corner. Groundwater and air monitoring will be performed. The two buildings will be demolished and institutional controls will be implemented.

The estimated cost for this alternative is $1,349,000 (Table 5-3).

5.3.3 Alternative 3: Excavation of Soils above Hot Spot Levels and Sediments above Baseline Levels, On-Site Disposal, and Institutional/Engineering Controls (Cap)

Alternative 3 would include the same components as Alternative 2 except that the only soils and sediment that would be transported off-site would be the estimated 130 cy of soils and 40 cy of sediment at concentrations above the on-site disposal criteria. All the remaining Whitaker Slough sediments, the drainage ditch sediments, the off-site risk-based concentrations sediment and all the bank soils would be disposed on-site in the former lagoon excavation area.

The estimated cost of Alternative 3 is $1,128,000. (See Table 5-5)

5.3.4 Alternative 4: Excavation of Soils above the Target Cleanup Levels and Sediments above the Baseline Level, Off-Site Disposal, and Institutional/Engineering Controls (No Cap)

Alternative 4 includes the following components: excavation of all on-site and off-site surface soils above the uplands and bank soil target cleanup levels, subsurface soils above the lead and PCB target cleanup levels, dredging of the Whitaker Slough and drainage ditch sediments, bank stabilization, off-site disposal and treatment if required by the land disposal restrictions of all excavated soils and sediments including the additional soils excavated for bank stabilization, groundwater monitoring, air pathway evaluation, building demolition, and institutional controls. The site would not be capped but would be graded in preparation for use. Institutional controls would be required to eliminate exposure to the subsurface residual LNAPL soils. The site would be backfilled with clean soil, compacted and graded.

The estimated cost of Alternative 4 is $1,598,000 (Table 5-6).

6. CRITERIA FOR EVALUATION OF ALTERNATIVES

The evaluation of remedial action alternatives includes the following three criteria:

- The protectiveness of the alternative based upon the standards of OAR 340 340-122-0040;
- The feasibility of the alternatives based upon the balancing factors set forth in OAR 340-122-0090(3).
- Remediation of hot spots of contamination to the extent feasible based upon the criteria set forth in OAR 340-122-0090(4)

These three criteria are described below.

6.1 PROTECTIVENESS

The protectiveness of the remedial action alternatives is evaluated relative to the site-specific RAOs defined in Section 4.2. A remedial action alternative may achieve protection through treatment; excavation and off-site disposal; engineering controls; institutional controls; other protective methods; or a combination of these.

6.2 BALANCING FACTORS

The balancing factors considered include effectiveness, long-term reliability, implementability, implementation risk, and reasonableness of cost. These are described in further detail below.

6.2.1 Effectiveness

Each remedial action alternative is assessed for its effectiveness in achieving protection, by considering the following criteria, as appropriate:

- Magnitude of risk from untreated waste or treatment residuals remaining at the facility absent any risk reduction achieved through on-site management of exposure pathways. The characteristics of the residuals are considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, propensity to bioaccumulate, and propensity to degrade;
- Adequacy of any engineering and institutional controls necessary to manage the risk from treatment residuals and untreated hazardous substances remaining at the facility;
- For hot spots in water, the extent to which the remedial action restores or protects existing and reasonably likely future beneficial uses of water;
- Adequacy of treatment technologies in meeting treatment objectives; and
- Time until the remedial action objectives would be achieved.

6.2.2 Long Term Reliability

Each remedial action alternative is assessed for its long-term reliability, by considering the following criteria, as appropriate:

- Reliability of treatment technologies in meeting treatment objectives;
- Reliability of engineering and institutional controls necessary to manage the risk from treatment residuals and untreated hazardous substances, taking into consideration the characteristics of the hazardous substances to be managed and the effectiveness and enforceability over time of engineering and institutional controls in preventing migration of contaminants and in managing risks associated with potential exposure; and
- Nature, degree, and certainties or uncertainties of any necessary long-term management (e.g., operation, maintenance, and monitoring).

6.2.3 Implementability

Each remedial action alternative is assessed for the ease or difficulty of implementing the remedial action, by considering the following criteria, as appropriate:

- Practical, technical, and legal difficulties and unknowns associated with the construction and implementation of a technology, engineering control, or institutional control, including potential scheduling delays;
- The ability to monitor the effectiveness of the remedy;
- Consistency with federal, state and local requirements; activities needed to coordinate with other agencies; and the ability and time required to obtain any necessary authorization from other governmental bodies; and
- Availability of necessary services, materials, equipment, and specialists, including the availability of adequate off-site treatment, storage, and disposal capacity and services, and availability of prospective technologies.

6.2.4 Implementation Risk

Each remedial action alternative is assessed for the risk from implementing the remedial action, by considering the following, as appropriate:

- Potential impacts on the community during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures;
- Potential impacts on workers during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures;
- Potential impacts on the environment during implementation of the remedial action and the effectiveness and reliability of protective or mitigative measures; and
- Time until the remedial action is complete.

