RECORD OF DECISION

State of Oregon
Department of Environmental Quality

For

JELD-WEN OF OREGON/ PELICAN BAY
KLAMATH FALLS, OREGON

Prepared By

OREGON DEPARTMENT OF ENVIORNMENTAL QUALITY
Eastern Region Cleanup Program
Bend Office

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1. INTRODUCTION

1.1 INTRODUCTION

This document presents the selected remedial action for soil and groundwater at the JELD-WEN of Oregon and Pelican Bay facilities (JWO/PB), in Klamath Falls, Oregon (Figure 1). The remedial action has been developed in accordance with Oregon Revised Statutes (ORS) 465.200 through 465.455, and Oregon Administrative Rules (OAR) 340-122-010 through 340-122-115.

The selected 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 Remedial Investigation, Baseline Risk Assessment, Ecological Risk Assessment and Feasibility Study (RI/FS) reports completed under Oregon Department of Environmental Quality (DEQ) Stipulated Order No. WMCSR-97-018, dated July 23, 1997.

1.2 SCOPE AND ROLE OF THE SELECTED REMEDIAL ACTION

The selected remedial action addresses the presence of pentachlorophenol (PCP) and dioxins and furans (D/F) present in soils and on-site and off-site shallow groundwater at the JWO/PB site. The selected remedial action consists of the following elements:

- Contaminant removal using groundwater extraction and treatment
- Excavation and off-site disposal of contaminated soil
- Monitoring
- Periodic Land and Water Use review
- Contingency Plan

2. SITE HISTORY AND DESCRIPTION

2.1 SITE LOCATION AND LAND USE

The JWO/PB site is located at 3307 Lakeport Blvd. in Klamath Falls, Oregon, Township 38 S, Range 09 E, Section 19, Tax Lots 300 and 400, Klamath County. The site is located on a relatively flat parcel in an industrial area of Klamath Falls adjacent to a golf course and residential homes. The JWO/PB facility and surrounding area have long been associated with mill activity. Historically, the Upper Klamath Lake (Lake) coastline was the site of numerous mills. The facility on which JWO and PB are located occupies a total of approximately 88 acres and is one of the few remaining active facilities along the Lake. Figure 2 illustrates the site layout. A private discharge pond that intercepts storm water and directs discharge of non-contact cooling water from the facility borders the site along the western boundary. Drainage from the discharge pond to Klamath Lake is controlled by a weir at the northern end. The terrain surrounding the discharge pond has been modified to accommodate the facility and the Harbor Isles golf course and driving range (HIGC). Little native vegetation exists in the immediate vicinity of the site. The ground elevation of the site is approximately 4105 feet above mean sea level.

2.2 PHYSICAL SETTING

2.2.1 Climate

Klamath Falls receives approximately 20 inches of precipitation annually with approximately 30 percent occurring as snowfall. The majority of the precipitation falls between October and May. The temperature varies considerably as the area is a high desert climate. Freezing morning temperatures can be encountered throughout the year and summer temperatures can reach into the mid-90°F range.

2.2.2 Geology and Hydrogeology

Geologic conditions observed during past investigations at the site indicate that surface soil typically consists of silty clay. The surface soils are underlain by a suite of interbedded clay and silt deposits and thicken in a westerly direction from a thickness of 3 feet east of the PB building to approximately 8 feet (total boring depth) below ground surface (bgs) towards the HIGC. Fluvial deposits of this type are typically uniform in nature, exhibit low permeability and high sorption capacity, and would limit subsurface migration of chemical constituents as compared to coarse-grained materials. Based on prior investigative data at the site, soft to massive fractured siltstone underlies the unconsolidated deposits at a depth of 4 feet bgs east of the PB building. The siltstone horizon was not encountered west of the PB building or on the HIGC driving range during the Hydropunch™ and monitoring well installation activities.

Regional groundwater contours indicate groundwater at 4,100 feet above mean sea level (msl). Ground surface elevation is 4,105 feet, and groundwater monitoring data confirms that the depth to the uppermost saturated zone ranges from 3 to 8 feet bgs across the site. Saturated conditions encountered during prior monitoring well drilling at the site have ranged from approximately 10 feet bgs east of the PB building to 3.5 feet bgs along the eastern bank of the discharge pond. The depth to water during the Hydropunch™ investigation was observed to occur at a depth of 2.5 feet bgs.

2.2.3 Surface Soils

Geologic conditions observed during past investigations at the site indicate that surface soil typically consists of silty clay. The surface soils are underlain by a suite of interbedded clay and silt deposits and thicken in a westerly direction from a thickness of 3 feet east of the PB building to approximately 8 feet (total boring depth) bgs towards the HIGC. Fluvial deposits of this type are typically uniform in nature, exhibit low permeability and high sorption capacity, and would limit subsurface migration of chemical constituents as compared to coarse-grained materials. Based on prior investigative data at the site, soft to massive fractured siltstone underlies the unconsolidated deposits at a depth of 4 feet bgs east of the PB building. The siltstone horizon was not encountered west of the PB building or on the HIGC driving range during the Hydropunch and compliance monitoring well installation activities.

2.2.4 Water-Bearing Zone

The depth of the uppermost saturated zone has been reported to range from 3 to 8 feet bgs across the site (AGI Technology, 1996). During the October 2002 groundwater sampling event, groundwater flow was generally oriented in a southwesterly direction. In the eastern portion of the site, the gradient was approximately 0.017 foot per foot (ft/ft), as measured between wells MW-3 and PBMW-6. In the western portion of the site, the gradient was approximately 0.003 ft/ft, as measured between wells PBMW-6 and PBMW-3.

Deep water-bearing zone pump tests were conducted on the JELD-WEN Trendwest well and Fiber well on March 20-21, 1999, and April 9-10, 1999, to evaluate vertical connectivity between the shallow and deep water-bearing zones. The Trendwest and Fiber wells were drilled to respective depths of 349 and 118 feet bgs, and cased to depths of 39 and 58.5 feet bgs, respectively. During the Trendwest well pump test, conducted at 300 gallons per minute (gpm), water levels were monitored in shallow zone wells PBMW-1, PBMW-8, PBMW-9, and

PBMW-11. During the JELD-WEN Fiber Well pump test, conducted at 100 gpm, water levels were monitored in shallow zone wells MW-1, MW-5s, MW-6s, and MW-7s. The results of both tests showed no observable vertical connectivity between the shallow and deeper water-bearing zones.

2.3 HISTORY OF OPERATIONS

Historically, the portion of the site that includes Ben Fab, Thomas Lumber, JELD-WEN Fiber, Klamath Door, and JELD-WEN of Oregon has been described as JWO. These operations were built from 1969 through 1977. Wood treatment operations were housed in the JWO building.

The Pelican Bay facility is currently used as an office and a storage area for doors and windows and is located at the southwestern portion of the site. The site is comprised of a single building and paved parking areas. Historically, over the last 75 years, the PB building has housed many lumber and wood-related operations. The building was originally constructed in 1918 by the Pelican Bay Lumber Company and was later purchased in 1948 by Caradco, a wood products company. Caradco operated the facility through 1960 as a lumber mill and a door and window manufacturing operation. JELD-WEN purchased the facility in 1960. To facilitate wood treatment, a dip tank was installed within the PB building in the 1950's and filled via an underground pipe from two aboveground storage tanks (AST). During the 1960's, it is estimated that approximately 3,000 gallons of 95% mineral spirits and 5% PCP wood treatment solution was used every three weeks. In 1969, all manufacturing and wood treatment operations within the building were discontinued and moved to the adjacent and recently completed JWO facility.

2.4 REGULATORY HISTORY

In 1986, JELD-WEN reported to the DEQ a release of pentachlorophenol-containing product from the dip tank. In April 1987, DEQ's Water Quality Program issued a Stipulated and Final Order requiring JELD-WEN to operate a groundwater treatment system to remove the PCP product from the groundwater. Monitoring wells were installed, and upon determination of PCP impact to groundwater, JELD-WEN implemented a DEQ-approved product recovery and treatment system to remove PCP-containing product from groundwater. Product and groundwater were pumped from two extraction trenches and treated on-site. Treated water from the system was discharged under permit into an infiltration trench on the property. Approximately 21.8 million gallons of water and 13,400 gallons of product were removed and treated by the system.

In August 1995, JELD-WEN and DEQ entered into a Voluntary Agreement to investigate the releases from both the Pelican Bay and JWO facilities. The groundwater system was discontinued in December 1995 after product was no longer being recovered from the extraction trenches. In July 1997, DEQ terminated the Voluntary Agreement because DEQ and JELD-WEN were unable to agree on the level of work necessary to complete the RI/FS. DEQ then issued a Unilateral Administrative Order requiring the RI/FS process be conducted according to a specified Scope of Work. Since that time JELD-WEN has worked with DEQ to complete the RI and FS and this document serves to summarize the results of those findings and presents the recommended remedy for the site.

It should also be noted that the DEQ Water Quality program administers a National Pollution Discharge and Elimination System (NPDES) permit with the facility. That permit has recently been renewed in 2004 and specifies only stormwater, non-contact cooling water, and treated groundwater may be discharged to the outfall into Upper Klamath Lake.

3. RESULTS OF INVESTIGATION(S)

3.1 NATURE AND EXTENT OF CONTAMINATION

During the course of investigations conducted at the site, a total of 46 soil borings and 22 wells have been installed to characterize the nature and extent of PCP and dioxins/furans in soil and groundwater beneath the site. Eleven wells have been installed on the JWO site, and 11 wells have been installed on the PB site. The results of previous investigations, including site history, investigation activities, and results, are primarily summarized in two documents (SECOR, 1996a, and SECOR, 1999c). In addition, groundwater monitoring reports have been submitted on a semiannual basis to document seasonal groundwater hydraulic conditions and PCP groundwater concentrations. Two indicator chemicals have been identified in soil and groundwater at the site. The contaminants identified include PCP and dioxins/furans. A summary of the investigative results is presented below.

3.1.1 Soil

Subsurface soil samples were collected from 23 soil borings in February 1996, three soil borings in May 1998, and 20 soil borings in September 2000.

In 1996, 23 soil borings (B-1 through B-23) were completed to depths ranging from 2.5 feet to 10 feet bgs in the vicinity of the discharge pond and the HIGC and sampled for analysis for PCP. Of the 11 samples in which PCP was detected, the soil analytical results for PCP ranged from 0.048 milligrams per kilogram (mg/kg) to 150 mg/kg.

In 1998, three surface soil samples (HH-1, HH-2, and HH-3, Figure 3) were collected from a small hill at the southeast corner of the Fiber building for analysis of PCP and dioxins/furans. This soil had been excavated during the construction of the warehouse at the south end of the Fiber building and during installation of a new dip tank in JWO. Dioxins/furans were detected in all three samples at concentrations ranging from 1.7×10^{-4} mg/kg 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) toxic equivalency quotient (TEQ) to 2.8×10^{-4} mg/kg TCDD TEQ. PCP concentrations were between 0.053 and 0.073 mg/kg.

In 2000, 20 borings were drilled on a random grid pattern (Figure 4). Two samples were collected from each boring location. Samples were collected from depths of 0 to 6 inches and at the groundwater interface (assumed at the time to vary between 6 and 10 feet bgs). Thirty-two samples were analyzed for PCP, and ten samples were analyzed for dioxins/furans. PCP was detected in three of the samples at concentrations ranging from 1.65 mg/kg to 17.9 mg/kg. Dioxins/furans were detected in all 10 samples at concentrations ranging from 5.26×10^{-6} mg/kg to 4.01 x 10^{-3} mg/kg.

PCP was detected in 29 percent of the soil samples analyzed for PCP. In all soil samples, except one location near the JWO dip tank and HH-1 to HH-3, which were collected from excavated soil, PCP was detected at, or near, the water table. This suggests that the PCP may have been released to the environment below ground near the water table. Dioxins/furans were detected in 100 percent of the soil samples analyzed for dioxins/furans, including surficial soils and deeper soils.

3.1.2 Groundwater

The results of previous site investigations and monitoring events have identified dissolved-phase PCP in shallow groundwater at the site. Wells MW-2 through MW-7, located at JWO, and wells PBMW-1 through PBMW-11, located at PB, have been monitored periodically since their installation, which occurred at various times from 1987 to the present. Groundwater and product recovery data for the extraction system that operated through 1995 is presented in Table 1.

In addition to the data from the groundwater monitoring, the extent of the plume across Harbor Isles Boulevard and the discharge pond was delineated through groundwater sampling from a series of 18 Hydropunch™ borings completed in May 1998.

