PRELIMINARY CLOSE OUT REPORT

McCormick & Baxter Creosoting Company Superfund Site

Portland, Oregon

September 2005

I. INTRODUCTION

This Preliminary Close Out Report (PCOR) documents that the Oregon Department of Environmental Quality (DEQ) has completed all construction activities for the McCormick & Baxter Creosote Company Superfund Site ("the site"), in accordance with the U.S. Environmental Protection Agency (EPA) guidance, *Close Out Procedures for National Priorities List Sites* (OSWER Directive 9320.2-09A-P, January 2000). EPA conducted a pre-final inspection on September 26, 2005, and determined that DEQ constructed the remedies in accordance with remedial design (RD) plans and specifications. DEQ has initiated activities necessary to achieve performance standards and site completion.

II. SUMMARY OF SITE CONDITIONS

Site Description

The McCormick & Baxter Creosoting Company site is a former wood treating facility located on the east bank of the Willamette River in Portland, Oregon. The site encompasses approximately 41 acres of land and an additional 23 acres of contaminated river sediments. The upland portion is on a terrace of imported sand fill (dredged material placed in the early 1900s) within the historic flood plain of the Willamette River. The upland area is generally flat and lies between a 120 foot high bluff along the northeast border and a 20 foot high bank along the Willamette River to the southwest. Currently the site is vacant except for a paved parking area, small shop building, two field office trailers and associated utilities which are used to support ongoing creosote extraction.

Inactive industrial properties border the site to the south and a residential area is located on the adjacent bluff. A Burlington Northern Santa Fe Railroad track crosses the west portion of the property, and Union Pacific Railroad tracks border the site to the east below the bluff. Beyond the Burlington Northern Santa Fe Railroad tracks, toward the west, is a former industrial property that is currently being developed as a public green space. Additionally, the 92 acre University of Portland college campus is located approximately one half mile east of the McCormick & Baxter Creosoting Company site. The perimeter of the property is fenced and posted with warning signs.

Three hydrostratigraphic units are present at the site: the shallow, intermediate, and deep aquifer zones, which are interconnected to varying degrees depending upon the location within the site. The shallow zone consists of poorly-graded dredge fill sand and wood debris and ranges in thickness from five to greater than 30 feet. In parts of the site, the shallow zone consists mostly of sawdust and wood chips up to 20 to 25 feet thick. The shallow zone acts as an unconfined aquifer that, except within the barrier wall area and close to the bluff away from the river, is in hydraulic connection with the river. Depth to groundwater ranges from approximately 20 to 25 feet below ground surface (bgs). The shallow zone is underlain by a silt aquitard ranging in thickness from zero near the river to greater than 100 feet closer to the bluff.

The intermediate aquifer zone is composed of fine to medium grained alluvial sand and is present below the silt aquitard over most portions of the site. This zone varies in thickness from zero to greater than 50 feet. In the north-central portion of the site, the intermediate zone is approximately 12 feet thick and hydraulically separated from the shallow aquifer. In the south-central portion of the site, the silt aquitard is greater than 100 feet thick and no intermediate aquifer zone is present. Along the beach adjacent to the river, the intermediate zone is up to 50 feet or more thick and is separated from the shallow zone by a discontinuous, thin silt layer.

The deep aquifer zone is present in all portions of the site. The deep zone consists of alluvial sands and is directly connected with the intermediate and shallow zones along the river margin. Near the center of the site, the deep zone is separated from the shallow zone by more than 100 feet of low-permeability silt. Near the bluff, the deep zone is composed of gravel and sands of the Troutdale Formation and Catastrophic Flood Deposits.

Shallow groundwater gradients generally exist from the bluff toward the river. Intermediate and deep zone groundwater surface elevations and gradients have been inferred to flow toward the river in these zones.

The Willamette River is the only surface water body at the site. Near the site, the river is approximately 1,550 feet wide with a typical maximum depth of about 40 to 50 feet below the Columbia River datum. Average flow rates in the river near the site range from 8,300 cubic feet per second (cfs) in summer to 73,000 cfs in winter.

Site History

Much of the McCormick & Baxter Creosoting Company site was created from dredged materials in the early 1900s. At that time a sawmill operated in the southeast portion of the property. McCormick & Baxter Creosoting Company was founded in 1944 to produce treated wood products, including lumber, piling, timbers, and railroad ties during World War II. The wood treating operations continued until October 1991.

Four retorts were located in the central processing area (CPA) at the site and used for various pressure treating processes which included the use of creosote, pentachlorophenol

(PCP), chromium, ammoniacal copper arsenate, ammoniacal copper zinc arsenate and Cellon (PCP in diesel oil, liquid butane and isopropyl ether). Also present at the site were a 750,000 gallon creosote product storage tank and tank farm area (TFA) with several additional tanks for storing wood-treatment chemicals. Historic site features are shown in Figure 1.

From 1950 to 1965 waste oil containing creosote and/or PCP was applied to the site soil for dust suppression in the CPA. Liquid process wastes were reportedly discharged to a low area near the tank farm prior to 1971.

The site included a wastewater discharge outfall that was used to discharge cooling water to the river when the plant was operating. Contact wastewater also was discharged from this outfall in the early years of operation. Three stormwater outfalls were also present along the river. Two of the outfalls were permitted under the National Pollutant Discharge Elimination System (NPDES). Following plant shutdown, DEQ placed earthen berms around stormwater collection sumps at the site as an early response action to minimize off-site discharge. The stormwater outfalls were removed as part of the first phase of the soil remedial action in 1999.