6.2.5 Reasonable Cost

Each remedial action alternative is assessed for the reasonableness of cost of the remedial action, by considering the following, as appropriate:

- Cost of the remedial action, including: direct and indirect capital costs; annual operation and maintenance costs; costs of any periodic review requirements; and net present value of all of the above;
- Degree to which the costs of the remedial action are proportionate to the benefits to human health and the environment created through risk reduction or risk management;
- With respect to hot spots of contamination in water, the degree to which the costs of the remedial action are proportionate to the benefits created through restoration or protection of existing and reasonably likely future beneficial uses of water; and
- The degree of sensitivity and uncertainty of the costs.

6.3 REMEDIATION OF HOT SPOTS

The evaluation of remedial action alternatives, with respect to the remediation of hot spots of contamination in media other than water, considers the treatment or excavation and off-site disposal at an authorized disposal facility or the combination of treatment or excavation, to the extent such measures are feasible based on the criteria in OAR 340-122-0085(7), and the balancing factors set forth in OAR 340-122-0090(3) and previously described. For hot spots of contamination in water, the evaluation of feasibility of treatment is based on criteria in OAR 340-122-0085(5) and the balancing factors set forth in OAR 340-122-0090(3) and described above.

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7. EVALUATION OF REMEDIAL ACTION ALTERNATIVES

This section evaluates the remedial action alternatives developed in Section 5 consistent with the requirements of OAR 340-122-085(4). In Sections 7.1 through 7.3 each alternative is evaluated: for achieving protectiveness, against the balancing factors, and for treatment of hot spot contamination, respectively. In Section 7.4 the alternatives are compared to each other. The results of the individual and comparative evaluations provide the basis for the recommended remedial action alternative described in Section 8. Note: DEQ has reconfigured the alternatives, deleted alternatives, and added alternatives from the presentation in the draft FS Report in order to simplify the presentation, consider on-site disposal, and present complete alternatives.

7.1 EVALUATION OF ACHIEVING PROTECTIVENESS

Alternative 1, no action, would not achieve protectiveness as the identified risks at the site would not be addressed. Alternatives 2 and 3 would achieve protectiveness for soil and groundwater as long as the cap is maintained properly. Alternative 4 would achieve protectiveness if the institutional controls addressing the subsurface residual LNAPL contamination are effective. None of the alternatives achieves protectiveness for sediment for the reasons discussed in Section 5.1.2. However, the sediment RAOs are met by Alternatives 2 through 4. Alternative 4 may not be protective of ecological receptors if development does not occur and habitat develops.

7.2 EVALUATION OF BALANCING FACTORS

This section evaluates the four alternatives against the five balancing factors: effectiveness, long-term reliability, implementability, implementation risk, and reasonableness of cost. Although none of the alternatives achieves protectiveness for sediment for the reasons discussed in Section 5.1.2, the alternatives do meet the RAOs. Since sediment is managed the same way in all the alternatives the balancing factors for the sediment component are briefly discussed here rather than in the discussion of each alternative. The recommended approach to sediment will be effective in meeting the sediment RAOs since by dredging the sediment the baseline levels will be met. The approach is implementable as dredging equipment is readily available. However, dredging the Whitaker Slough at the location might be complicated by the steep banks on both sides of the slough. The remedy has long term reliability because the sediments above the baseline levels will be removed from the slough and it is cost-effective. There is implementation risk related to the dredging of sediments. However, dredging will be controlled using silt fences and other technologies to minimize resuspension and migration downstream of sediments.

7.2.1 Alternative 1: No Action

Although the alternative is implementable, does not result in implementation risk and has no cost, it is not effective or reliable as the RAOs are not met.

7.2.2 Alternative 2: Excavation of Soils above Hot Spot Levels and Sediments above Baseline Levels, Off-Site Treatment, Off-Site Disposal, and Institutional/Engineering Controls (Cap)

Effectiveness

After excavation, the contaminated hot spot soils would be removed from the site and transported to a permitted hazardous waste treatment and disposal facility. Off-site soils at concentrations above industrial and residential risk-based concentrations would also be excavated and disposed off-site. Therefore, the risk associated with hot spot contamination and off-site contamination identified in the baseline risk assessment would be reduced to acceptable levels. Residual contamination above risk-based cleanup levels would be present on-site, but institutional/engineering controls, including the cap, would adequately manage the residual risks. Therefore, this alternative would be effective in meeting the RAOs and achieving protection of human health and the environment in soil and groundwater.

Long-Term Reliability

This alternative would remove the contaminated hot spot soil from the site, and residual risk would be managed adequately upon completion. Therefore, this alternative would achieve the RAOs and have long-term reliability as long as the cap and institution controls are maintained.