At the JWO facility, the results from the May 2003 sampling event indicated the presence of PCP at concentrations ranging from <1.0 microgram per liter (µg/L) in well MW-7s near the private discharge pond to 189,000 µg/L in well MW-2 in the Fiber Building. Tetrachlorophenols (TCPs) were detected in wells MW-2 (6,380 µg/L), MW-5s (3,060 µg/L), and PBMW-6 (440 µg/L). TCP is a biodegradation product of PCP, and the presence of TCPs in low concentrations relative to the concentration of PCP is an indication that slow biodegradation of PCP is probably occurring in these areas. At the PB facility, PCP levels ranged from <1.0 µg/L in wells to 25,200 µg/L. TCPs were detected in well PBMW-6 at a concentration of 742 µg/L.

3.1.3 Surface Water

Surface water in the discharge pond discharges to Upper Klamath Lake at Outfall 001 (Figure 2) under a National Pollutant Discharge Elimination System (NPDES) permit. Per the conditions of the permit, surface water is sampled at Outfall 001. PCP has been detected four times in the last 5 years ranging from 1.0 µg/L to 69 µg/L.

3.1.4 Sediment

Sediment samples were collected from the fire pond, the discharge pond, and the Klamath Lake inlet. All sediment samples were analyzed for PCP and dioxins/furans. On May 4 and 5, 1998, 12 sediment samples were collected from four different areas (i.e., fire pond, private discharge pond, lower canal, and Klamath inlet) concurrently with biota samples collected for the Ecological Risk Assessment (ERA). The analytical data for sediment and biota tissue were separated into two different data sets based on comparable concentrations within each data set. One data set includes samples collected from the fire pond and south portion of the private discharge pond (Data Set 1). The other data set includes samples collected from the north portion of the private discharge pond, the lower canal, and the Klamath Lake inlet (Data Set 2).

The sediment results are presented in the Focused Remedial Investigation Report (SECOR 1999). In general, the results indicated the presence of dioxin in samples from both data sets and PCP in samples from Data Set 1. No PCP was detected in the samples from Data Set 2 at, or above, the laboratory method reporting limits (MRLs).

The results for Data Set 1 indicated the presence of dioxin in each of the six samples, ranging from 170 picograms per gram (pg/g) 810 pg/g. Dioxin concentrations in the samples collected from Data Set 2 ranged from 0.23 pg/g to 44 pg/g.

The PCP results from Data Set No. 1 indicated detections in four of the six samples, ranging from below the laboratory MRLs in samples S-0-SED and S-3-SED to 0.21 mg/kg in sample S-2-SED. The fact that samples from Data Set No. 2 did not exhibit detections of PCP likely indicates that past PCP releases from the facility to groundwater have not impacted Zone 2 of the private discharge pond, the lower canal, or the Klamath Lake Inlet. The results also indicate that the drainages entering Zone 2 of the discharge pond from the facility have also likely not impacted the discharge pond with PCP.

3.2 RISK ASSESSEMENT

A Baseline Human Health Risk Assessment (BHHRA) was conducted in 2001 (SECOR, 2001) at the site to evaluate the level of risk associated with the presence of the existing PCP in groundwater, and both PCP and dioxins/furans in soil to potential human receptors. PCP produces non-cancer toxic effects that are evaluated using a Hazard Index (HI) and produce cancer toxic effects that are expressed as Lifetime Excess Cancer Risk (LECR). Dioxins/furans produce only cancer toxic effects. The following three hypothetical human receptor populations were evaluated in the BHHRA:

- Hypothetical on-site outdoor industrial worker receptor
- Hypothetical on-site indoor industrial worker
- Hypothetical on-site outdoor trench worker

Details of the BHHRA are presented in the Baseline Human Health Risk Assessment (SECOR 2001a, b). Table 2 summarizes the exposure pathway risks for the hypothetical on-site receptors as determined in the BHHRA.

3.2.1 On-Site Outdoor Trench Worker Scenario

The results of the BHHRA for the hypothetical on-site trench worker receptor indicated a total HI of 50, which is above the target HI of 1. The exposure pathway producing this adverse non-cancer health effect is dermal exposure to groundwater containing PCP.

The total LECR for this receptor was 8 x 10^{-3}, which is above DEQ's target risk of 1 x 10^{-5} for occupational exposures to multiple carcinogens. The LECR risk is due to dermal exposure to groundwater containing PCP (3 x 10^{-3}) and two individual dioxins/furans congeners, OCDD and 1,2,3,4,6,7,8-HpCDD (6 x 10^{-3}). All three chemicals each contribute greater than 1 x 10^{-6} risk to the total risk. Therefore, according to DEQ acceptable risk policy, PCP and the two congeners exceed the acceptable target of 1 x 10^{-6} for individual chemicals.

3.2.2 Outdoor Industrial Worker Scenario

For the hypothetical outdoor industrial worker, the results of the BHHRA indicated an HI of 3 x 10^{-3}, which is well below the target HI of 1. This indicates that adverse non-cancer health effects are not anticipated for this receptor under the exposure conditions evaluated.

The LECR of 2 x 10^{-5} for this receptor is above DEQ's target risk for cumulative exposures to multiple carcinogens (equal to 10^{-5}). The risk is due almost entirely to incidental ingestion exposure to dioxins and furans in surficial soil. This result indicates that adverse cancer health effects may be anticipated for this receptor under the exposure conditions evaluated.

The risk was calculated using the maximum detected concentration (MDC) of dioxins/furans in surface soil (2.8 x 10^{-4} mg/kg TCDD TEQ). The MDC was detected in sample HH-1 from the surficial fill material at the southeast corner of the Fiber building.

3.2.3 Indoor Industrial Worker Scenario

The results for the hypothetical indoor worker receptor indicated an HI of 4 x 10^{-5}, which is well below the target HI of 1, and an LECR of 5 x 10^{-8}, which is well below DEQ's target risk of 1 x 10^{-6}.

3.2.4 Target Cleanup Levels

Based on the results of the BHHRA, in particular those results that exceed acceptable cancer risk and non-cancer hazards, acceptable site concentrations of the chemicals of concern (COCs) were calculated. These acceptable concentrations or target cleanup levels (TCLs) are based on the results of the assessment of exposures to the on-site trench worker and the outdoor industrial worker.

3.2.4.1 On-Site Trench Worker – Dermal Exposure to Groundwater

TCLs were calculated for dermal exposures to PCP and dioxins/furans in groundwater by the trench worker receptor. For PCP, the LECR exceeded the acceptable level of 1 x 10^{-6} for an individual chemical by a factor of 3,000, and the HI exceeded the acceptable level of 1 by a factor of 50; therefore, the TCL has been calculated using the LECR. The MDC groundwater concentration used to calculate the LECR is 115,000 μg/L; therefore, the TCL for PCP in groundwater is 38 μg/L. The LECR of 6 x 10^{-3} due to exposure to dioxins/furans in groundwater by the on-site trench worker receptor is 6,000 times the acceptable risk level of 1 x 10^{-6} for an individual chemical. The MDC used to calculate the risk is 5.76 x 10^{-2} μg/L (57,600 picograms per liter [pg/L]). Therefore the TCL for total dioxins/furans in groundwater is 9.6 x 10^{-5} μg/L (96 pg/L) TCDD TEQ, and the TCL for any individual congener in groundwater is 9.6 x 10^{-6} μg/L (9.6 pg/L) TCDD TEQ.

3.2.4.2 Outdoor Industrial Worker – Ingestion of Soil

TCLs were calculated for ingestion and dermal contact exposures to dioxins/furans in surficial soil. The LECR due to PCP was well below the acceptable risk level. For dioxins/furans, the LECR exceeded the acceptable level of 1 x 10^{-5} for multiple chemicals by a factor of 1.6 and exceeded the acceptable level of 1 x 10^{-6} for an individual chemical by a factor of 16. The MDC for surficial soil that was used to calculate risk is 2.8 x 10^{-4} milligrams per kilogram (mg/kg) TCDD TEQ. Therefore, the TCL for total dioxins/furans in soil is 1.75 x 10^{-4} mg/kg (175 pg/g) TCDD TEQ. The TCL for any individual congener of dioxins/furans in soil is 1.75 10^{-5} mg/kg (17.5 pg/g) TCDD TEQ.

3.2.4.3 Residual Petroleum Contamination from Pelican Bay USTs

Two USTs that contained gasoline and/or diesel fuel were removed from the Pelican Bay part of the facility in March 1992 (LUST File Number 18-92-0017, Tank Permit Numbers ACABD and ACABE). The levels of petroleum residuals reported in the letter as remaining in site soil and groundwater after the UST removal and excavation do not exceed the risk-based concentrations (RBCs) published by DEQ (DEQ, 2003), except for the levels of benzene and total xylenes in groundwater (18 μg/L and 1,210 μg/L, respectively), which exceeded the RBCs for the ingestion of tap water pathway of 0.35 μg/L and 210 μg/L, respectively. As previously discussed, drinking water use is not a beneficial use of the groundwater that is impacted; therefore, no additional cleanup is required regarding the residual contamination these former USTs.

Two additional USTs were decommissioned in the Thomas Lumber Area. Contamination associated with these USTs (LUST File Number 18-03-0611, Tank Permit Numbers ACABF and ACABG) is not included in this remedial action. Oversight of the Thomas Lumber Area USTs is provided separately by DEQ's UST Cleanup program.

3.2.5 Ecological Risk Assessment

The ecological risk assessment was completed in accordance with *Oregon's Guidance for Ecological Risk Assessment (DEQ, 1998e).*

As part of the 1999 Focused Remedial Investigation, a Level II ERA was completed for the private discharge pond located along the western boundary of the facility. It was conducted according to the guidelines presented by the DEQ Guidance for Ecological Risk Assessment, Levels I, II, and III (DEQ, 1997a, b, c, and d) and the EPA Proposed Guidelines for Ecological Risk Assessment (USEPA, 1996). The specific approach, scope of work, and objectives for the ERA were based on subsurface soil and groundwater evaluations conducted by AGI (AGI, 1996); the Conceptual Ecological Evaluation – Private Canal (SECOR, 1996b); sediment, surface water, and biotic data previously collected by JELD-WEN personnel in December 1996 and July 1997; and the Focused RI/FS Work Plan (SECOR, 1998). A complete presentation of the ERA is included in the document entitled Focused Remedial Investigation Report (SECOR, 1999c), and the methods and results are summarized below.

The purpose of the ERA was to evaluate whether the chemicals of potential ecological concern (CPECs, PCP, and dioxins/furans) at the site would adversely affect the current and/or future ecological health of the private discharge pond system. The ERA consisted of a wildlife survey to assess endpoint diversity and abundance; selection potential ecological receptor endpoints (coots and heron); identification of potentially complete exposure pathways (ingestion of sediment, snails, and mosquito fish by herons); sampling of respective media including sediment and various aquatic flora and fauna (snails and mosquito fish); and data evaluation and conclusions.

The results of the ERA indicated the following:

- Threatened or endangered endpoint species and associated critical habitat were not present at the site. Relative to the open waters of Upper Klamath Lake, a very small number of birds were observed in the discharge pond and lower canal over two separate one-month observation periods in two different seasons.
- Data from the sampling of environmental media demonstrated that bio-concentration had not occurred in snails and mosquito fish and that the CPECs were not readily bioavailable to the biota in the discharge pond and lower canal.
- The highest detected PCP concentration in sediment (0.21 mg/kg) did not exceed the screening benchmark value (SBV) of 0.40 mg/kg and should not pose an ecological risk to receptors.
- The toxicity quotients (TQ) for dioxins/furans in sediment and biota tissue were well below the acceptable target level of 1 and should not pose an ecological risk to receptors. For the two complete exposure pathways at the site (ingestion of sediment and snails and/or mosquito fish by the Great Blue Heron), worst-case exposure conditions within the discharge pond do not appear to represent a risk to the heron receptor. The maximum TQ was estimated to be 0.57. In addition, because herons and other carnivorous birds were not actually observed in the discharge pond, the threat to this receptor from possible exposure to dioxins/furans associated with sediment and biota at the site is negligible.

Based on these results, the ERA concluded that ecological risk to the assessment endpoints at the site is not likely.

3.3 BENEFICIAL USE AND HOT SPOT DETERMINATION

The criteria used to evaluate remedial alternatives for groundwater and surface water depend on whether a "hot spot" is present or not, as determined by a loss of "current or reasonably likely future" beneficial use of the water resource. 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."