Two major spills have reportedly occurred at the site; a 50,000-gallon creosote release in the tank farm area in approximately 1950 and a large spill of an unspecified volume of creosote from a tank car near the tank farm in 1956.

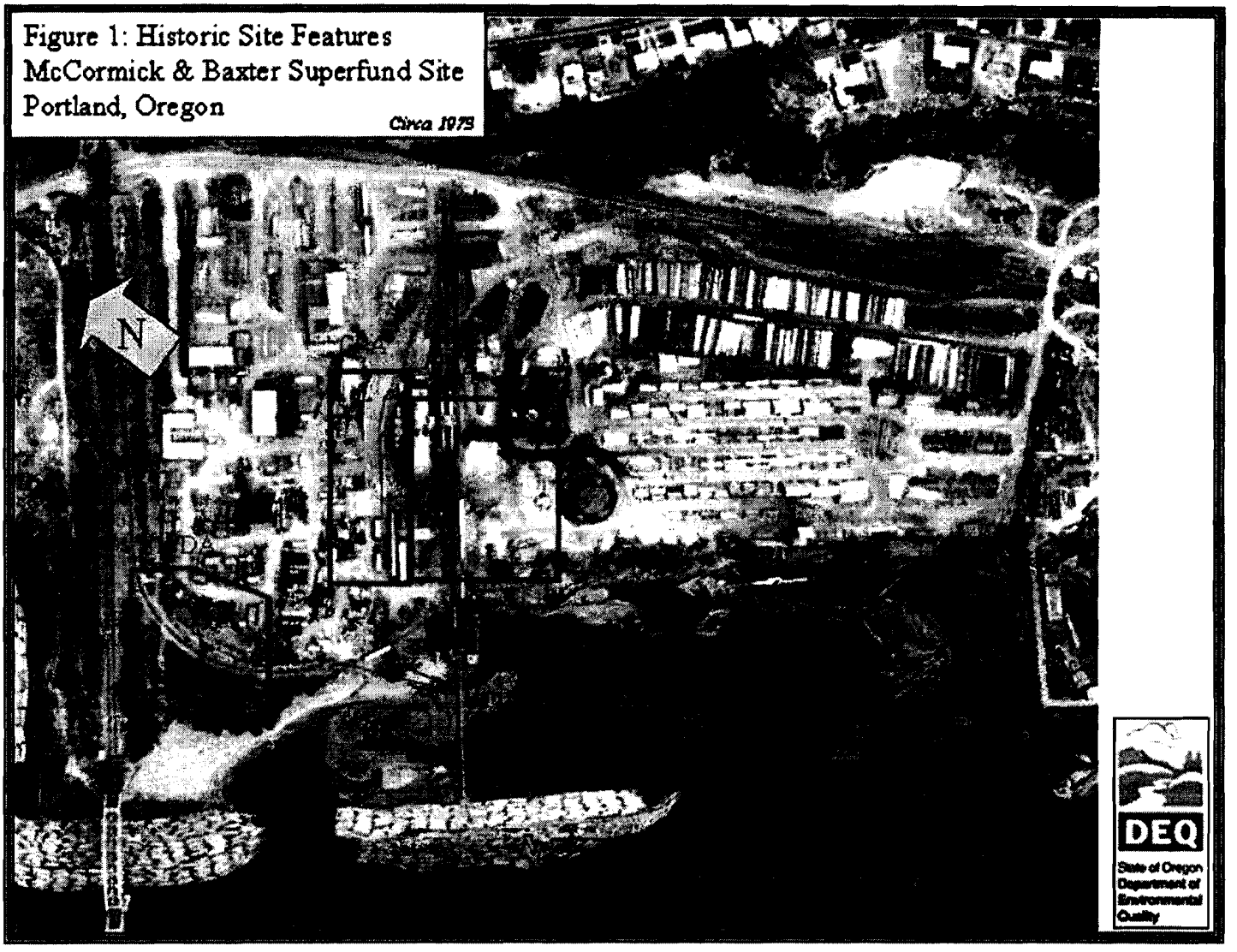
Sludge from site processes was disposed at an unknown off-site location until 1968. From 1968 to at least 1973 residues from the retorts, oil/water separator, and evaporators were disposed on-site in the former waste disposal area (FWDA) in the western portion of the site. Beginning in 1972 wood preservative sludge was placed in metal containers that were stored on site in the FWDA. After 1978 wood preservative sludge was shipped to Chem-Security System, Inc., a permitted hazardous waste disposal facility near Arlington, Oregon. In 1981 the hazardous waste storage area was secured with a fence and lock and a manifest system was implemented to comply with hazardous waste regulations.

Concrete walls and slabs were built around the ACZA (ammoniacal copper zinc arsenate) process and storage facilities in 1980 to prevent spills from entering the soil. The retorts and retort openings were lined with concrete, but the integrity of the concrete was not verified. The creosote lines and other pipelines passed through a concrete underground walkway that extended from the tank farm to the retort building. In 1985 two feet of soil and sludge were excavated from the tank farm and shipped to a hazardous waste landfill. Visibly contaminated soil remained at the tank farm.