Implementability

Excavation equipment, dredging equipment, labor, and trucks are readily available to implement this alternative. Materials such as clean backfill are also typically readily available. Treatment/disposal facilities are limited but available. Therefore, this alternative is implementable.

Implementation Risk

Implementation risks for this alternative include risks associated with gravel excavation from the former lagoon area, contaminated soil excavation, dredging sediments, and transport of soil and sediment to the off-site disposal location. This alternative would generate contaminated dust during excavation. Dust suppression controls, such as applying water, are easily implementable and would greatly reduce the potential for fugitive dust. In addition, using PPE and following health and safety procedures (e.g., decontamination procedures) are standard operating practices for workers involved in construction activities at hazardous waste sites. Management of the steep bank represents a challenge for implementation of the bank stabilization task. This alternative has moderate implementation risk.

Reasonableness of Cost

This alternative would cost $1,349,000 to implement. This cost includes excavation, transportation, off-site treatment and/or disposal, backfilling, capping, and implementation of institutional controls. This cost is reasonable considering it is lower than Alternative 4 but higher than Alternative 3.

7.2.3 Alternative 3: Excavation of Soils above Hot Spot Levels and Sediment above Baseline Levels, On-Site Disposal, and Institutional and Engineering Controls (Cap)

Effectiveness

This alternative would remove all soil and sediment above the on-site disposal criteria from the site and would manage the remaining soil and sediment under a cap. The alternative is considered effective in achieving protectiveness for soil because exposure to the on-site contaminants will be eliminated with the cap. The concentrations in the soil that will be placed in the former lagoon will be below the on-site disposal criteria. Those concentrations can remain on-site and do not have to be removed or actively treated as long as a cap is present. The protectiveness will depend on maintenance of the cap over time.

Long-Term Reliability
This alternative is reliable because all contamination above the on-site disposal criteria, including upland hot spots will be transported off site. The remaining contaminated soil will be placed on-site without treatment. Placement of a cap over the fill area is reliable in preventing exposure to hazardous substances. The soil that will be placed in the lagoon area will primarily be the bank soils which contain contaminant concentrations below the uplands soil hot spot concentrations. The sediments are also at lower concentrations and can be managed on-site. The contamination will be covered with a cap to eliminate direct exposure. The existing contamination on-site has been present on the property for many years. It is expected that at these concentrations additional impacts to groundwater are unlikely. Monitoring will be used to confirm that conclusion. In addition, if the assumption is incorrect the interceptor trench is in place to capture LNAPL that might be mobilized. This alternative would achieve the RAOs and have long-term reliability as long as the cap and institutional controls are maintained.

Implementability
This alternative is implementable for the same reasons as Alternative 2.

Implementation Risk
This alternative includes the same implementation risks as identified for Alternative 2 except that the transportation risks are higher due to the higher volume of soil that will be transported off-site.

Reasonableness of Cost

The estimated cost of this alternative is $1,128,000. This alternative is less costly than the other alternatives simply because only a small percentage of the soil that must be managed will be transported, treated, as required by land disposal restrictions, and disposed of off-site.

7.2.4 Alternative 4: Excavation of Soils above Target Cleanup Levels and Sediments above Baseline Levels, Off-Site Disposal of All Excavated Soil, and Institutional/Engineering Controls (No Cap)

Effectiveness
This alternative would remove soil contamination above risk-based cleanup levels and hot spot levels, and along with institutional controls for control of exposure to subsurface contaminated subsurface soils would be effective in meeting the RAOs.

Long-Term Reliability
This alternative would achieve the RAOs and have long-term reliability because there would be no unacceptable residual risk to manage except for subsurface soil in the residual LNAPL zone. Residual LNAPL contamination in subsurface soils would remain but could be easily managed with institutional/engineering controls.

Implementability
This alternative is implementable for the same reasons as Alternative 2.

Implementation Risk
This alternative has moderate implementation risk for the same reasons as Alternatives 2 and 3 although the risk would be higher in Alternative 4 because the volume of soil managed and transported off-site will

be significantly higher.

Reasonableness of Cost
The cost estimate for implementation of Alternative 4 is $1,598,000. This cost includes excavation, transportation, off-site treatment and disposal, backfilling, and implementation of institutional/ engineering controls (excluding cap placement). These costs are high but may be reasonable considering the increased effectiveness and long-term reliability of this alternative. These costs are more uncertain than those of the other alternatives. Confirmation sampling throughout the site would be required to verify that contamination above the cleanup levels has been removed. Additional soil removal beyond that estimated in the FS is possible.