3.3.1 Groundwater Beneficial Use Determination

A Beneficial Water Use Determination (BWUD) is required at sites where a release of hazardous substances has impacted groundwater or surface water, or has the potential to impact groundwater or surface water, through contaminant migration. This BWUD has been prepared to address PCP impacts in site groundwater. The two primary components of the BWUD are the definition of the locality of facility (LOF) and documentation and evaluation of the current and reasonably likely future beneficial water uses within the LOF.

The LOF is defined in OAR 340-122-115(34) as any point where human or ecological receptors contact, or are reasonably likely to contact, facility-related hazardous substances. The revised LOF has been defined by reviewing groundwater analytical data in addition to the results of the fate and transport modeling, as illustrated on Figure 5.

Contaminant fate and transport modeling was performed to evaluate both the extent and concentration of PCP in groundwater at the site. The fate and transport of PCP dissolved in groundwater at the site are controlled by advection, dispersion, adsorption, and degradation. The affect of these processes on contaminant fate and transport were modeled using AT123D, a two-dimensional groundwater fate and transport model, run for a 30-and 60-year time interval. The model computes the spatial-temporal concentration distribution of contaminants in the aquifer system and predicts the transient spread of a contaminant plume through a groundwater aquifer. The fate and transport processes accounted for in AT123D include advection, dispersion (both hydrodynamic and molecular), adsorption, and decay. Very low to no rate of decay and retardation constants were used in the model.

Based on the identified current uses of groundwater in the LOF, the following receptors could potentially be exposed to contaminated groundwater:

- Excavation or trench workers working within the LOF.
- Employees and visitors at commercial and industrial facilities with irrigation wells located within the LOF.
- Coots and herons in the private discharge pond.

Land use information was collected from the Klamath County and the City of Klamath Falls Planning Departments, since both city and county jurisdictions overlap within the LOF. Based on the information provided, the municipal zoning designations for the JELD-WEN facility and the HIGC are heavy industrial (IH) and light industrial (IL). The County comprehensive plan designation for both facilities is industrial (I). As the HIGC is located on industrial land, JELD-WEN maintains a conditional use permit for the use. The remaining properties in the LOF are regulated under municipal jurisdiction and are listed as residential. Zoning designations within these properties are segregated among planned unit development (PUD), single-family, and medium-density. The comprehensive plan designations are PUD single-family, PUD open-space, single-family, and medium-density. No existing conditional uses exist within these zones and no amendments for zoning changes are proposed for these zones.

Other than the connection to the private discharge canal and the beneficial use for aquatic life, no current beneficial use of groundwater within the shallow water-bearing zone in or surrounding the LOF was identified during the 1998 survey. Based on the well log data, there has historically been a preference for using groundwater from deeper water-bearing zones rather than the shallow water-bearing zone.

The shallow groundwater does not have an identified beneficial use as groundwater; however, it is hydraulically connected to the discharge pond, which discharges to Upper Klamath Lake, both of which have beneficial uses as habitat for potential ecological receptors. The discharge from the discharge pond to Klamath Lake is monitored monthly per the requirements of a National Pollutant Discharge Elimination System (NPDES) permit.

The current and anticipated future beneficial water uses were determined based on information collected from the Klamath Falls Public Works Department (KFPWD). According to the KFPWD, all residences in the vicinity of the site are connected to the municipal supply. The drinking water supply for the JWO/PB facility and the HIGC is municipal. The irrigation water supply for the HIGC is provided from the Trendwest well (349 ft total depth) operated by JELD-WEN. The industrial water supply for the JWO/PB facility is provided from the Trendwest well.

Well completion depths ranged from 118 to 1,095 feet bgs, well below the impacted shallow water-bearing zone at the site. Of the identified domestic wells, completion depths range from 118 to 391 feet bgs. Pumping tests conducted on site from the deeper wells indicate little connection between the shallow aquifer and deeper water bearing zones.

Beneficial uses were evaluated for the shallow water-bearing zone considering current use and the following factors listed in OAR 340-122-080(3)(f)(F):

- Historical land and water uses
- Anticipated future land and water uses
- Concerns of community and nearby property owners
- Regional and local development patterns
- Regional and local population projections
- Availability of alternate water sources

The following factors were considered when determining reasonably likely future water use:

- Land Use and Development Trends and Patterns: According to the Zoning and Land Use-Planning Department of the City of Klamath Falls, the zoning of the site and surrounding areas to the north and east are zoned a mix of light to heavy industrial. West of the site is Klamath Lake. South of the site is zoned medium density residential. The zoning and land use is not expected to change within the next 20 years.
- Current and Historic Water Use and Trends in Water Use: Deep groundwater within the LOF is currently used as irrigation and industrial water. Historically, it has been used as drinking water, but users switched to municipal drinking water as it became available. There has been no current or historical use of the shallow water-bearing zone.
- Federal, State, and Local Regulations: There are no regulations restricting the use of groundwater in the LOF.
- Water Rights: Rights exist to use water within the LOF as drinking water; however, they are not currently being exercised.
- Availability of an Alternate Water Supply: The City of Klamath Falls provides a public drinking water source that is available in the area of the LOF.

Based on the groundwater well log survey and evaluation of current and future land and water uses within the LOF, current and future beneficial uses of deep groundwater will reasonably likely consist of both industrial supply and irrigation. As zoning designations within the LOF are projected to remain under the current designations, private residential drinking water use would not be considered reasonably likely in areas that are expected to remain industrial or PUD within the city limits.

Currently, the only beneficial use related to the shallow water-bearing zone within the LOF is the aquatic life beneficial use of the private discharge pond, to which the shallow groundwater may potentially discharge.

3.3.2 Surface Water Beneficial Use Determination

Beneficial uses for surface water in the Klamath River Basin are identified in OAR 340-41-0962, Table 19. The contaminants from the site are not likely to affect the Beneficial Uses of the Klamath River as long as the facility maintains compliance with NPDES permit requirements.

3.3.3 Hot Spots

OAR 340-122-115(32) defines hot spot of contamination as:

> (a) For groundwater or surface water, hazardous substances having a significant adverse effect on beneficial uses of water or waters to which the hazardous substances would be reasonably likely to migrate and for which treatment is reasonably likely to restore or protect such beneficial uses within a reasonable time, as determined in the feasibility study; and
>
> (b) For media other than groundwater or surface water, (e.g., contaminated soil, debris, sediments, and sludges; drummed wastes; "pools" of dense, non-aqueous phase liquids submerged beneath groundwater or in fractured bedrock; and non-aqueous phase liquids floating on groundwater), if hazardous substances present a risk to human health or the environment exceeding the acceptable risk level, the extent to which the hazardous substances:

(A) Are present in concentrations exceeding risk-based concentrations corresponding to:

(i) 100 times the acceptable risk level for human exposure to each individual carcinogen;

(ii) 10 times the acceptable risk level for human exposure to each individual noncarcinogen; or

(iii) 10 times the acceptable risk level for exposure of individual ecological receptors or populations of ecological receptors to each individual hazardous substance.

(B) Are reasonably likely to migrate to such an extent that the conditions specified in subsection (a) or paragraphs (b)(A) or (b)(C) would be created; or

(C) Are not reliably containable, as determined in the feasibility study.

For the outdoor trench worker, potential exposure to PCP and dioxins/furans in soils did not result in adverse health effects that exceeded acceptable levels; however, the potential adverse health effects related to direct contact exposure to groundwater exceeded the acceptable risk levels by more than 100 times the acceptable risk level (ARL). It is assumed that there is a hot spot of contamination in all areas where the PCP concentration in groundwater exceeds 3,800 µg/L or the concentration of any individual congener in groundwater exceeds 9.6 x 10-4 µg/L (960 pg/L) TCDD TEQ. The areas where these concentrations are exceeded are illustrated on Figure 6.

The on-site and off-site PCP concentrations exceed the MCLs established by the EPA for drinking water; however, because it is not reasonably likely that the shallow groundwater will be used for drinking water, the contamination does not present a significant adverse effect.

Based on the results of groundwater monitoring data, it is unlikely that PCP concentrations in the private discharge pond would exceed the 15 µg/L Screening Benchmark Value (DEQ, 1998e) for aquatic life in surface water. PCP concentrations in groundwater monitoring wells near the discharge pond have been decreasing. The only known samples of the discharge pond water are the surface water sampling results for the NPDES discharge, collected at Outfall 001, and four surface water samples (S-1 to S-4) collected by AGI and reported in the May 24, 1996 Supplemental Remedial Investigation Report. The only identified instance when the PCP concentration in Outfall 001 exceeded the DEQ Water Quality freshwater chronic criteria (13 µg/L) was in October 2001, when the sample contained 69 µg/L. However, PCP was not detected at concentrations above the MRL (0.001 to 0.002 µg/L) in 33 of 37 samples collected from the discharge pond effluent since January 1999.

The groundwater contamination does not present a potential significant adverse effect to the current, or reasonably likely future, beneficial uses of groundwater within the LOF; however, due to the risk posed to an excavation worker through dermal contact with groundwater pathway, this FS has been developed under the assumption that there is the potential for hot spots of contamination on site.

3.4 ESTIMATE OF CONTAMINANT MASS AND CONTMIANTED MEDIA

The lateral extent of the hot spot in groundwater is approximately 90,000 square feet on the JWO facility and approximately 22,500 square feet on the PB facility (Figure 6). The estimated volume of mobile free product is approximately 300 gallons. The estimated area and volume of dioxin contaminated soil is 875 square feet and 100 cubic yards, respectively.

3.5 PILOT TESTS AND INTERIM REMOVAL ACTIONS

3.5.1 Groundwater Treatment System

JELD-WEN implemented a DEQ-approved product recovery and treatment system to remove PCP-containing product from groundwater in March 1987. Product and groundwater were pumped from two extraction trenches and treated on-site using granular activated carbon and UV Oxidation. The UV oxidation system was not effective in treating the PCP/oil contaminant. Treated water from the system was discharged under permit into an infiltration trench on the property. Approximately 21,800,000 gallons of water and 13,400 gallons of product were removed and treated by the system. The system was shut down in November 1995.

3.5.2 Underground Storage Tank Removals

During removal of two former gasoline fuel underground storage tanks (UST) in March/April 1992, both PCP and fuel-related compounds were detected in soil and groundwater at the PB site. The source of the PCP was suspected to have involved the door and window treatment operation. Groundwater monitoring wells were installed and have been monitored on a regular basis through the present.

3.5.3 Pilot Test for Electrically Enhanced Bioactive Barrier (EEBB) technology

A pilot test was performed to evaluate the effective of the Electrically Enhanced Bioactive Barrier (EEBB) technology. The Pilot Test was conducted by Environmental Management Services, Inc. (EMS), of Eugene, Oregon, and the results were reported in their January 22, 2003 report, *Pilot Test Report: BioLance/Electrically Enhanced Bioactive Barrier.* The EEBB pilot test system began operation in September 2001 and was operated until October 2002. Two test cells were installed in areas with PCP contamination—one north of PBMW-6 and one south of PBMW-6— and monitoring points were installed upgradient, downgradient, and within the treatment cells.

EMS reported that, "Both operational data and geochemical data suggest the JELD-WEN EEBB pilot test performed as expected given site conditions [i.e., low soil permeability]. Acceptable dissolved hydrogen concentrations were developed in each test cell and PCP concentrations appeared to reduce in one of the test wells (TC2). The lack of measurable PCP in the other test well (TC1) and the non-uniform distribution of low levels of PCP in TC2 limit the ability to quantify reaction rates.

Evidence from TC2 appears to indicate that PCP loss was occurring within the system. The loss of PCP appears to be coupled to a loss of sulfate within the system. However, the absence of detectable levels of intermediates (phenol, dichlorophenol, lactate, and acetate) and end product methane was not consistent with reductive dechlorination. Therefore, the pilot test does not provide sufficient data to conclude the Biolance/EEBB technology is an effective method for treating PCP contaminants at the JWO/PB facility."

4. PEER REVIEW SUMMARY

Technical documents produced during the investigation of the JELD-WEN of Oregon/ Pelican Bay site have been reviewed by a technical team at DEQ. The team consists of the project manager/hydrogeologist, and a toxicologist. The team unanimously supports the recommended remedial action.

5. DESCRIPTION OF REMEDIAL ACTION OPTIONS

5.1 REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) are media-specific goals for protecting human health and the environment. Site-specific RAOs were developed in the Feasibility Study (FS) (SECOR, 2004) for soil and groundwater for the purpose of achieving protection of human health, ecological receptors, and beneficial uses, as required by OAR 340-122-040. The RAOs for the site are as follows:

For groundwater:

1. Prevent dermal exposure to groundwater containing PCP or dioxins/furans at levels that would cause the HI to be greater than 1 or the risk to be greater than 1×10^{-6} for an individual carcinogen or 1×10^{-5} for multiple carcinogens.
2. Prevent or minimize migration of PCP in groundwater that would cause unacceptable risk levels, increased off-site contaminant concentrations, increased aerial extent of the plume, or ecological risk in the discharge pond.
3. Treat hot spots of contamination to the extent feasible, per OAR 340-122-090(4).