Site investigations have revealed many releases of wood-treating chemical compounds to soils, groundwater and sediments as a result of these operations. Contaminants detected include polynuclear aromatic hydrocarbons (comprising 85% of the creosote), PCP, arsenic, chromium, copper, zinc and dioxins/furans. Three main contaminant sources existed at the site: the FWDA which is located in the western corner of the site adjacent

Figure 1: Historic Site Features
McCormick & Baxter Superfund Site
Portland, Oregon

Circa 1973



to the Willamette River and was characterized by a large depression where waste oils, retort sludges and wastewater were disposed over a period of several years; the CPA which is located in the center portion of the cite and is where retorts, PCP mixing shed and ACZA storage areas were formerly located; and the TFA which is located in the south-central portion of the site and is the former location of the main tank farm, creosote storage tank and several other wood treatment process-related tanks or process areas. Releases from these source areas, in particular the TFA and FWDA, in the form of insoluble wood-treating contaminants or non-aqueous phase liquids (NAPL) have significantly impacted subsurface soils, groundwater and sediment. Remedial investigations identified two large NAPL plumes that were migrating to the river and impacting surface water and sediments.

Regulatory History

The McCormick & Baxter Creosoting Company began environmental investigations of their property in 1983. Based on those investigations, DEQ entered into a Stipulated Order with McCormick & Baxter Creosoting Company in 1987 requiring the implementation of corrective actions. Corrective actions included the installation and operation of a groundwater extraction and treatment system, construction of drip pads in retort areas, construction of covered storage areas for treated wood, and collection and treatment of stormwater. In December 1988 the McCormick & Baxter Creosoting Company filed for Chapter 11 bankruptcy, and in 1990 DEQ assumed responsibility for completing the investigations and cleanup activities at the site. In October 1991 the McCormick & Baxter Creosoting Company ceased operations.

DEQ began the Remedial Investigation and Feasibility Study in 1990 and issued a public notice of a proposed cleanup plan in January 1993. DEQ elected not to finalize the proposed remedial actions at the site due to the proposed addition of the site to the National Priorities List (NPL) by EPA in June 1993. The McCormick & Baxter Creosoting Company site was added to the NPL on June 1, 1994. DEQ completed a revised Feasibility Study in 1995.

DEQ and EPA entered into a Superfund State Contract (SSC) in May 1996. The SSC documents the responsibilities of DEQ as the lead agency and EPA as the support agency during the remedial action. Among other items, the SSC specifies cost sharing between DEQ and EPA. The SSC was most recently amended in February 2005.

Removal Actions

Removal Actions were completed by DEQ under State cleanup rules prior to site listing on the National Priority List (NPL) and under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) authority between site listing and issuance of the Record of Decision (ROD). These actions included:

- Installation of a fence around the McCormick & Baxter Creosoting Company site to control access.

- Placement of warning buoys along the river and posting of warning signs on the fence.
- Mitigation of potential off-site migration of contaminated airborne particulates through dust control measures such as grass seeding and limitation of site traffic.
- Storm water containment through diversion and collection of storm water in retort sumps.
- Maintenance, sale and transfer of remaining wood-treating chemicals.
- Demolition and off-site disposal of several site structures and materials, including the sale and removal of salvageable equipment and materials from the site.
- Removal of asbestos material from retorts and buildings and recycling or disposal of chemicals stored in the laboratory.
- Disposal of 151 drums of wood-treating process waste.
- Treatment of approximately 400,000 gallons of storm water collected from retort sumps and discharge to the Willamette River.
- Collection and analysis of approximately 650 soil samples to identify the most highly contaminated areas for initial removal actions.
- Excavation and off-site disposal of approximately 377 tons of contaminated soil from three "hot spot" areas.
- Installation of an interceptor trench downgradient of the tank farm area to recover light nonaqueous-phase liquid (LNAPL).
- Dismantling of chemical storage tanks, retorts, and several buildings, and off-site disposal of sludges.
- Installation and monitoring of 21 new wells to further delineate the extent of NAPL contamination.
- Recovery of NAPL from monitoring and extraction wells. Starting in 1989 creosote was purged every week from 5 monitoring wells at the site. Approximately 450 gallons were recovered between July 1989 and November 1991. By February 1995 more extraction wells had been added to the system and approximately 1,800 additional gallons of creosote had been removed.
- Installation of a fully automated pilot-scale wastewater treatment system to separate NAPL and treat groundwater removed through total fluid extraction efforts in the TFA. Wells in the FWDA were used for pure-phase NAPL extraction and were not connected to this treatment system. The treatment system in the FWDA consisted of an oil/water separator, an in-line anthracite/clay filter, two granulated activated carbon units, and a metals treatment unit.
- Modification in 1994 of the fully automated TFA system to a 40 hour per week system. The fully automated system required constant monitoring and temporary shutdown of the extraction system to minimize recovery of groundwater. Field data collected between 1992 and 1994 indicated that weekly pumping yielded as much NAPL as the fully automated system.

Remedy Selection

In March 1996 EPA and DEQ issued one ROD for the site to address several different media: contaminated soil, groundwater, stormwater and Willamette River sediment. The

selected remedy required the following media-specific actions to mitigate the principal threats at the site:

1. Excavation and biological land treatment of the most highly contaminated PAH and PCP contaminated soil, stabilization of the most highly contaminated arsenic-contaminated soil and consolidation and capping of treated soil.
2. Enhancement of the existing groundwater and NAPL extraction and treatment system to remove NAPL and hydraulically control contaminated groundwater in a limited area in the immediate vicinity of the extraction wells.
3. As a contingency remedy, installation of a vertical subsurface barrier wall in the event that mobile NAPL cannot be reliably controlled using hydraulic methods.
4. Sediment capping.
5. Monitoring.
6. Institutional controls.