7.3 HOT SPOT ANALYSIS

Alternative 1 would not remediate hot spots of contamination. Alternatives 2 through 4 do treat hot spots through stabilization and solidification or off-site disposal. Alternative 4 treats hot spots for soil at concentrations above the upland soil hot spot concentrations through stabilization and solidification and/or off-site disposal. However, soil bank hot spots and sediment hot spots are not treated or disposed off-site. The hot spot concentration for bank soil is significantly lower than that for the upland soils because different receptors are being protected. The bank soils can erode into the slough and cause adverse effects to ecological receptors in the Slough and humans through fish consumption. Once the bank soil is placed up onto the uplands area and erosion is no longer an issue, the hot spot concentration for upland soils will apply and these soils can be placed on the site in the AOC.

7.4 COMPARATIVE ANALYSIS OF REMEDIAL ACTION ALTERNATIVES

This section compares the remedial action alternatives with respect to the remedy selection criteria described in Section 6.

7.4.1 Protectiveness

Alternative 1 is the only alternative that is not protective. Alternatives 2 through 4 would all be protective for soil and groundwater if implemented and monitored as proposed. A description of the protectiveness for the sediment component of the recommended remedy is presented in Section 5.1.2.

7.4.2 Effectiveness

Alternative 1 would not be effective in achieving protection because no action would be taken to reduce or manage risks. Alternative 4 would be the most effective, because there would be no surface soil contamination above target cleanup levels remaining on site. Alternative 2 would be the next most effective because less soil would be taken off site than with Alternative 4 but more than Alternative 3. All of the alternatives address the residual LNAPL contamination in the subsurface soils through institutional controls. The contamination does not appear to be mobile. As long as this assumption is correct and the institutional controls are in placed and implemented, all the alternatives are effective in addressing the residual LNAPL.

7.4.3 Long-Term Reliability

Alternative 1 would not be reliable because no action would be taken to reduce risks. Alternative 4 has the greatest long-term reliability because there would be no site cap to maintain, thereby reducing the amount of long-term management. Alternatives 2 and 3 would be somewhat less reliable because these alternatives would rely on a cap to manage remaining site contamination above the cleanup levels. The need for long-term management would be greater for Alternatives 2 and 3 than for Alternative 4.

7.4.4 Implementability

Alternative 1 would be the most implementable because no action would be required. Alternative 3 is rated second in implementability because off-site transport and disposal is limited. Alternative 2 is rated third because, even though the volume of soil and sediment managed is the same as Alternative 3 more is transported off-site. Alternative 4 would be the least implementable because it would require more excavation, more extensive confirmation sampling to ensure that the site could be released for unrestricted use, and more soil and sediment transported off-site.

7.4.5 Implementation Risk

Alternative 1 would involve no action and therefore there would be no implementation risk. Alternative 3 is rated second, having the least implementation risk of the remaining alternatives, because only a small percentage of the total volume of soil would have to be transported off-site, resulting in reduced risks associated with transportation to off-site disposal facilities. Alternative 2 is rated third because more soil is transported off site than Alternative 3 but less than Alternative 4. Alternative 4 is rated fourth with the highest implementation risk because it would include excavation, transport, and treatment of a large volume of soil.

7.4.6 Reasonableness of Cost

Alternative 3 at the estimated cost of $1,128,000 would be the lowest-cost alternative that would achieve the RAOs. Alternative 2 would be next at the estimated cost of $1,349,000. Alternative 4 would be the most expensive alternative, estimated to cost $1,598,000 to implement. Alternative 1 would not cost anything but would not be protective or achieve the RAOs.

7.4.7 Remediation of Hot Spots

Alternative 1 does not remediate hot spots. Alternatives 2 through 4 include remediation of hot spots including off-site treatment through solidification and/or stabilization and off-site disposal or off-site disposal without treatment. Alternatives 2 and 4 include off-site disposal or treatment of all hot spots. Alternative 3 requires treatment and/or off-site disposal of all hot spots except for the sediment and bank soil hot spots. All bank soils and sediment below the on-site disposal criteria, regardless of whether they are identified as hot spots prior to excavation, will not be hot spots once placed upland on the property.

7.5 SOIL ALTERNATIVES CONCLUSIONS/RECOMMENDED SITE REMEDY

Based on the results of the comparative analysis of the alternatives in Section 7.4, DEQ has selected Alternative 3 as the recommended alternative for the site. This alternative meets RAOs. The alternative has the least implementation risk and is the most implementable alternative for the alternatives that meet the RAOs. In addition, the cost estimate for this alternative is more than $200,000 less than the cost estimate for the next lowest alternative (Alternative 2). This alternative will be effective in meeting the RAOs for the site. Exposure to the residual LNAPL will be controlled through an institutional control addressing worker protection during excavation and trenching work. Hot spots of soil contamination will be treated (except for the bank soil and sediment hot spots). The bank soil hot spot levels and sediment hot spots levels are significantly lower than the uplands hot spot soils levels because the bank soil and sediment hot spot levels address risks associated with the slough sediment. Bank soil data or sediment data do not show exceedances of the uplands hot spot soil concentrations. Removal and treatment of the bank soils at hot spot concentrations, which are at concentrations below the upland hot spot levels, is not cost effective considering that remediation of (treatment and/or disposal of) all the hot spot soils would cost an estimated additional $218,000. In addition, the soils will be placed in the former lagoon area and capped. Available site data and observations on the site suggest that it would be very unlikely for the contamination in the soils to migrate to the Slough in the future, although monitoring will be performed to determine whether that conclusion is correct. The alternative is the most cost effective alternative meeting all the RAOs.