For soil:

4. Prevent ingestion of surficial soil containing dioxins/furans at levels that would cause the risk to be greater than 1×10^{-6} for an individual carcinogen or 1×10^{-5} for multiple carcinogens.

These RAOs will be protective of human health and the environment, as demonstrated by the BHHRA and ERA.

The following acceptable risk levels (ARLs) were calculated for groundwater, surface water and soil to protect the identified beneficial uses and potential receptors for the most restrictive pathway considered.

	Acceptable Risk Level (µg/L)		Acceptable Risk Level (mg/Kg)	
COC	**Groundwater[a]**	**Surface Water**	**Soil**	**Sediment**
Pentachlorophenol	38	13[1]	21	0.4[2]
Dioxins/Furans	9.6×10^{-5}	NA	1.75×10^{-4}	7.54×10^{-4}

Notes : 1 Source OAR 340-041 Table 20 Water Quality Freshwater Chronic Level

2 DEQ Guidance for Ecological Risk Assessment, Level II Screening Benchmark Values, 1998

5.1.1 General Response Actions (GRAs)

GRAs describe actions that will satisfy the RAOs. Like RAOs, they are medium-specific and may include containment, treatment, disposal, institutional controls, or a combination of these actions. Each GRA identified in this evaluation has been evaluated based on five remedy selection factors: effectiveness, long-term reliability, implementability, implementation risk, and cost reasonableness. This section presents the methodology used to select the GRAs.

During the FS, remedial action alternatives (RAAs) are developed based on the following categories of GRAs, each of which is discussed below:

- Monitoring
- Engineering and Institutional Controls
- Treatment
- Excavation
- Combination of the Above

5.1.2 Screening of Remedial Action Technologies

The Feasibility Study (FS) identified and screened potentially suitable remedial technologies, based on basic applicability to the site, such as the nature of contaminants and site physical characteristics (SECOR, 2004). The rationale for the technology screening process is illustrated in Table 3. Based on the results of the screening process, the following remedial technologies will be evaluated as components of remedial action alternatives:

5.1.2.1 Groundwater Monitoring

Groundwater and surface water monitoring would be completed on a regular basis until the site is closed. Effectiveness will be evaluated based on trends in PCP concentrations in groundwater, the performance of any treatment alternative, and to verify the plume is not migrating beyond the LOF.

5.1.2.2 Engineering Controls

Fill in Discharge Pond

This technology would include the installation of an underground drainage line and filling in of the discharge pond within the LOF to remove exposure pathways for ecological receptors. It includes the following conceptual design features:

- A culvert to transport water through the area.
- Aggregate fill below, and along, the east side of the culvert.
- A liner of some sort along the west side of the culvert to prevent migration in that direction.
- Grading along the base of the excavation to create 100-foot long "cells" in which water would flow to collection points at which wells could be installed in the future.

- 4-inch PVC or HDPE pipeline along the east side of the culvert with periodic tees and stub ups that could potentially be used in the future to connect to wells and a pipeline to treatment or discharge.

Soil Cover

For this remedial technology, to prevent incidental ingestion of surficial soil, the existing landscaping, in the area near the southeast corner of the JELD-WEN Fiber of Oregon building where dioxins/furans concentrations in surficial soil exceed the ARL, would be covered with a high-density polyethylene (HDPE) liner, and the liner would be covered with landscaping rock. The area at which the liner would be installed is illustrated on Figure 6. Annual inspections of the liner would be conducted by an independent party to certify that the liner is effectively limiting contact with the contaminated soil.

5.1.2.3 Institutional Controls

Easement and Equitable Servitude

Institutional controls including an Easement and Equitable Servitude (E&ES) to the deed prohibiting installation of drinking water wells within the LOF, regulating the design of other wells installed within the LOF requiring a soil management plan for excavation work, and limiting land use changes.

5.1.2.4 Treatment Technologies

Natural Attenuation

Under this RA, natural processes are relied upon to reduce PCP concentrations in groundwater through dilution, dispersion, and degradation. Natural attenuation at the site appears to be dominated by dilution and dispersion due to the slow rate of biodegradation.

Bio-Reactive Trench

A bio-reaction trench approximately 1,400 feet in length and approximately 10 feet deep would be excavated and filled with a substrate, such as wood dust, that enhances bioremediation of the contaminated groundwater plume (Figure 6). The trench would serve as a barrier to contamination, and groundwater passing through this zone would be remediated in-situ. A pilot test would likely be required to verify that the technology would be effective.

In-situ Chemical Oxidation

This RA would be focused at treating the source of dissolved PCP concentration in groundwater by oxidizing PCP adsorbed to soil in the source locations. Four shallow injection points would be installed in each of the five potential source locations (Figure 6) and batches of an aqueous solution of Fenton's reagent injected into the ground on a semiannual basis for two years (i.e., four batches total). A pilot test would likely be required to verify that the technology would be effective.

Groundwater Extraction and Treatment (GWET)

The existing GWET system (Figure 6) could be used in a variety of ways to control groundwater migration and enhance cleanup of the site. Three modes of operation are being proposed as remedial alternatives and are discussed below. Each of these modes would use portions of the existing groundwater extraction and treatment system.

The existing GWET system would be re-engineered for better treatment performance and ease of operation. The re-engineering would include bypassing the existing UV-Oxidation system and installation of bag filters to improve solids removal. The revised system would treat 5 to 10 gpm of groundwater. Treatment is expected to include the existing sand filter, new bag filters, and the existing or new activated carbon filters. JELD-WEN has evaluated options for discharge of the treated water and determined that it will be discharged to the discharge pond. Backup disposal options will be re-use in the non-contact cooling water system and boiler or discharge to the City of Klamath Falls public treatment works. Discharge to the discharge pond would require an exemption through the Cleanup Program.

A. Use Existing GWET System as Back-Up (Inactive)

The existing GWET would be maintained in a state of readiness as a backup measure for the natural attenuation alternative. This option assumes that the GWET would be restarted when concentrations at the compliance points exceed a target value. This would provide an extra level of protectiveness for the natural attenuation option without the risk or cost of a continuously running system.

B. Operate Existing GWET System (Active)

In this scenario, operation of the existing GWET would begin after the system was reconfigured. The system would operate nearly full time depending on the availability of reuse options for discharge. Backup discharge options would only be utilized if the system were down for over a week due to reuse availability. The system would pump groundwater from the existing extraction trenches at a rate between 5 and 10 gpm.

C. Expand Existing GWET System

An expanded GWET would include a new extraction trench on the PB portion of the property in the vicinity of PBMW-2, as shown on Figure 10. The proposed extraction trench is approximately 225 feet long. This location does not appear to be close enough to the existing injection trench to be influenced negatively by the higher permeability of the injection trench. The new trench will be constructed in a similar manner as the existing extraction trenches, which were shown to be very effective at producing water and generating an acceptable capture zone. It is expected to be approximately 10 to 12 feet deep and 3 feet wide and backfilled with permeable granular material for drainage.

The pump removing groundwater from the new trench will be located in a concrete vault at the north end of the trench and connected to the re-engineered groundwater treatment system via an underground pipeline. A total groundwater extraction flow rate of 10 to 15 gpm would be expected from the expanded extraction system.

5.1.2.5 Excavation

This technology would involve excavation and transport for off-site disposal of the soil containing dioxin located in the landscaped hill southeast of the Fiber building. Based on additional sampling, the area to be excavated, which is approximately 875 square feet, is shown, to scale, on Figure 11. The top 3 feet of soil would be excavated, resulting in approximately 100 cubic yards of material for disposal. Approval for disposal from the landfill would be based on the results of the previous testing. Excavated soil would be shipped per all applicable rules and regulations for shipment of waste materials. Following excavation, 3 feet of clean fill would be placed in the area of the excavation, and the area would be re-landscaped.

5.2 REMEDIAL ACTION ALTERNATIVES (RAAs)

Potential remedial technologies that were eliminated in the screening process are identified in Table 3. Based on the technology screening evaluation, the following RAAs are proposed to achieve the groundwater and soil RAOs.

The following RAAs have been evaluated for groundwater:

1. Monitored Natural Attenuation (MNA)
2. MNA and Institutional Controls
3. MNA, Institutional Controls, and Fill in the Discharge Pond
4. MNA, Institutional Controls, and Bio-Reactive Trench
5. MNA, Institutional Controls, and In-Situ Chemical Oxidation
6. MNA, Institutional Controls, and Existing GWET System (Inactive)
7. MNA, Institutional Controls, and Existing GWET System (Active)
8. MNA, Institutional Controls, and Expanded GWET System

The following RAAs have been evaluated for soil:

9. Excavation, and Backfill
10. Soil Cover and Institutional Controls

6. EVALUATION OF REMEDIAL ACTION OPTIONS

6.1 EVALUATION CRITERIA

The criteria used to evaluate the remedial action alternatives described in Section 5 are defined in OAR 340-122-090, and establish a two-step approach to evaluate and select a remedial action. The first step evaluates whether a remedial action is protective; if not, the alternative is unacceptable and the second step evaluation is not required. The remedial alternatives considered protective are evaluated and compared with each other using five balancing factors. The five balancing factors are 1) effectiveness in achieving protection, 2) long-term reliability, 3) implementability, 4) implementation risk, and 5) reasonableness of cost.

Where a hot spot has been identified, an evaluation of how each alternative achieves the specific requirements for treatment of hot spots is also included. The alternative that compares most favorably against these balancing factors and complies with the hot spot criteria, is selected for implementation. A residual risk assessment is then conducted for the selected alternative to document that it is protective of human health and the environment.

The following subsections evaluate each RAA against its protectiveness, its preference to treat hot spots of contamination, and the remedy selection factors (effectiveness, long-term reliability, implementability, implementation risk, and reasonableness of cost). Each RAA has been assigned a rating of 1 to 10 for each of these criteria. Table 4 summarizes the results of this evaluation.

6.2 PROTECTIVENESS

The protectiveness of a given remedial action is evaluated by comparing actual or estimated future COC concentrations to the acceptable risk levels (ARLs) described in Section 5.1 of this document.

Oregon cleanup laws require that remedies be protective of human health and the environment. The protectiveness of each RAA has been evaluated on a scale of 1 to 10 based on the likelihood that the RAA will meet the standard for protectiveness. A score of 1 indicates that it is not protective, a score of 5 indicates that there is a good possibility that it will be protective, and a score of 10 indicates that it is definitely protective. The protectiveness of institutional controls are considered to be less than a permanent remedy, and a remedy that includes an institutional control is scored 2 points lower than a similar RAA that uses a permanent remedy.

6.3 PREFERENCE TO TREAT HOT SPOTS OF CONTAMINATION

Oregon cleanup laws require that remedies treat hot spots of contamination. The extent to which each RAA treats hot spots of contamination has been evaluated on a scale of 1 to 10, with 10 being the best to treat hot spots.

6.4 BALANCING FACTORS

The remedial action alternatives determined to be protective are evaluated against the following balancing factors defined in OAR 340-122-090(3):

- **Effectiveness in achieving protection.** The evaluation of this factor includes the following components:
  - Magnitude of the residual risk from untreated waste or treatment residuals, without considering risk reduction achieved through on-site management of exposure pathways (e.g., engineering and institutional controls). The characteristics of the residuals are considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, propensity to bio-accumulate, and propensity to degrade.
  - Adequacy of any engineering and institutional controls necessary to manage residual risks.
  - The extent to which the remedial action restores or protects existing or reasonably likely future beneficial uses of water.
  - Adequacy of treatment technologies in meeting treatment objectives.
  - The time until remedial action objectives are achieved.

The effectiveness of each RAA is evaluated on a scale of 1 (not effective) to 10 (very effective) with respect to these criteria in Table 4. The effectiveness of institutional controls is considered to be less than a permanent remedy, and a remedy that includes an institutional control is scored 2 points lower than a similar RAA that uses a permanent remedy.

- **Long-term reliability.** The following components are considered when evaluating this factor, as appropriate:
  - The reliability of treatment technologies in meeting treatment objectives.
  - The reliability of engineering and institutional controls needed to manage residual risks, taking into consideration the characteristics of the hazardous substances being managed, the ability to prevent migration and manage risk, and the effectiveness and enforceability over time of the controls.