In March 1998 an amended ROD was issued by EPA and DEQ to change a component of the selected remedial action for contaminated soil. The soil remedy in the original 1996 ROD called for excavation and on-site biological treatment. After the ROD was signed, DEQ initiated additional soil sampling for remedial design. This sampling found that dioxin contamination was more widespread than the previous analyses indicated. Accordingly, DEQ and EPA reevaluated the remedy and subsequently selected an alternative, which called for removal and off-site disposal of shallow soil with concentrations above designated action levels and capping the remaining contaminated soil.

In August 2002 EPA and DEQ issued an "Explanation of Significant Differences" (ESD) explaining the decision to implement the contingency remedy for groundwater as specified in the 1996 ROD. The groundwater remedy selected in the ROD included a contingency for installing an impermeable subsurface barrier wall in the event that either (1) NAPL could not be reliably contained using hydraulic methods or (2) the barrier wall improves the overall cost-effectiveness of the groundwater remedy. DEQ and EPA determined that NAPL had not been contained using groundwater/NAPL extraction and recovery measures and concluded that hydraulic control of NAPL or groundwater had not been established in either the TFA or the FWDA. To implement the contingency plan, DEQ and EPA selected a fully encompassing, impermeable subsurface barrier wall alignment surrounding the TFA and the FWDA, and a riverfront alignment located along the ordinary high-water mark of the Willamette River.

Remedial Actions

Following is a summary of Remedial Actions implemented by DEQ under CERCLA authority following issuance of the ROD, ROD Amendment and ESD.

Soil Removal

The purpose of the soil remedy selected in the amended ROD was to eliminate the potential for future human contact with soil less than 4 feet in depth that has contaminant concentrations above removal action levels (*i.e.*, "principal threat" or "hot spot soil"). Action levels for contaminated soils were defined for excavation and off-site disposal for arsenic, pentachlorophenol and total carcinogenic polynuclear aromatic hydrocarbons (cPAHs). These action levels indirectly addressed the removal of dioxins/furans by assuming their presence predominantly in the same areas where elevated concentrations of PCP and PAHs are found in soil.

Soil excavation activities were performed from February through May 1999 and effectively eliminated the presence of the contaminated soils above removal action levels. In several major source areas excavation proceeded to depths of 8 to 10 feet. Approximately 32,604 tons of contaminated soil and debris were excavated and disposed offsite at permitted landfills. A total of 33,128 tons of clean sand was imported from an off-site quarry to back fill the excavation pits.

Documentation, record drawings and a detailed summary of the soil removal construction activities are provided in the *Phase 1 Soil Remedial Action Summary Report,* by E & E, dated November 1999.

Upland Soil Cap

The selected soil remedy requires capping upland areas where residual soil contamination remains above human health and ecological risk-based protective levels. Documentation, record drawings and a detailed summary of the upland soil cap construction activities will be provided in the *Upland Soil Cap Construction Summary Report*, (E & E, November 2005 - anticipated).

Construction activities for the upland soil cap were performed between March and September 2005 and included the following major components: demolition and off-site disposal of existing structures and infrastructure; reinstallation of key support facilities; construction of an impermeable cap within a 14.7-acre portion of the subsurface barrier wall (the barrier wall is described under Remedial Actions for the Groundwater Operable Unit); and construction of an earthen soil cap outside of the impermeable cap.

Demolition and removal were conducted from May through June 2005 and included the removal of all remaining structures and disposal of the generated waste in a State-approved disposal facility. All existing water, gas, and electrical utilities were removed or abandoned. Fire hydrants were removed and any associated piping was grouted to prevent preferential flow paths, and water lines were capped. Demolition items were salvaged, scrapped or disposed of as non-hazardous waste or hazardous waste. Concrete, creosote-contaminated steel and asbestos-containing water pipe was also buried on site. All on-site burial locations were surveyed. Twenty groundwater monitoring wells were abandoned.

Support facility construction was conducted from March to July 2005 and included the reinstallation of a 0.8-acre paved entrance road and parking area; construction of a 25-foot by 40-foot shop building shop building; and reinstallation of electrical, telephone and water services.

A Resource Conservation and Recovery Act (RCRA) type impermeable cap was constructed over the entire 14.7-acre area inside of the barrier wall, excluding the riparian zone bordering the river. Capping of the riparian zone had been completed in 2004 as part of the sediment cap construction. The purpose of the impermeable cap is to minimize infiltration of rainwater into the contaminated areas within the wall. The impermeable cap is composed of the following materials listed below in order from bottom to top:

- 8,000 cubic yards of sand used as a leveling layer about 4 inches thick.
- 72,000 square yards of high density polyethylene (HDPE) geomembrane liner.
- 72,000 square yards of a geocomposite plastic 'fabric' that allows water to flow laterally.
- 47,000 cubic yards of sand of varying depths to allow for drainage.
- 12,000 cubic yards of 4"-minus crushed rock forming a screened biotic barrier layer approximately 6 inches thick.
- 72,000 square yards of geotextile filter fabric.
- 24,000 cubic yards of topsoil placed approximately 9 to 12 inches in depth.
- 20 species of native grasses to provide a diverse and sustainable herbatious cover in order to minimize surface erosion.

The impermeable cap has a minimum thickness of 29 inches; however, the thickness varies because of varying subgrade and the final grade of the site. The sand drainage layer increases in depth to create the grades necessary to achieve site drainage. The maximum thickness of the cap is approximately 7 feet, which includes a 4-inch sand leveling layer, a 62-inch sand drainage layer, a 6-inch rock biotic barrier and 12 inches of topsoil.