Section 8 provides a detailed description of the remedy.

8. RECOMMENDED REMEDIAL ACTION

On the basis of the detailed evaluation of the alternatives summarized in Section 7, the recommended remedial action is Alternative 3 which provides the best balance of protectiveness, effectiveness, implementability, long-term reliability, short-term risk and reasonableness of cost. The estimated present worth cost over 30 years for the recommended remedial action is $1,128,000 (Table 5-5).

The Nu-Way Oil Site is being managed under the Department of Environmental Quality's Orphan Site Program. The remedy selected by DEQ for the site, or portions of the remedy for the site, will be implemented either by DEQ or by other parties, such as future property owners. The recommended remedy for the site may be implemented in phases depending on the availability of funds from the Orphan Program and depending on whether parties other than DEQ are involved with implementation. One potential approach to phasing the project is to complete the soil and sediment excavation and disposal and the bank stabilization as the first phase and delay placement of the cap until property development or sale.

8.1 DESCRIPTION OF THE RECOMMENDED REMEDIAL ACTION

The components of the recommended remedial action for the Nu-Way Oil site are presented in the sections below.

8.1.1 Definition of an Area of Contamination

An area of contamination (AOC), defined in Figure 8-1, includes the entire site and portions of adjacent properties impacted by Nu-Way activities. Consolidation of contaminated soil and sediment from their existing locations to the former lagoon area will take place within the AOC without triggering hazardous waste management requirements or other regulations. Although the boundary of the AOC extends onto the adjacent properties to permit consolidation of soils from those properties into a common area, disposal within the AOC will only occur on Nu-Way Oil property currently owned by Mr. Geary and not on the adjacent properties.

8.1.2 Soil Excavation

Site vegetation will be removed as necessary from the uplands area, the drainage ditch, and the bank and the two buildings on the property will be demolished. Gravel in the former lagoon area will be removed from the pit and stockpiled on site for use later as part of the soil cap. The removal will limit excavation within the Conservation Zone as much as possible. Figure 8-2 shows the on-site disposal area and the location of the Conservation Zone. Approximately 130 cy of uplands hot spot soils, 840 cy of bank soils, and 20 cy of off-site soil above the industrial and residential target cleanup levels will be excavated using standard, earth-moving equipment and consolidated on the Nu-Way property in stockpiles segregated by concentration levels to the extent possible. Approximately 130 cy of soil at concentrations above the on-site disposal criteria will be profiled, transported off-site, treated to meet landfill disposal requirements as required, and disposed off-site in a Subtitle C landfill, as appropriate. Remaining excavated soils will be placed in the former lagoon excavation area. The upland area will be graded and compacted in preparation for the cap.

8.1.3 Whitaker Slough and Drainage Ditch Sediment Excavation

Approximately 1650 cy of contaminated sediment will be excavated from the slough under an Army Corps of Engineers 404 permit and 401 certification using barge mounted excavators with either a standard bucket or clamshell or using an equivalent approach identified during remedial design by dredging contractors. Sediment in the impacted area will be removed down to the 5 feet National Geodetic Vertical Datum, which is approximately 1.5 feet of sediment. In addition, in five areas identified during the remedial investigation additional sediment impacted above the Columbia Slough Baseline concentrations will be removed. These additional excavated areas will be filled in using natural sloughing of surrounding sediment. Excavated sediment will be dewatered and treated on-site to permit discharge to the Nu-Way property or discharge to the Whitaker Slough. Sediment will be profiled and sediment at concentrations above the on-site disposal criteria will be transported off-site, treated through solidification and/or stabilization to meet landfill disposal requirements, and disposed of off-site. The remaining sediment at concentrations below the on-site disposal criteria will be placed in the former lagoon area. Confirmation sampling will be performed in the slough following dredging.

Approximately 15 cubic yards of sediment from the drainage ditch along the southwest side of the Nu-Way Oil property will be removed using standard earth-moving equipment to a depth of approximately one foot around the entry point to the storm water pipe and upstream approximately 20 feet. The ditch will be backfilled with clean sand and rock. The excavated sediment will be placed in the former lagoon excavation area without further characterization.