- The nature and degree of uncertainties associated with any necessary long-term management (e.g., operations, maintenance, monitoring).

The reliability of each RAA with respect to these criteria is evaluated on a scale from 1 (low reliability) to 10 (high reliability) in Table 4.

- **Implementability.** This factor includes the following components:

  - Practical, technical, legal difficulties and unknowns associated with the construction and implementation of the technologies, engineering controls, and/or institutional controls, including the potential for scheduling delays.

  - The ability to monitor the effectiveness of the remedy.

  - Consistency with regulatory requirements, activities needed to coordinate with and obtain necessary approvals and permits from other governmental bodies.

  - Availability of necessary services, materials, equipment, and specialists, including the availability of adequate treatment and disposal services.

  The implementability of each RAA is ranked from 1 (difficult to implement) to 10 (easy to implement) in Table 11.

- **Implementation Risk.** This factor includes evaluation of the potential risks and the effectiveness and reliability of protective measures related to implementation of the remedial action, including the following receptors: the community, workers involved in implementing the remedial action, and the environment; and the time until the remedial action is complete.

The implementation risk of each RAA is rated from 1 (high risk) to 10 (low risk) in Table 4.

- **Reasonableness of Cost.** This factor assesses the reasonableness of the capital, operation and maintenance (O&M), and periodic review costs for each remedial alternative; the net present value of the preceding; and if a hot spot has been identified at this site, the degree to which the cost is proportionate to the benefits to human health and the environment created through treatment of the hot spot.

  In general, the least expensive remedial action is preferred unless the additional cost of a more expensive corrective action is justified by proportionately greater benefits to one or more of the other balancing factors. For sites with hot spots, the costs of remedial actions must be evaluated to determine the degree to which they are proportionate to the benefits created through restoration or protection of beneficial uses of water. A higher threshold will be used for evaluating the reasonableness of costs for treatment of hot spots than for remediation of areas other than hot spots. The sensitivity and uncertainty of the costs are also considered.

7. COMPARATIVE ANALYSIS OF REMEDIAL ACTION ALTERNATIVES

In this section, the remedial action alternatives are compared with each other for each of the remedy selection criteria identified in Section 6. The comparative evaluation is summarized in Table 4. The comparative evaluation was made by completing a head-to-head comparison of the retained remedial technologies and is based on the ability to meet the RAO and consideration of the balancing criteria for remedial actions as provided in OAR 340-122-0090, and discussed in Section 6.4. A maximum of 10 points is awarded to the more favorable technology for each head to head ranking. In order to evaluate reasonableness of costs, planning level cost estimates were developed for each remedial technology. These planning level cost estimates were based on numerous assumptions because conceptual design has not been completed for each technology. Cost estimates represent a 30-year (or less when applicable) life-cycle. While adequate for decision-making purposes, final cost estimates will depend on the scope of the final remedial design.

7.1 PROTECTIVENESS

For groundwater the highest Ranking RAA for Protectiveness are RAA 8 (Expanded GWET System -10), RAA 3 (Fill in the Discharge Pond -8), and RAA 5 (Bio-Reactive Trench-8). RAA 8 was the highest ranking because it prevents migration of groundwater to surface water across both properties. For soil RAA 9 ranked the highest because it removes the source of the adverse health effect.

7.2 PREFERENCE TO TREAT HOT SPOTS OF CONTAMINATION

For groundwater RAA 5 (In-situ Chemical Oxidation), and RAA 7 and 8 (Active GWET Systems) ranked the highest to treat Hot Spots of Contamination. The Expanded GWET (RAA 8) ranked highest due to its improved capture area for the Hot Spots and the fact that the technology has been proven to reduce contaminant mass.

7.3 EFFECTIVENESS

For groundwater, RAA 9 ranked the highest due to its ability to remove contaminant mass in a moderate time. Excavation (RAA 10) was the ranked best for soil.

7.4 LONG-TERM RELIABILITY

RAA 3 (Fill in the Discharge Pond) ranked the highest for groundwater long-term reliability due to its removal of the surface water body. The bio-reactive trench and the active GWET systems also ranked high due to their proven technology. For soils excavation (RAA 9) ranked highest because the contaminant source would be readily removed. RAA 3 and RAA 9 do not require long-term monitoring or maintenance costs.

7.5 IMPLEMENTABILITY

RAA 1 (Groundwater Monitoring) was ranked highest followed by RAA 2 (Monitoring and institutional controls) and the existing GWET system alternatives (RAA 7 and 8). The GWET systems are very implementable because they are already in place. The soil excavation alternative (RAA 9), ranks the highest soil alternative for implementability.

7.6 IMPLEMENTATION RISK

RAA 4 (Bio-reactive trench) and RAA 6 (Existing Inactive GWET) ranked slightly higher in this category compared with the other alternatives due to the limited contact with installation or operation of the system. RAA 10 ranked slightly higher that excavation in this category due to the minimal exposure to place cover material on the surface soils.

7.7 REASONABLENESS OF COST

Reasonableness of cost is evaluated in two steps. First, the cost of the alternative is determined using standard engineering practices. Second, the degree to which the costs are "proportionate to the benefits" is determined. OAR 340-122-090(4) provides principles relating to cost reasonableness. The expected net present value of each RAA has been estimated based on engineering estimates of the capital, operations and maintenance, and monitoring and reporting costs for each RAA (Table 5). To evaluate whether costs are proportionate to the benefits, the net present value is compared to the effectiveness of the RAA to determine a rank between 1 and 10. The preference of a specific RAA to treat hot spots of contamination is evaluated as a separate category that is weighted equally to this cost reasonableness category.

The net present cost of the groundwater alternatives range from $140,000 (RAA 1) to $740,000 (RAA 3). For soils the excavation (RAA 9) cost is $23,000 and the Soil Cover (RAA 10) cost is $18,000. The cost benefit of each RAA taking into account the effectiveness criteria, resulted in RAA 1 and 2 ranked the highest in this category, followed closely by RAA 8 (Expanded GWET system). For soils RAA 10 (Soil Cover) ranked moderately higher than the excavation alternative.

7.8 Evaluation Summary

As shown in Table 4, the groundwater alternatives ranked from a high of 52 out of 70 points (RAA 8 – Expanded GWET System) to a low of 30 out of 70 points (RAA 1 - Groundwater Monitoring). RAA 9 (Excavation) ranked highest of the soil alternatives with 49 out of 70 points. RAA 10 (Soil Cover) received 45 out of 70 points.

8. SELECTED REMEDIAL ACTION ALTERNATIVE

On the basis of the detailed evaluation and comparison of the alternatives in the Feasibility Study and summarized in Sections 6 and 7, as well as the RAOs for the site, Alternative 8 – Expand the Groundwater Extraction System for groundwater and Alternative 9 – Excavation of dioxin/furan containing soils rank highest, are protective, exhibit high long-term reliability, have low implementation risk, and have high cost reasonableness. Both alternatives treat hot spots of contamination as defined in OAR 340-122-090 (4). Alternative 8 also includes groundwater monitoring to assess the GWET performance and of the PCP contaminant plume, and institutional controls.

Because of these uncertainties associated with the successful implementation of this selected remedial alternative, a periodic monitoring, review and contingency plan will be developed that will evaluate the performance of the remedy, and allow for changes that will allow the remedy to meet the RAOs. The objective of the periodic monitoring, review and contingency plan will be to maintain the overall protectiveness of the selected remedy.

8.1 DESCRIPTION OF THE RECOMMENDED ALTERNATIVE

8.1.1 EXPAND GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

This alternative includes re-engineering, expansion, and operation of the existing groundwater extraction and treatment system, with discharge of treated water to the discharge pond. A new extraction trench would be installed on the Pelican Bay site in the approximate location shown on Figure 6. The system would be monitored using the existing groundwater monitoring network augmented with wells where necessary to document system performance and maintain adequate definition of the plume.

8.1.2 INSTITUTIONAL CONTROLS

The selected remedial alternative includes institutional controls including an Easement and Equitable Servitude (E&ES) to the deed prohibiting installation of drinking water wells within the LOF, regulating the design of other wells within the LOF, requiring a soil management plan for excavation work, and limiting land use changes.

8.1.3 EXCAVATION

The selected remedial alternative also includes the excavation of dioxins/furans impacted surficial soils (up to 3 feet depth) that exceed the acceptable risk levels as shown on Figure 3.

8.1.4 GROUNDWATER MONITORING

Groundwater monitoring of the shallow groundwater will be conducted to monitor the performance of the remedial alternative and insure that the residual contamination is not migrating beyond the Locality of the Facility.

8.1.5 REMEDIAL DESIGN WORKPLAN

A remedial design workplan will be developed to identify the any remaining data needs in order to adequately design the remedial alternative, lay out the steps needed to successfully implement the recommended alternative. This includes the various permits required to thermally treat petroleum contaminated soil, the various sampling that will need to be performed to verify 'clean' soil, adequately treated soil, and to segregate characteristic hazardous waste from solid waste.

8.1.6 PERIODIC MONITORING, REVIEW AND CONTINGENCY PLAN

There are a number of uncertainties at the site that make it difficult to predict the long-term effectiveness of the selected remedial action alternatives described above, including:

- Heterogeneity in the subsurface.
- Potential changes in future beneficial use of groundwater or surface water.
- Potential changes in future land use and zoning.
- Changes in community concerns regarding remedial actions at the site.
- Long-term performance of the remedial action.

Because of these uncertainties, a periodic monitoring, review and contingency plan will be developed that will evaluate the performance of the remedy, and any changes that may affect the ability of the remedy to meet the RAOs. The objective of the periodic monitoring, review and contingency plan will be to maintain the overall protectiveness of the selected remedy by establishing a series of decision criteria and related response actions for each potential area of uncertainty identified above, and the RAOs identified in Section 5 of this document.

The first component of the contingency plan will be a review of both performance monitoring data and local land and water uses. If monitoring data exceed trigger values in select monitoring wells, an expanded monitoring program will be initiated. If the supplemental monitoring indicates that the RAOs are not being met, additional remedial actions will be evaluated to ensure that human health and the environment are protected.

8.2 RESIDUAL RISK ASSESSMENT

The residual risk related to the selected RAA is below acceptable risk levels. The two human health exposure pathways for which the baseline risk exceeded acceptable risk levels are dermal contact with groundwater by the excavation worker receptor and ingestion of surficial soils by the outdoor industrial worker receptor. The first pathway would be managed by the groundwater extraction and treatment system and institutional controls on excavations. The second pathway would be managed by the excavation of the dioxins/furans-containing soil that exceeds the target cleanup levels. Potential risks to ecological receptors in the discharge pond due to migration of the contaminated groundwater into the surface water will be prevented by the hydraulic control provided by the GWET system.

9. PUBLIC COMMENT AND NOTICE

DEQ's notice of the proposed remedial action was published in the Secretary of State's Bulletin on October, 1, 2004, as well as in the Klamath Falls Herald and News. The 30-day public comment began on October 1 and ended on November 1, 2004. No comments were received during the comment period.

10. FINAL DECISION OF THE ADMINISTRATOR

The selected remedial action for the JELD-WEN of Oregon / Pelican Bay Facilities in Klamath Falls, Oregon is protective and to the maximum extent practicable, is cost reasonable, effective and implementable. The selected remedy therefore satisfies the requirements of ORS 465.315 and OAR 340-122-90. The detailed evaluation of how the selected remedial action meets the regulatory requirements is provided in Section 7 and 8 of this report.

Joni Hammond, Eastern Region Administrator

Oregon Department of Environmental Quality

12-3-04

Date

11. APPENDIX

ADMINISTRATIVE RECORD INDEX

JELD-WEN of Oregon / Pelican Bay
Klamath Falls, 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 JWO/PB site are listed below. Additional background and supporting information can be found in the JWO/PB project file located at DEQ Eastern Region Office, 2146 NE Fourth St., Bend, Oregon.

SITE-SPECIFIC DOCUMENTS

AGI Technology, 1996. Supplemental Remedial Investigation, JELD-WEN of Oregon/Pelican Bay, Klamath Falls, Oregon. May 1996.

Environmental Management Services, Inc., 2002. Pilot Test Report Biolance/Electrically Enhanced Bioactive Barrier. September 9,2002.

JELD-WEN, inc., 1994. Sampling and Analysis Plan. September 30.

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SECOR International Incorporated, 1995. Phase I Remedial Investigation Report Including the September 1995 Groundwater Sampling Event. October 6.

SECOR International Incorporated. 1996a. Phase I Remedial Investigation Summary, Pelican Bay/JELD-WEN of Oregon. January 12.