The impermeable cap also consists of a subsurface drainage system above the HDPE liner to collect storm water percolating through upper soil, rock and sand layers of the cap. Storm water is collected in the geocomposite fabric and perforated piping and conveyed by gravity flow through conveyance piping to an outfall structure which daylights at the Ordinary High Water (OHW) level of the Willamette River (*i.e.*, 14 feet above the Columbia River Datum).

An earthen soil cap, consisting of a 2-foot layer of imported top soil, was installed over 18.9 acres of the site outside of the barrier wall area excluding the gravel entrance road and parking area. The purpose of this cap is to prevent direct contact with low-level contamination remaining in the soils throughout the rest of the site. The soil layer is underlain with a demarcation layer consisting of orange HDPE safety fencing, to provide a distinction between the clean soil cap and contaminated soil. The earthen soil cap was seeded with native herbaceous vegetation.

A storm water management system was also constructed to minimize storm water runoff from the site to neighboring properties and the Willamette River. This system consists of a swale that conveys storm water directly to an on-site retention/infiltration pond. The surface of the soil cap is constructed with sloped surfaces (approximately 1% slope) to direct surface water runoff towards the drainage swale.

A 6-foot high chain-link fence was also reinstalled along the site perimeter. Along the riverfront the fence is located at the top of the bank, inland of the riparian zone. Gravel access roads were constructed around the perimeter of the site (except along the north side where the drainage swale is located), with spurs that cross the interior area to allow monitoring and maintenance of the site.

Creosote Recovery

Creosote (i.e., NAPL) recovery began in 1989 as a Removal Action. Approximately 450 gallons were recovered between July 1989 and November 1991. By February 1995 more extraction wells had been added to the system and approximately 1,800 additional gallons of NAPL had been removed.

NAPL recovery continued following issuance of the ROD in March 1996. Through March 2004 monthly extraction volumes of NAPL from extraction wells in the TFA and FWDA ranged from 0.4 to 73 gallons, with some periods of no extraction. As of September 2005 approximately 6,000 gallons of NAPL have been removed from groundwater.

Since the McCormick & Baxter Creosoting Company facility was shut down in 1991, various extraction methods have been attempted to optimize NAPL recovery. The goal of the extraction was to remove and deplete NAPL pools to residual levels to minimize or prevent migration into the Willamette River. Key NAPL extraction activities are summarized below.

- 1998: The treatment system in the TFA was again modified. Previously, total fluids extracted from three wells were conveyed to the former pilot treatment system and treated by a DAF system. This system required extensive oversight and was expensive to operate (*e.g.*, chemical costs). The system operated 40 hours per week (Monday through Friday) when a technician was on site to perform operation and maintenance activities. To allow for continuous operation and to reduce costs and operator requirements, the system was replaced with one resembling that employed in the FWDA consisting of an oil/water separator, an in-line anthracite/clay filter, two granulated activated carbon units and a metals treatment unit.

- 1999 & 2000: The volume of NAPL extracted by the automated systems was found to be similar to the volume removed via manual extraction using skimmers. In addition, it was determined that manual extraction could be conducted for

approximately half the cost of operating the automated systems. Therefore, the FWDA and TFA NAPL extraction systems were shut down in September 2000 and NAPL extraction was continued manually.

- 2004 – Current: Select wells inside and outside the barrier wall are monitored weekly for the presence and thickness of NAPL. NAPL is extracted weekly from interior and exterior wells if the thickness is greater than 0.4 feet. NAPL recovery is continuing until the effectiveness of the barrier wall and sediment cap has been verified.

Subsurface Barrier Wall

As required by the ESD, a fully encompassing, impermeable subsurface barrier wall was designed and installed to meet the remedial action objective of minimizing NAPL discharges to the Willamette River and sediment to protect human health and the environment. The alignment of the wall surrounding the TFA, CPA and the FWDA, and along the riverfront at the OHW of the Willamette River was designed to cut off the upgradient sources of dense non-aqueous phase liquid (DNAPL) and LNAPL in the TFA and FWDA and prevent NAPL migration from these areas to the river.

The majority of the subsurface barrier wall was constructed from April through September 2003 with the exception of eight sheet piles that met refusal before achieving design depth. The resulting gaps were pressure grouted in July 2004. The construction of the barrier wall is documented in the report, *Remedial Action Construction Summary Report, Combined Sheet Pile and Soil-Bentonite Barrier Wall*, Ecology & Environment, Inc., 2004.

The barrier wall was constructed to fully encompass approximately 17.8 acres of NAPL impacted groundwater and the main contaminant source areas at the site, including the TFA and FWDA. The total length of the wall is 3,792 linear feet and the depth varies from approximately 45 feet below ground surface (bgs) to 80 feet bgs to account for differences in the topography and soil profile at the site.

Approximately 1,440 feet of the barrier wall along the bank of the Willamette River were constructed using steel sheet piles. Installation methods involved a panel-driving technique, which consisted of setting and partially driving six to eight sheet pile pairs (a panel).

Approximately 2,355 linear feet of soil-bentonite barrier wall were installed to depths of up to 80 feet bgs to the side and upgradient of the primary contaminant source areas. The excavated trench was held open using a slurry mix of bentonite and water, which was later displaced by the denser soil-bentonite mixture. The mixing operation occurred concurrently with excavation within the wall's perimeter. The soil-bentonite mixture consisted of soil excavated from the trench, slurry from the trench, imported clayey soil, and dry bentonite. The mixing and placement were accomplished by an excavator and bulldozer.