8.1.4 Bank Stabilization and Capping

Prior to initiation of bank stabilization monitoring wells that are in the area of soil removal for the stabilization activities will be decommissioned. Approximately 1860 cy of additional bank soil beyond that described in Section 8.1.2 will be removed from the bank under the same permit described in Section 8.1.3. The bank will be recontoured to a slope of 1.5:1 horizontal to vertical. The additional soil removed for bank stabilization will be placed in the former lagoon area. Clean soil will be imported to the bank to implement the bank stabilization design. The clean soil provides a cap on the bank. During stabilization a rock toe will be constructed and the bank will be reinforced with geogrids. Following bank stabilization the riparian area will be replanted with native vegetation.

8.1.5 Uplands Capping

The soils and sediments placed in the former lagoon area will be capped initially with the gravel that was removed from the former lagoon area followed by imported clean soil to construct a two foot permeable cap on the site. Alternate approaches to capping can be implemented, such as paving and placement of buildings on site.

The cap would be constructed of two feet of clean soil placed and compacted in 6-inch lifts. The entire Nu-Way site would be capped. However, approximately 13,870 square feet of property in the southeast corner of the site has already been capped with asphalt. The estimate for soil volume for the cap therefore does not include that area. Installation of the cap will require importing approximately 8,875 tons of gravel, which will be graded and compacted over an area of approximately 11,578 square yards. An additional 15% of material would be imported to the site to allow for cap shrinkage during compaction. Figure 8-3 shows the extent of the cap.

Phasing of implementation of the remedial action may occur resulting in a delay of placement of the permanent cap. If the permanent cap is not placed on the property within one year following completion of the soil and sediment management actions the area in the Conservation Zone will be temporarily stabilized using a one foot cap which will be hydroseeded.

Capping can be delayed to accommodate potential development plans. However, if the cap is not completed within five years of construction completion for the remainder of the remedy, DEQ will consider construction of the cap independent of development.

8.1.6 Air Pathway Evaluation

During remedial design, additional sampling will be performed for the indoor air pathway to reevaluate the conclusions of the risk assessment. If the sampling confirms that further remedial action is required to address this exposure pathway, a contingency remedy will be selected to address the pathway.

8.1.7 Groundwater Monitoring

Groundwater monitoring will be performed to verify assumptions regarding groundwater contamination. It is anticipated that groundwater samples will be collected from on-site monitoring wells on an annual basis following completion of the soil and sediment actions at the site. Wells will be monitored for total and dissolved lead and chlorinated volatile organics. Groundwater monitoring will continue for at least a period of five years. The monitoring requirements and schedule will be reevaluated no later than the first five year review. The monitoring will also provide data to review the indoor air pathway and the assumptions regarding mobility of the residual LNAPL. A performance and compliance monitoring plan will be developed for the groundwater monitoring program. The plan will include details, including the schedule, of the monitoring required for the site. The monitoring plan identify and describe methods for data analysis to evaluate trends in groundwater quality after implementation of the remedy, trends in LNAPL migration into the interceptor trench, and trends in concentrations of volatile organic compounds in groundwater that potentially impact indoor air and trench and excavation workers. Groundwater data evaluation will be used to confirm the following: assumptions regarding groundwater contamination, effectiveness of the remedial action, and protection of beneficial uses of groundwater and surface water.

8.1.8 Institutional Controls

An Easement and Equitable Servitude (EES) will be prepared for the Nu-Way Oil site including, but not limited to, the following:

- Restrictions on groundwater use;

- Requirements to follow an institutional and engineering control plan for the site, including maintenance procedures for the uplands cap and the interceptor trench;
- Requirements for protection of workers potentially exposed to site contaminants; and,
- Review of groundwater use within the locality of the facility periodically as long as the site restrictions apply.

An institutional and engineering control plan will be prepared for the site and will include, but not be limited to, inspection, maintenance, and reporting procedures. The owners of the Nu-Way property will grant DEQ an easement to implement the institutional controls of the Record of Decision. An EES may also be required for the adjacent properties and will be negotiated with the property owners.

8.1.9 Waste Management Plan

A waste management plan will be developed for the property to address any soil or groundwater impacted or potentially impacted by site contamination. Following completion of the remedy COCs will remain in soils on the property under the cap. Whenever the cap is breached any soils generated from below the cap must be managed according to the Waste Management Plan. Any soil generated during on-site activities such as redevelopment should be profiled to determine the appropriate management and disposal of soils, which may include placement under the cap, if feasible.

8.1.10 Periodic Reviews

DEQ will conduct periodic reviews on an annual basis for the first five years of remedy implementation to ensure that the remedial action remains protective for present and future public health, safety, and welfare, and the environment. Subsequent periodic reviews will be performed at least every five years. Periodic reviews will include the evaluation of site monitoring data, progress reports, inspection and maintenance reports, land and beneficial water uses for the site and site vicinity, compliance with institutional controls, and any other relevant information. Monitoring data will be evaluated on an annual basis to confirm that the established RAOs for the site are being attained and that the monitoring program is adequate. DEQ may implement contingency measures in the event that the monitoring data or other information suggests that the remedy will not successfully address the RAOs in a timely fashion.