SECOR International Incorporated. 1996b. Conceptual Ecological Evaluation-Private Canal, JELD-WEN of Oregon/Pelican Bay, Klamath Falls, Oregon. November 1.

SECOR International Incorporated. 1996c. Supplemental Remedial Investigation Report, Pelican Bay/JELD-WEN of Oregon. May 24.

SECOR International Incorporated. 1998. Focused Remedial Investigation/Feasibility Study Workplan, JELD-WEN of Oregon/Pelican Bay Site, Klamath Falls, Oregon. March 19.

SECOR International Incorporated, 1999a. Groundwater Monitoring Work Plan. January 19.

SECOR International Incorporated, 1999b. Deep Water-Bearing Zone Pump Test Work Plan.

February 2.

SECOR International Incorporated, 1999c. Focused Remedial Investigation Report. July 7.

SECOR International Incorporated, 2000. Human Health Risk Assessment Workplan. June 22.

SECOR International Incorporated, 2001a. Baseline Human Health Risk Assessment. March 20.

SECOR International Incorporated, 2001b. Revised Baseline Human Health Risk Assessment Draft. December 19.

SECOR International Incorporated, 2002. Feasibility Study Work Plan. March 13.

SECOR International Incorporated, 2003. Draft Feasibility Study Report. April 11.

SECOR International Incorporated, 2004. Revised Final Feasibility Study. June 24.

STATE OF OREGON

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

Oregon's Hazardous Substance Remedial Action Rules, Oregon Administrative Rules, Chapter 340, Division 122, adopted by the Environmental Quality Commission in 1997.

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

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

Oregon's Water Quality Criteria, Chapter 340, Division 41, Table 20.

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

GUIDANCE AND TECHNICAL INFORMATION

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

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

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

DEQ, 1998c. Guidance for Conduct of Deterministic Human Health Risk Assessment. May 1998 (updated 5/00).

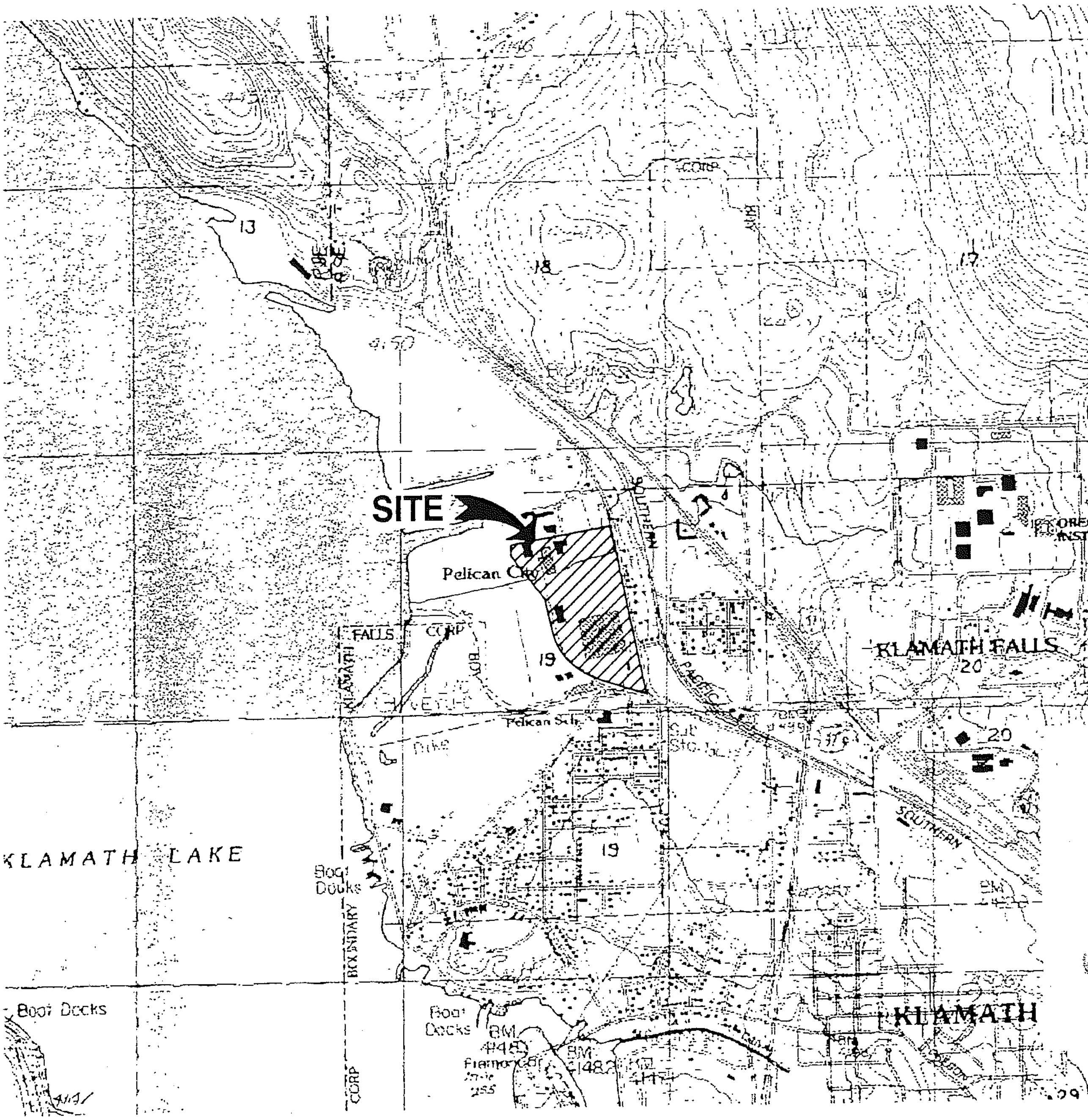
DEQ, 1998d. Guidance for Conducting Feasibility Studies. July 1998.

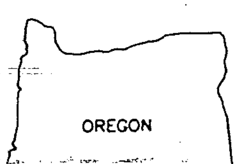
DEQ, 1998e. Guidance for Ecological Risk Assessment: Levels I, II, III, IV. April 1998 (updated 12/01).

DEQ, 1998f. Guidance for Identification of Hot Spots. April 1998.

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

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





QUADRANGLE LOCATION

N

0 1/2 1

APPROXIMATE SCALE (MILES)

REFERENCE: USGS 7.5 MINUTE QUADRANGLE; WOCUS, OREGON; 1985

7730 SW MOHAWK STREET TUALATIN, OREGON PHONE: (503) 691-2030/692-7074 (FAX)	FOR: JELD-WEN OF OREGON PELICAN BAY FEASIBILITY STUDY KLAMATH FALLS, OREGON		SITE LOCATION MAP	FIGURE: 1
	JOB NUMBER: 15IT.JWCKF.FS.0003	DRAWN BY: KAM	CHECKED BY: SRH	APPROVED BY: SRH	DATE: 03/22/04

15OT-JWCKF-FS-3-1(1)