The segment of wall between the Willamette River and the TFA (approximately 900 linear feet) is keyed into a silt aquitard and extends to a depth of approximately 70 to 80 feet bgs. The segment of barrier wall between the Willamette River and Willamette Cove and the FWDA (approximately 1,100 linear feet) is a "hanging wall" because deeper soil in this area consists of interbedded sand and silt lenses with no continuous, competent aquitard to key into. This segment of the wall extends to a depth of 70 to 80 feet bgs. The segment of the wall located upgradient and side gradient of the TFA and FWDA (1,800 linear feet) is keyed into the silt aquitard and has a depth of 45 feet bgs.

Although the barrier wall segment located downgradient of the FWDA does not key into a continuous, competent aquitard, this segment of the wall was extended to such a depth that DNAPL migration toward the river will be substantially retarded.

Review of NAPL Recovery Innovative Technologies

The 1996 ROD required pilot testing to evaluate innovative technologies, such as surfactant flushing, to increase the effectiveness of NAPL removal. This requirement was modified in the 2002 ESD because NAPL accumulations on site (at that time) appeared to be decreasing and there were concerns that, in the absence of containment, the pilot tests could mobilize NAPL and increase discharges to the river.

DEQ, through its contractors, GeoEngineers Inc. and Aquifer Solutions Inc., prepared a technical memorandum that develops and evaluates several innovative technologies and presents a cost-benefit analysis of the most promising innovative technology for enhanced NAPL extraction, the current method of NAPL recovery and additional capping of potential seeps with Organoclay (capping with Organoclay is discussed under the Sediment Operable Unit). The evaluation of innovative technologies utilizes two general criteria: effectiveness and implementability at the site. The following technologies were developed and evaluated in the report: six-phase soil heating; dual-phase extraction or bioslurping; dynamic underground stripping and hydrous pyrolysis oxidation; in situ flushing; waterflood oil recovery; hydrogen peroxide in situ bioremediation; and membrane filtration system. The cost-benefit analysis considers the cost to construct, operate and decommission the most promising innovative technology; that of the existing system for NAPL recovery; and a scenario where no further NAPL recovery is performed and potential seepage of NAPL is contained by the targeted use of additional Organoclay.

At this time, no additional construction is foreseen at this site. However, as part of the Five Year Review, the results of this or future evaluations will be considered for opportunities to improve the long-term protectiveness or cost efficiencies of the selected remedy.

Sediment Cap

The selected sediment remedy required capping areas that contain contaminant concentrations above human health and ecological risk-based protective levels or that

exhibit significant toxicity to biological organisms in the near surface. Documentation, record drawings and a detailed summary of the sediment cap construction activities will be provided in the *Sediment Cap Construction Summary Report*, (E & E, November 2005 - anticipated).

Construction activities during the sediment cap implementation consisted of the following major components: removal of approximately 1,630 pilings, bulkhead and dock remnants, in-water debris, a derelict barge in Willamette Cove, and other Willamette Cove features; construction of a multi-layer sediment cap using sand, organoclay, and armoring; monitoring well abandonment and modification; bank regrading; and disposal and demobilization.

The sediment cap footprint encompasses approximately 23 acres. Its shoreward boundary extends along the shoreline from the south end of the property downstream into Willamette Cove to the north. Its riverward boundary at the furthest offshore location extends into the Willamette River to an approximate depth of 46 feet (Columbia River Datum), outside of the limits of the USACE-designated navigational channel, and to 16 feet deep in Willamette Cove. The cap consists of a 2-foot thick layer of sand layer over most of the cap footprint with a 5-foot thick layer of sand over several more highly contaminated areas. Approximately 131,000 tons of sand was placed from July 7 through October 28, 2004.

Within the cap footprint were areas of known NAPL migration (*e.g.*, seep areas). In the Willamette Cove and TFA NAPL seep areas, the cap incorporated 600 tons of Organoclay to prevent breakthrough of the NAPL through the cap. Organoclay is bentonite or hectorite clay that has been modified to be hydrophobic and to have an affinity for non-soluble organics.

The sediment cap design incorporated different types of armoring to prevent erosion of the sand and Organoclay layers. The specific armoring material and where it was installed was dependent on the expected hydraulic and physical environments (*e.g.*, currents, wave energy, erosive energies, etc.). Articulating concrete block (ACB) mats were installed along the shore and in shallow water where erosive forces would be the greatest due to wave action. ACB is individually formed interlocking concrete blocks. Rock armor included 6-inch-minus, 10-inch-minus, and riprap. All shallow water 10-inch-minus and ACB armoring layers were underlain with a woven geotextile fabric and 4-inch thick layer of 3-inch-minus filter rock. This fabric and rock was installed to hinder the migration of the sand through the larger and more porous armoring layer or layers.

ACB installation began on July 7, 2004, and proceeded from the downstream end of the site in the Willamette Cove to the upstream work limits. Installation of ACB mats was allowed only after the subgrade, including sand cap and gravel filter layer, was verified by DEQ's construction oversight contractor. The ACB installation was completed on October 28, 2004.

The 6-inch-minus rock was basalt and/or andesite. Approximately 23,250 tons of 6-inch-minus cobble were placed over the sand cap and as edge treatment where the 6-inch-minus cobble areas abutted the ACB.

The 10-inch-minus rock used as armoring is comprised of angular basalt and/or andesite. Approximately 23,300 tons of 10-inch-minus rock was placed in the near-shore embayment.