8.1.11 Contingency Measures

The following contingency measures will be implemented as necessary:

- In the draft FS a vapor barrier consisting of impermeable plastic sheeting for crawlspaces and a concrete floor sealant for buildings with slab on grade foundations were identified as the recommended alternative for the air pathway, if a remedy was required. If results of the additional monitoring indicate unacceptable risk this contingency will be implemented. Other engineering controls to mitigate unacceptable risk may be evaluated and proposed during remedial design. If a vapor barrier or other engineering controls are installed they will be monitored to ensure their integrity.

- If recovery well monitoring shows significant accumulation of LNAPL, then LNAPL recovery from the interceptor trench will be initiated.

- If groundwater monitoring indicates that groundwater discharge to the Whitaker Slough is above the ambient water quality criteria, a review of options to address the non-compliance will be performed and a contingency implemented, as necessary.

8.2 SATISFACTION OF PROTECTION AND FEASIBILITY REQUIREMENTS

8.2.1 Protectiveness

The recommended remedial action for soil and groundwater is protective of human health and the environment. The acceptable risk levels for human health prescribed by the Oregon Environmental Cleanup Statute and implementing rules are $1x10^{-6}$ excess lifetime cancer risk for individual carcinogens, $1x10^{-5}$ for cumulative carcinogens, and a hazard index of one for non-carcinogens. The recommended remedy manages soil and groundwater contamination such that the residual risk is below the $1x10^{-6}$. Soil above risk-based concentrations are either transported off site or disposed of on site under a cap so that direct exposure is eliminated. Institutional controls are part of the remedy and include requirements for maintenance of the soil cap, restriction of groundwater use, and protection of trench and excavation workers. The recommended remedy also includes monitoring of the recovery wells in the interceptor trench and groundwater wells to evaluate impacts of the remedy and conclusions regarding groundwater contamination. In addition, engineering controls to limit potential current and future exposure to COCs in indoor air are included as a contingency.

The recommended remedial action for sediment results in residual concentrations in sediment in the area dredged below the ambient concentrations in the Columbia Slough but not necessarily below the risk-based concentrations. Further reduction to levels to achieve a $1x10^{-6}$ excess lifetime cancer risk for individual carcinogens and a hazard index of one for non-carcinogens is not feasible due to the wide spread contamination in the Slough exceeding these levels. The Nu-Way Oil site will be classified as a Tier 1 site in the Columbia Slough watershed, a classification system established in Section 5.1.1 of the Columbia Slough Sediment Record of Decision (DEQ 2005b). At Tier 1 sites the sediment is removed to meet the baseline numbers, not the risk-based concentrations. The risk posed by baseline concentrations of contaminants is expected to decline over time as a result of additional source control measures, sediment cleanup actions conducted by other private parties, and natural recovery mechanisms in the aquatic environment. The effectiveness of these measures in ultimately achieving risk-based concentrations in the sediment will be evaluated as part of the City of Portland's long-term monitoring plan for the Slough.

8.2.2 Balancing Factors

Remedial actions recommended by DEQ are based on a balance of effectiveness, implementability, long-term reliability, short term risk, and reasonableness of cost. As discussed in Section 7.0 the recommended soil alternative provides the best balance of these criteria.

8.2.3 Remediation of Hot Spots

The recommended alternative includes treatment or removal, to the extent practicable, of soils and sediments above the uplands soil hot spot concentrations.

8.2.4 Land Use and Beneficial Water Use

DEQ has evaluated current and reasonably anticipated future land uses at the site and surrounding properties when selecting the recommended remedial action. DEQ also considered present and potential future land uses at the facility in determining risk-based cleanup levels for the site. All the properties affected by the Nu-Way Oil contamination, including the Halton Company property, the RCI property, and the Geary Property are zoned industrial. Industrial use is considered a reasonably likely future use. The Ellett property is currently residential however. Although the property is zoned industrial and is located within the industrial sanctuary, it will remain residential as long as the current owner wants to use the property for residential property.

APPENDIX A

ADMINISTRATIVE RECORD INDEX
Staff Report
Nu-Way Oil Site
Portland, Oregon

The Administrative Record consists of the documents on which the recommended remedial action for the site is based. The primary documents used in evaluating remedial action alternatives for the Nu-Way Oil site are listed below. Additional background and supporting information can be found in the Nu-Way Oil project file located at DEQ Northwest Region Office, 2020 S.W. 4th Avenue, Portland, Oregon.

Site- Specific Documents in Chronological Order

USEPA, 1986. Final Report NuWay Oil Company, Portland, Oregon, U.S. EPA Remedial Planning/Field Investigation Team (REM/FIT) Zone II.

USEPA, 1988. Technical Assistance Team, Site Assessment Final Report for: NuWay Oil Company, Portland, Oregon.

Parametrix, 1993. Nu-Way Oil Remedial Investigation/Removal Assessment.