N:/JELD-WEN

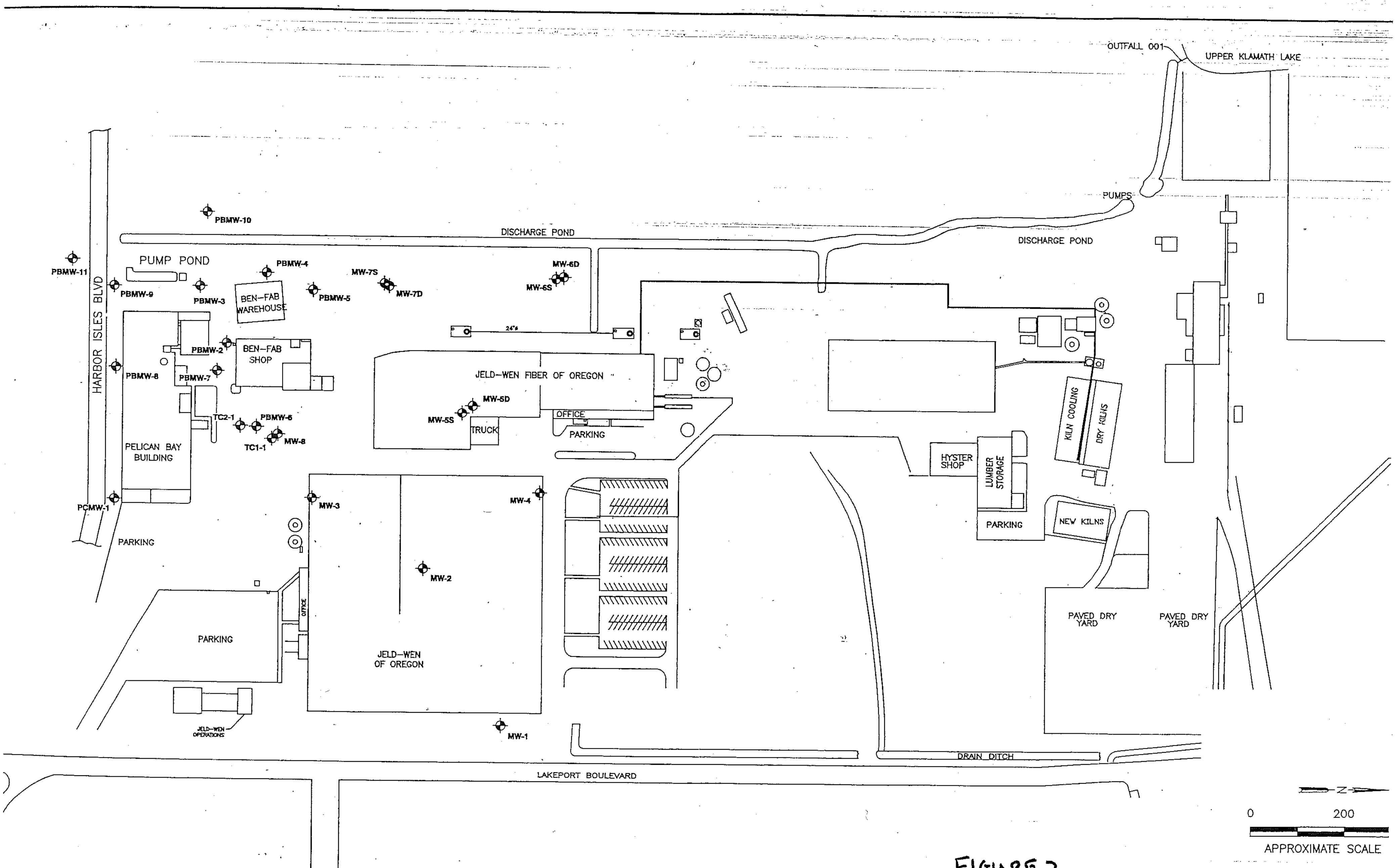


FIGURE 2

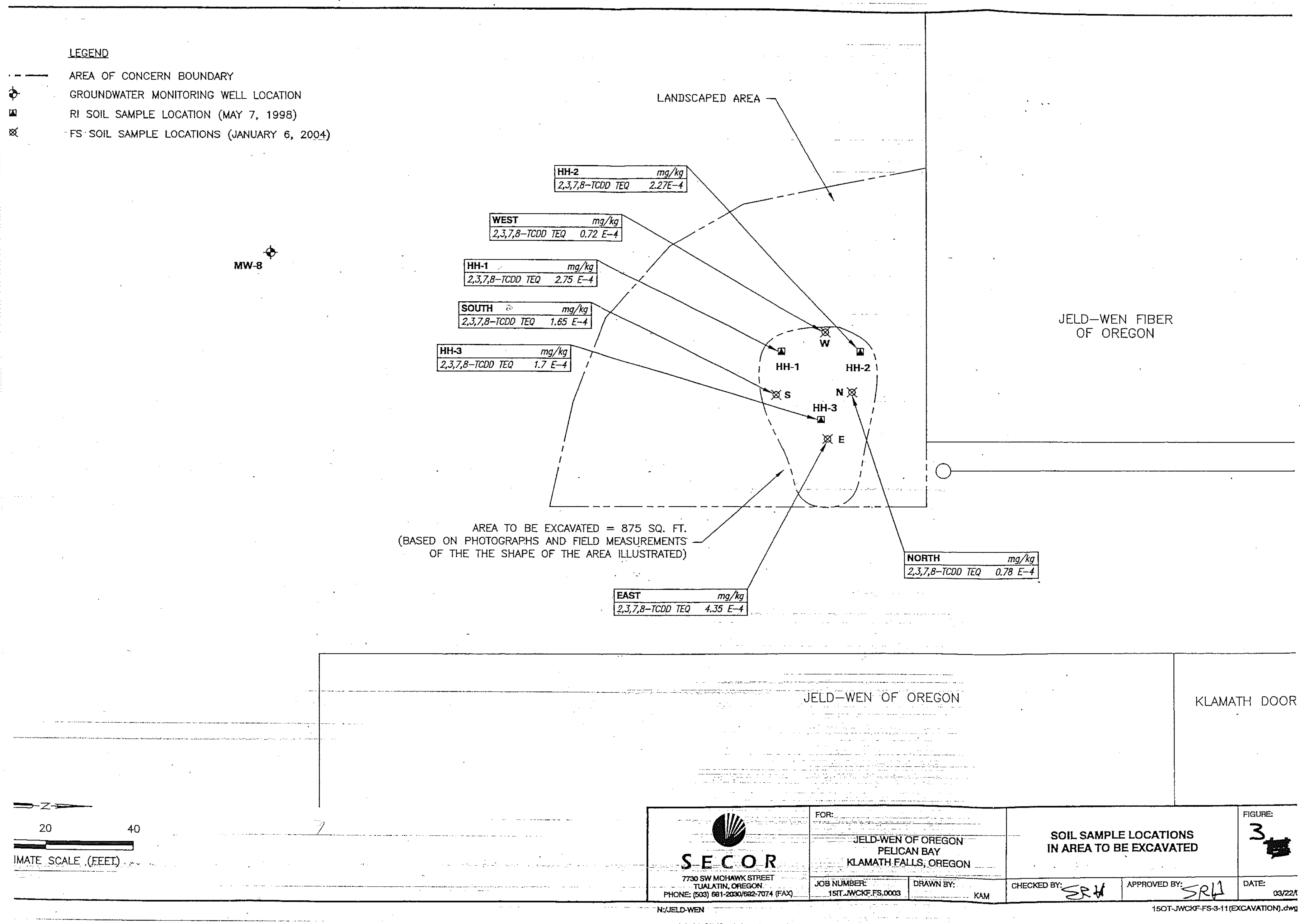
LEGEND

MW-5 GROUNDWATER MONITORING WELL LOCATION

SECOR 7730 SW MOHAWK STREET TUALATIN, OREGON PHONE: (503) 691-2030/692-7074 (FAX)	FOR: JELD-WEN OF OREGON PELICAN BAY KLAMATH FALLS, OREGON	SITE PLAN AND MONITORING WELL LOCATIONS
	JOB NUMBER: 15IT.JWCKF.FS.0003 / DRAWN BY: KAM	CHECKED BY: SRH / APPROVED BY: SRH

N:/JELD-WEN

15OT-JWCK



LEGEND
AREA OF CONCERN BOUNDARY
GROUNDWATER MONITORING WELL LOCATION
RI SOIL SAMPLE LOCATION (MAY 7, 1998)
FS SOIL SAMPLE LOCATIONS (JANUARY 6, 2004)
MW-8
LANDSCAPED AREA
HH-2 mg/kg 2,3,7,8-TCDD TEQ 2.27E-4
WEST mg/kg 2,3,7,8-TCDD TEQ 0.72 E-4
HH-1 mg/kg 2,3,7,8-TCDD TEQ 2.75 E-4
SOUTH mg/kg 2,3,7,8-TCDD TEQ 1.65 E-4
HH-3 mg/kg 2,3,7,8-TCDD TEQ 1.7 E-4
NORTH mg/kg 2,3,7,8-TCDD TEQ 0.78 E-4
EAST mg/kg 2,3,7,8-TCDD TEQ 4.35 E-4
W
HH-1
HH-2
N
S
HH-3
E
AREA TO BE EXCAVATED = 875 SQ. FT.
(BASED ON PHOTOGRAPHS AND FIELD MEASUREMENTS
OF THE THE SHAPE OF THE AREA ILLUSTRATED)
JELD-WEN FIBER OF OREGON
JELD-WEN OF OREGON
KLAMATH DOOR
20
40
IMATE SCALE (FEET)
SECOR
7730 SW MOHAWK STREET
TUALATIN, OREGON
PHONE: (503) 681-2030/682-7074 (FAX)
N:/JELD-WEN
FOR:
JELD-WEN OF OREGON
PELICAN BAY
KLAMATH FALLS, OREGON
JOB NUMBER: 15IT.JWCKF.FS.0003
DRAWN BY: KAM
SOIL SAMPLE LOCATIONS
IN AREA TO BE EXCAVATED
CHECKED BY:
APPROVED BY:
FIGURE: 3
DATE: 03/22/
15OT-JWCKF-FS-3-11(EXCAVATION).dwg

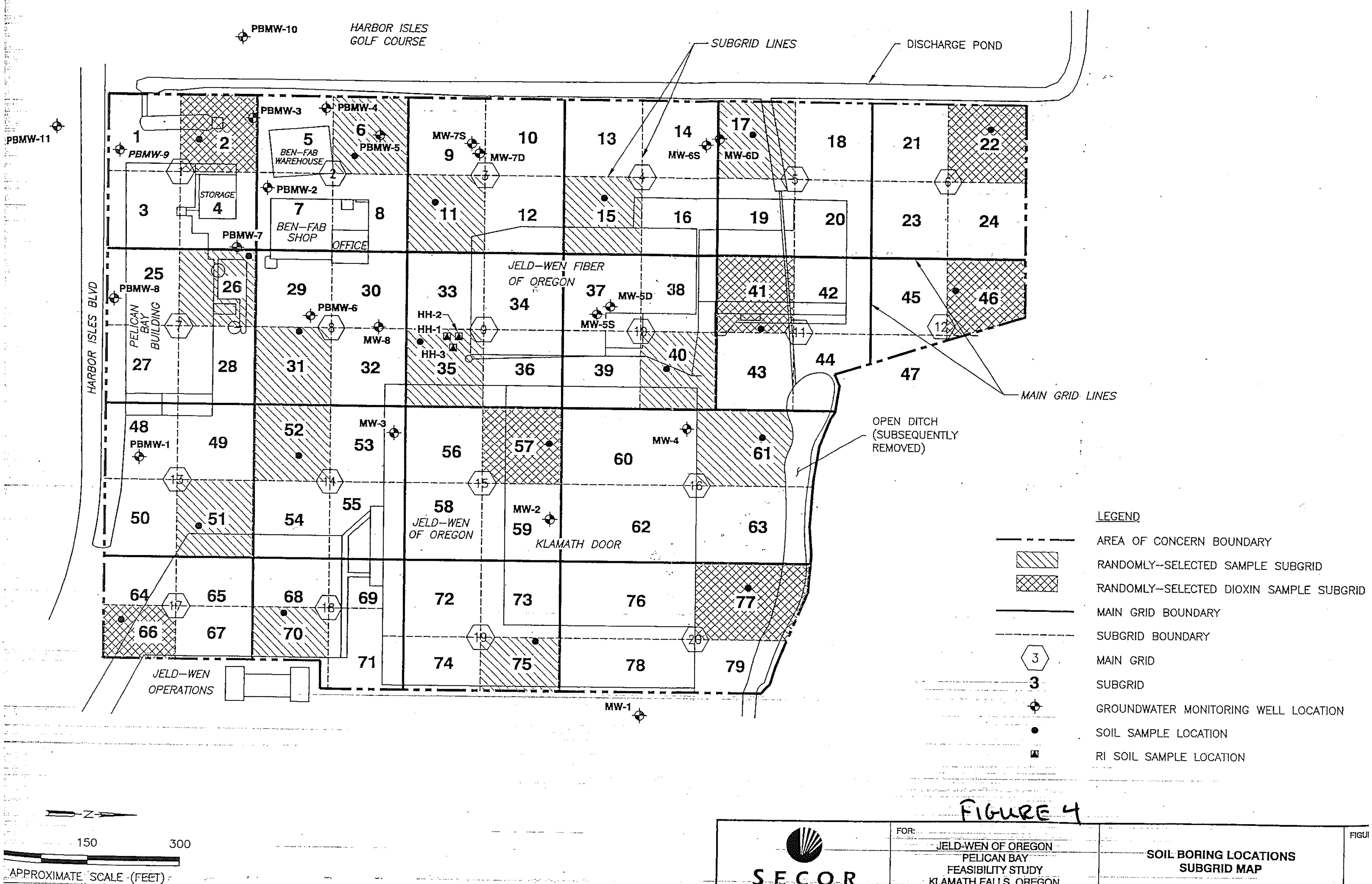
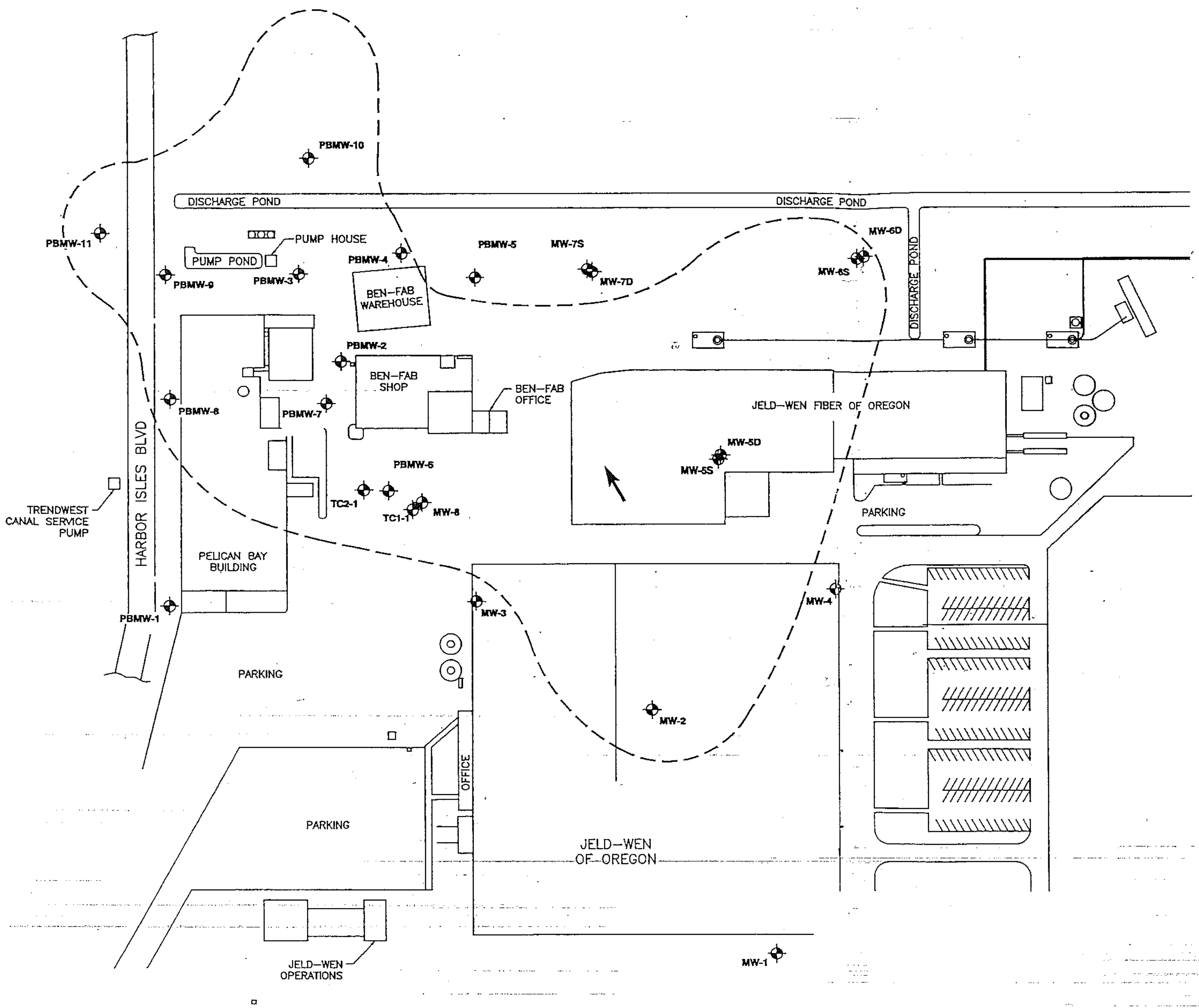


FIGURE 4

SECOR 7730 SW MOHAWK STREET TUALATIN, OREGON PHONE: (503) 691-2030/692-7074 (FAX)	FOR: JELD-WEN OF OREGON PELICAN BAY FEASIBILITY STUDY KLAMATH FALLS, OREGON	SOIL BORING LOCATIONS SUBGRID MAP	FIGU
	JOB NUMBER: 15IT.JWCKF.FS.0003	DRAWN BY: KAM	CHECKED BY: SRH	APPROVED BY: SRH	DATE