The riprap material used for construction of the boulder clusters and the rock mound is composed of durable angular boulders less than 3 feet in diameter. Approximately 558 tons of riprap was placed along the shoreline and on an offshore shoal between the embayment and the river at the McCormick & Baxter Creosoting Company site. Each boulder cluster consisted of six to seven boulders.

As a result of the sediment cap construction 18 monitoring wells were abandoned and 36 monitoring wells were modified in accordance with Oregon Water Resources Department (OWRD) requirements (*e.g.*, boreholes were over-drilled and grouted with bentonite).

A 6.3-acre riparian zone was created by regrading the riverbank, placement of a demarcation layer, placement and grading of two feet of imported clean fill (topsoil), placement of a turf reinforcement mat, and hydroseeding with native grasses.

Due to concerns with the instability of two City of Portland's high pressure sewer lines, the sediment cap construction work in this area was delayed pending completion of repairs and stabilization by the City. The final portion of the sediment cap around the sewer lines was completed in September 2005. The subgrade sewer lines cross the Willamette River from the northwest corner of the site and are at depth below the navigation channel. During the initial construction of the sediment cap, it was discovered that a portion of the sewer lines was exposed and unsupported.

Prefinal, Final and Joint Inspection

DEQ and its construction oversight contractor (E&E) conducted prefinal and final inspections with the construction contractors. The purpose of these contract required inspections was to identify the "punch list" and to verify that all punch list items have been adequately addressed prior to the contractor demobilizing from the site. Documentation of these inspections and successful completion of the construction work is provided in the series of construction summary reports prepared by E&E.

As specified by the NCP for Fund lead sites requiring operation and maintenance, an inspection was conducted jointly by DEQ and EPA at the end of all construction activities. This "joint inspection" was performed on September 26, 2005.

Institutional Controls

The ROD specifies institutional controls for the soil, groundwater and sediment remedies:

- Physical restrictions (*e.g.*, fencing), warning signs, and safety measures until completion of the remedies.
- Controls on future uses of the property that are inconsistent with the level of protectiveness achieved by the cleanup.
- Prohibition on any use of the shallow and intermediate aquifers and prohibition on drinking water use of the deep water aquifer.
- Prohibition on disturbance of the sediments.

These controls and prohibitions are to be set forth in a DEQ and EPA approved form, such as deed restrictions or restrictive covenants, running with the land and enforceable by DEQ against the present and future owners of the property.

DEQ currently maintains a site perimeter fence and warning signs and restricts public access to the site. These physical site restrictions will be maintained into the foreseeable future.

DEQ also has obtained a permanent easement (No. 31530-EA) for the sediment cap from the Oregon Division of State Lands (DSL). This easement prohibits the anchoring and grounding of non-recreational vessels and the use of all motor propelled vessels. The easement specifies that the sediment cap may be closed to all public uses if DEQ determines that the area poses a threat to public health or the environment. This easement was recorded with Multnomah County on May 12, 2004. DEQ also has placed buoys along the perimeter of the sediment cap warning boaters of navigational hazards. Following completion of the record drawings in the fall of 2005 for the final component of the sediment cap (*i.e.*, the high pressure sewer mains), DEQ will provide record drawings along with access restrictions to the National Oceanic and Atmospheric Administration (NOAA) which maintains the Notice to Mariners on navigational charts.

DEQ will require deed restrictions to be recorded upon the sale of the property. At minimum these restrictions will prohibit development within the 6.3-acre restored riparian area along the riverbank as required by the Endangered Species Act Biological Opinion issued by the National Marines Fisheries Service, prohibit use of site groundwater as specified by the ROD and restrict excavation of site soils unless authorized by DEQ. Currently DEQ and EPA are negotiating with a viable prospective purchaser. In the event that these negotiations do not result in sale of the property, DEQ will ask the current property owner to record the deed restrictions.

Redevelopment Potential

A Site Re-Use Assessment was conducted between February 2000 and June 2001 by the City of Portland Bureau of Planning under a grant by EPA. In developing reuse recommendations the City analyzed the site's redevelopment potential and engaged stakeholders and the interested public in learning about, proposing and jointly considering what uses would best fit the site. The City's findings were presented in a final report dated June 2001 which has been endorsed by the Portland City Council.

In conducting the assessment, the City developed a list of reuse criteria that would need to be balanced in order to arrive at the most feasible land reuse, such as minimizing traffic impacts, ensuring adequacy of infrastructure, being compatible with cleanup remedies, serving an identified market or community needs and being consistent with the City of Portland Comprehensive Plan. Using these criteria, the City developed, presented and discussed a variety of reuse ideas and conceptual site plans. Four reuse scenarios were further studied and reviewed at public open houses: an open space demonstration site, recreational use, industrial use and mixed use (residential, commercial and university facilities). Project consultants prepared market feasibility and traffic analysis reports for these four scenarios. The City concluded that the site is best suited for recreational use.

III. DEMONSTRATION OF CLEANUP ACTIVITY QUALITY ASSURANCE AND QUALITY CONTROL

All work performed at the site was consistent with the ROD, amended ROD, ESD and design documents. Final soil cap, sediment cap and barrier wall designs, which were reviewed and approved by EPA and DEQ, contained construction quality assurance programs to verify that the work was performed in accordance with the ROD, amended ROD, ESD and remedial design plans and specifications.