DEQ, 1994. Memorandum from Ken Cameron to Bill Dana describing soil sampling.

E&E, 1995c. Interim Removal Action Measure Report.

E&E, 1995a. Final Interim Removal Action Measure Report, Whitaker Slough.

E&E, 1996. Supplemental Lagoon Investigation Report.

E&E, 1997. Removal Action Summary Report.

E&E, 1998b. Baseline Risk Assessment, Nu-Way Oil Company, Portland, Oregon.

E&E,1999a. Baseline Risk Assessment Addendum, Nu-Way Oil Company, Portland, Oregon.

E&E, 1999b. Supplemental Remedial Investigation Push Probe Drilling and Sampling Results at the Nu-Way Oil Site.

E&E, 1999c. Supplemental Remedial Investigation, Oil Reprocessing Area Investigation Report.

E&E 2000a. Data Report for Whitaker Slough Bank Sampling.

E&E 2000b. Feasibility Study Data Gap Investigation Report.

DEQ, 2001a. Draft Internal Memorandum from Debbie Bailey to Nu-Way Oil File on October 17 and 18 Push-Probe Investigation.

E&E, 2003a. Final Soil and Groundwater Report.

E&E, 2003b. Final Storm Drain System Evaluation and Sampling Report.

E&E, 2004a. Final Baseline Risk Assessment, Nu-Way Oil Site, Portland, Oregon.

E&E 2004b. Draft Feasibility Study, Nu-Way Oil Site, Portland, Oregon.

DEQ, 2005a. Summary of the Risk Assessment and Derivation of Cleanup Levels Technical Memorandum.

E&E, 2005. Technical Memorandum, Volumes Calculations for the Recommended Remedy.

State of Oregon Laws and Regulations

Oregon's Environmental Cleanup Laws, Oregon Revised Statutes 465.200-.900, as amended by the Oregon Legislature in 1995.

Oregon's Hazardous Waste Rules, Chapter 340, Divisions 100 - 120.

Oregon's Water Quality Criteria, Chapter 340, Division 41, Willamette Basin Basin.

Oregon's Groundwater Protection Act, Oregon Revised Statutes, Chapter 468B.

Guidance and Technical Information

Brost, Edward J. and DeVaull, George E., 2000. *Non-Aqueous Phase Liquid (NAPL) Mobility Limits in Soil*, Soil and Groundwater Research Bulletin, American Petroleum Institute, June.

DEQ, 2005b. Columbia Slough Sediment Record of Decision.

DEQ, 2003. Risk-Based Decision Making for Remediation of Petroleum Contaminated Sites.

DEQ, 2002a. Columbia Slough – Baseline Concentrations, documentation of Methodology. November.

DEQ, 2002b. Default Background Concentrations for Metals. Memorandum from the Toxicology Work Group to the Cleanup Project Managers. October.

DEQ, 2001a. Cleanup Program Quality Assurance Policy. September 1990, updated April.

DEQ, 2001b. Guidance for Ecological Risk Assessment: Levels I, II, III, IV. April 1998 (updated 12/01).

DEQ 2000. Guidance for Conduct of Deterministic Human Health Risk Assessment. Updated May.

DEQ, 1998a. Consideration of Land Use in Environmental Remedial Actions. July.

DEQ, 1998b. Guidance for Conducting Beneficial Water Use Determinations at Environmental Cleanup Sites. July 1998.

DEQ, 1998c. Guidance for Conducting Feasibility Studies. July.

DEQ 1998d. Guidance for Identification of Hot Spots. April.

DEQ, 1998e. Guidance for Use of Institutional Controls. April.

USEPA, 1988. Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA. Office of Emergency and Remedial Response. OSWER Directive 9355.3-01. October.

USEPA, 1989a. Transport and Rate of Contaminants in the Subsurface. Robert S. Kerr Environmental Research Laboratory. EPA/625/489/019.

USEPA, 1989b. Exposure Factors Handbook. Office of Health and Environmental Assessment. EPA/600/8-89/043. May.

USEPA, 1989c. Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part A, Interim Final. Office of Solid Waste and Emergency Response. EPA/540/1-89/002. December.

USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive No. 9285.6-03, March.

USEPA, 1991b. Supplemental guidance for Superfund Risk Assessments in Region 10. U.S. Environmental Protection Agency. August.

USEPA, 1992. Integrated Risk Information System. Office of Research and Development. Cincinnati, Ohio.

USEPA, 2002. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E., Supplemental Guidance for Dermal Assessment), Interim Guidance.

USGS, 1996. Water Quality of the Lower Columbia River Basin: Analysis of Current and Historical Water-Quality Data through 1994. USGS Water-Resources Investigation Report 95-4292.

Verschueren, Karel, 1983. Handbook of Environmental Data on Organic Chemicals. Van Nostrand Reinhold, New York.