DEQ, through an oversight contractor (E&E), performed rigorous oversight of all construction activities. Detailed summaries of construction activities, documentation of construction quality assurance and quality control and copies of record drawings (*i.e.*, as-built drawings) are provided in a series of construction summary reports:

Phase 1 Soil Remedial Action Summary Report, McCormick & Baxter Creosoting Company, Portland, Oregon, by Ecology & Environment, Inc., November 1999.

Remedial Action Construction Summary Report, Combined Sheet Pile and Soil-Bentonite Barrier Wall, McCormick & Baxter Creosoting Company, Portland, Oregon, by Ecology & Environment, Inc., April 2004.

Remedial Action Construction Summary Report Addendum, Jet Grouting of Steetpile Refusal Areas Barrier Wall, McCormick & Baxter Creosoting Company, Portland, Oregon, by Ecology & Environment, Inc., June 2005.

Remedial Action Construction Summary Report, Sediment Cap Construction Summary Report, McCormick & Baxter Creosoting Company, Portland, Oregon, by Ecology & Environment, Inc., November 2005 - anticipated.

Remedial Action Construction Summary Report, Upland Cap Construction Summary Report, McCormick & Baxter Creosoting Company, Portland, Oregon, by Ecology & Environment, Inc., November 2005 - anticipated.

IV. ACTIVITIES AND SCHEDULE FOR SITE COMPLETION

The following activities will be completed according to the schedule in the table below:

TASK	ESTIMATED COMPLETION	RESPONSIBLE ORGANIZATION
Preparation of Construction Summary Reports for Sediment Cap and Upland Soil Cap	November 2005	DEQ
O&M Plan and Manuals	December 2005	DEQ with EPA concurrence
Revegetation with Trees and Shrubs along Shoreline and in Upland Areas	February 2006	DEQ
Technical Impracticability Waiver and ESD to Modify Groundwater Remedial Action Objectives	June 2006	DEQ & EPA
Operational and Functional Determination	September 2006	DEQ
Final Remedial Action Report	September 2006	DEQ
Site Completion (Final Close Out Report/Approval)	September 2006	DEQ & EPA
2nd Five-Year Review	October 12, 2006	DEQ with EPA concurrence
Additional Five-Year Reviews	Every five years	DEQ with EPA concurrence
Deed Restrictions on Future Use of Property	Upon Sale of Property	Purchaser of Site with DEQ concurrence
Long-Term Monitoring and Maintenance	Indefinitely	DEQ
Site Deletion	2011 (after the third Five-Year Review)	EPA

All construction completion requirements for the site as specified in OSWER Directive 9320.2-09A-P (January 2000) have been met. Specifically, all construction activities identified in the ROD, amended ROD and ESD have been successfully implemented and inspected by EPA and DEQ. No additional construction activities are expected at this time

Operation and maintenance (O&M), performance monitoring and institutional control enforcement are components of the remedial action and will be performed by DEQ.

V. SUMMARY OF REMEDIATION COSTS

Since initiation of site studies and removal actions in July 1989 through achievement of construction completion in September 2005, DEQ and EPA have expended a total of $45,631,276. Additionally, $1,154,151 is budgeted for October 2005 through September 2006 for a variety of tasks including monitoring to determine that the remedy is Operational & Functional, ongoing recovery of NAPL and performing routine site maintenance during this period.

Costs to construct the remedies selected in the ROD, amended ROD and ESD and to operate and maintain the groundwater treatment system since issuance of the ROD (*i.e.,* Remedial Action costs) total $33,482,507. In comparison, the estimated Remedial Action costs total $22,346,000. The difference of $11,136,507 between the estimated Remedial Actions costs and the actual costs is primarily attributed to construction of sediment remedy. The additional cost to construct the sediment remedy results from an increase in the capping area, the need for armoring over all portions of the cap and the use of Organoclay to contain the NAPL seeps.

The following table provides a breakdown of the remediation costs.

ACTIVITY	COSTS
State Funded Investigations, Studies and Removal Actions (7/89 – 5/96)	**$7,579,098**
EPA Funded Removal Actions (4/95 – 9/96)	**$769,943**
Remedial Design (5/96 - 9/05)	**$3,799,728**
Remedial Action (5/96 – 9/05)	
Soil Removal	$5,348,207
Upland Soil Cap	$7,670,000 (estimate)
NAPL Recovery	$4,824,455
Barrier Wall	$3,639,845
Sediment Cap (excluding Sewer Repair)	$11,617,369
Sewer Repair Cap	$382,631 (estimate)
Total Remedial Action =	**$33,482,507**
TOTAL REMEDIATION COST (through September 30, 2005)	**$45,631,276**
Budgeted Future Remedial Action (10/05 – 9/06)	
Operational and Functional Determination, ongoing NAPL recovery and routine site maintenance	**$1,154,151**

VI. FIVE-YEAR REVIEWS

Hazardous substances will remain at the Site above levels that allow unlimited use and unrestricted exposure after completion of the remedial actions. EPA and DEQ will conduct statutory five-year reviews to determine the effectiveness of the remedial action pursuant to 40 U.S.C § 9621(c) of CERCLA.

The first five-year review for the site was performed in October 2001 by DEQ with concurrence from EPA. The review determined that the remedies for soil and groundwater that were currently in progress at that time were performing as designed and that the necessary operation and maintenance was being performed. DEQ also recommended that an evaluation of installing a vertical physical barrier at the site be performed because of continuing migration of NAPL to river sediments.

The next five-year review will be performed prior to October 12, 2006.

VII. APPROVAL

Approved By:

Daniel D. Opalski
Director, Office of Environmental Cleanup
U.S. Environmental Protection Agency

9/27/05
Date