N:/JELD-WEN

15OT-JWCKF-FS-3-4(



LEGEND

MW-7S EXISTING MONITORING WELL LOCATION

GROUNDWATER FLOW DIRECTION

LOCALITY OF FACILITY BOUNDARY

N

0 160 320

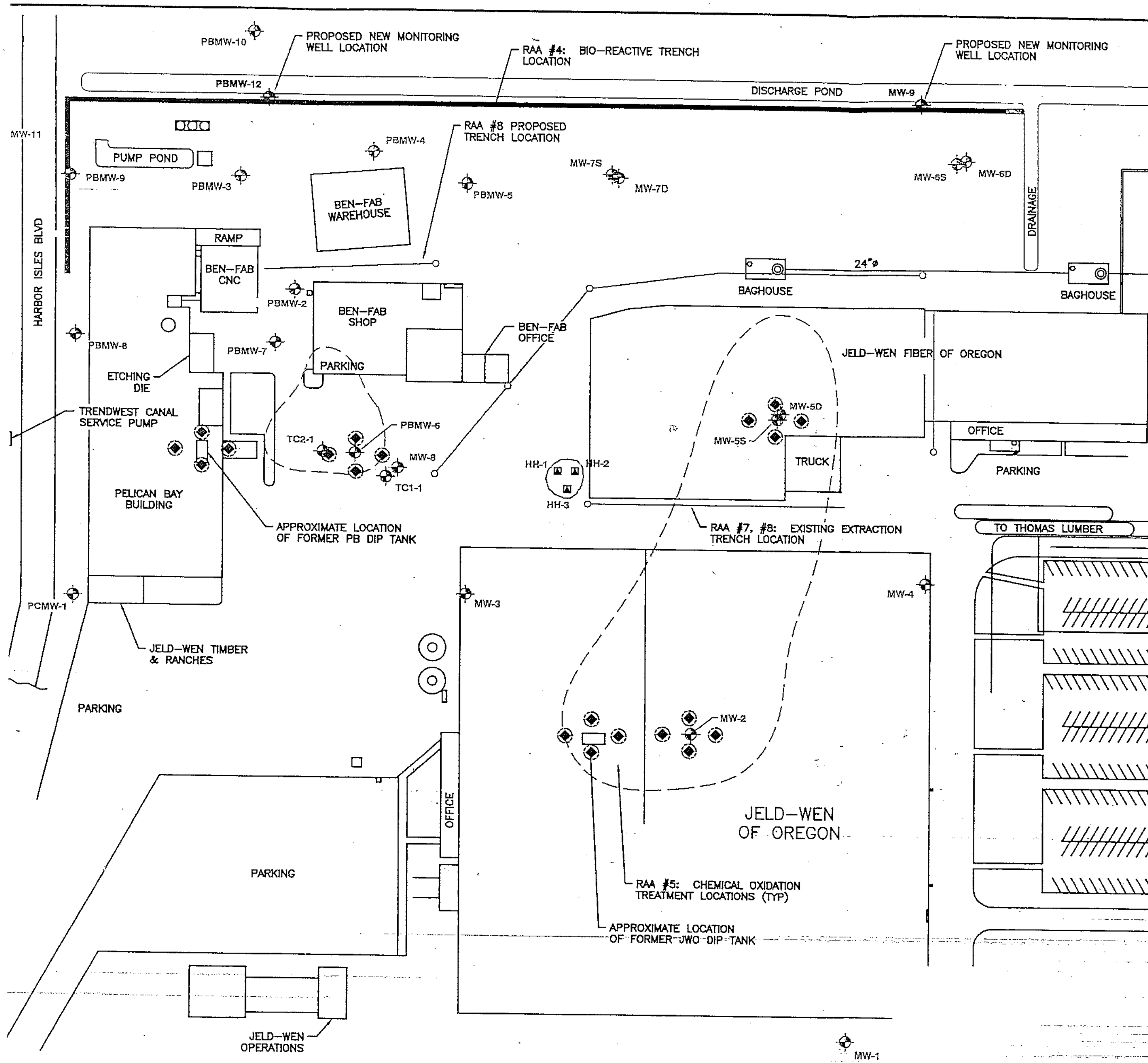
APPROXIMATE SCALE (FEET)

FIGURE 5

SECOR 7730 SW MOHAWK STREET TUALATIN, OREGON PHONE: (503) 691-2030/692-7074 (FAX)	FOR: JELD-WEN OF OREGON PELICAN BAY KLAMATH FALLS, OREGON		REVISED LOCALITY OF FACILITY		FIGURE
	JOB NUMBER: 15IT.JWCKF.FS.0003	DRAWN BY: KAM	CHECKED BY: SRH	APPROVED BY: SRH	DATE:

N:/JELD-WEN

15OT-JWCKF-FS-3-7E(L



LEGEND

MW-5	EXISTING GROUNDWATER MONITORING WELL LOCATION
MW-9	PROPOSED GROUNDWATER MONITORING WELL LOCATION (ALL RAAs)
	EXISTING EXTRACTION/INJECTION TRENCH (RAA #6, #7
	PROPOSED EXTRACTION TRENCH (RAA #8)
	PROPOSED AREA OF EXCAVATION OR SOIL COVER (RA #10)
	POTENTIAL HOT SPOT OF CONTAMINATION
	PROPOSED BIO-REACTIVE TRENCH (RAA #4)
	PROPOSED CHEMICAL INJECTION POINT (RAA#5)

N

0 150

APPROXIMATE SCALE (FEET

FIGURE 6

SECOR
7730 SW MOHAWK STREET
TUALATIN, OREGON
PHONE: (503) 691-2030/692-7074 (FAX)

FOR:
JELD-WEN OF OREGON
PELICAN BAY
KLAMATH FALLS, OREGON

PROPOSED REMEDIAL ACTION ALTERNATIVE CONCEPTUAL DESIGNS

JOB NUMBER:	DRAWN BY:	CHECKED BY:	APPROVED BY:
15IT.JWCKF.FS.0003	KAM		

FILE NAME: K:\1-CLIENTS\Jeld-Wen\JWCKF\FS\0003\15OT-JWCKF-FS-3-10(REMEDIAL).dwg | Layout Tab: Layout1 15OT-JWCKF-FS-3-10(R

Table 1. Historical Treatment System Data
JELD-WEN of Oregon / Pelican Bay
Klamath Falls, Oregon

Date	Groundwater				Liquid Phase Product		
	Total Volume (gallons)	Volume Per Period (gallons)	Period Length (days)	Average Flow Rate (1) (gpd)	Total Volume (gallons)	Volume Per Period (gallons)	Average Flow Rate (1) (gpd)
March 1987	299,340	299,340	82	3,650	3,475	3,475	42
November 1987	2,429,670	2,130,330	274	7,782	6,360	6,360	17
January 1989	6,236,310	3,806,640	426	8,939	9,890	9,890	13
December 1990	9,285,590	3,049,280	700	4,359	11,305	11,305	10
January 1992	11,681,530	2,395,940	396	6,050	12,570	12,570	8
January 1993	15,307,290	3,625,760	365	9,934	13,090	13,090	7
December 1993	18,094,574	2,787,284	334	8,345	--	--	--
January 1995	19,704,490	1,609,916	396	4,065	13,150	13,150	5
November 1995	21,820,620	2,116,130	303	6,984	13,376	13,376	5

Notes:

-- = Not measured

(1) Average flow rate = (total flow volume for the period) / (number of days in the period)

(2) Low product recovery from January 1989 through June 1989 was probably due to problems with the recovery trench pump and probes (personal communication, Randy Souders, BenFab Shop Manager, May 22, 1990).

Table 2 Summary of BHHRA Results
JELD-WEN of Oregon / Pelican Bay
Klamath Falls, Oregon

Receptor and Exposure Pathways	Hazard Index		Lifetime Excess Cancer Risk	
	RME	CTE	RME	CTE
Hypothetical On-Site Trench Worker				
Ingestion of COPCs in Soil	3.E-05	1.E-07	5.E-07	2.E-09
Dermal Contact with COPCs in Soil	5.E-05	2.E-07	1.E-07	6.E-10
Dermal Contact with COPCs in Groundwater	**5.E+01**	1.E-02	**8.E-03**	**4.E-03**
Inhalation of Vapors from Soil	7.E-05	1.E-06	3.E-09	3.E-11
Inhalation of Vapors from Groundwater	3.E-05	2.E-10	2.E-09	6.E-15
Inhalation of Particulates	3.E-06	5.E-08	5.E-08	1.E-09
Total	**5.E+01**	1.E-02	**8.E-03**	**4.E-03**
Hypothetical Outdoor Industrial Worker				
Ingestion of COPCs in Soil	2.E-05	1.E-06	**2.E-05**	3.E-07
Dermal Contact with COPCs in Soil	2.E-05	2.E-06	2.E-06	4.E-08
Inhalation of Vapors from Soil	3.E-05	5.E-07	3.E-08	2.E-10
Inhalation of Vapors from Groundwater	3.E-03	2.E-08	3.E-06	6.E-12
Inhalation of Particulates	2.E-09	3.E-10	2.E-09	7.E-11
Total	3.E-03	4.E-06	**2.E-05**	3.E-07
Hypothetical Indoor Industrial Worker				
Inhalation of Vapors from Soil	2.E-06	4.E-08	3.E-09	1.E-11
Inhalation of Vapors from Groundwater	3.E-05	3.E-10	4.E-08	8.E-14
Total	4.E-05	4.E-08	5.E-08	1.E-11

Notes:
Bold numerals indicate risk that exceeds DEQ acceptable risk levels.
HI = Hazard Index
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
COPC = Contaminant of Potential Concern

Table B. Remedial Technology Screening
JELD-WEN of Oregon / Pelican Bay
Klamath Falls, Oregon

Identified Remedial Technologies	Relevant Screening Criteria [1]			Comments	Retained (Yes/No)
	Effectiveness Low/Med/High	Implementability Low/Med/High	Cost Low/Med/High		
Engineering Controls					
Surface cap (clean fill and vegetative cover)	High	High	Low	None	Yes
Fill in discharge pond	High	High	High	None	Yes
Institutional Controls					
Administrative controls to ensure that excavation workers wear PPE	High	Medium	Low	None	Yes
Land use restrictions	High	Medium	Low	None	Yes
Treatment					
EEBB	Low	Low	High	Pilot test showed that this technology was not effective.	No
Existing groundwater extraction system	Medium	High	Low	None	Yes
Expanded groundwater extraction system	High	Medium	Medium	None	Yes
Reactive barrier	High	High	High	None	Yes
In-situ bioremediation	Low	Medium	Medium	The effectiveness of bioremediation is uncertain, and impermeable soils make oxygen and nutrient transfer difficult.	No
In-situ chemical oxidation	Medium	Medium	Medium	None	Yes
Excavation					
Spot removal of dioxins/furans impacted surface soil	Medium	High	Medium	The risk due to ingestion of surface soils by occupational workers is only slightly over acceptable levels, and excavation is significantly more expensive than capping.	No
Removal of PCP source areas	Medium	Low	High	Much of the PCP soil impact is beneath process buildings.	No

Table 4. RAA Evaluation Summary
JELD-WEN of Oregon / Pelican Bay
Klamath Falls, Oregon

	RAA#1 MNA	RAA#2 MNA and Deed Restrictions	RAA#3 MNA, Deed Restrictions, and Fill In Discharge Pond	RAA#4 MNA, Deed Restrictions, and Bio-Reactive Trench	RAA#5 MNA, Deed Restrictions, and In Situ Oxidation	RAA#6 MNA, Deed Restrictions, and Existing GWET System (Inactive)	RAA#7 MNA, Deed Restrictions, and Existing GWET System (Active)	RAA#8 MNA, Deed Restrictions, and Expanded GWET System	RAA#9 Excavation	RAA#10 Soil Cover
Protectiveness	1	2	8	8	4	2	6	10	10	8
Treatment of Hot Spots	2	2	2	2	8	2	6	9	NA	NA
Effectiveness	1	2	3	3	4	2	6	9	10	8
Long-Term Reliability	1	2	8	7	4	6	7	7	10	7
Implementability	10	9	7	5	5	9	9	8	9	8
Implementation Risk	5	5	5	6	5	6	5	5	5	6
Reasonableness of Cost	10	10	3	1	5	9	6	4	5	8
TOTAL	30	32	36	32	35	36	45	52	49	45

Notes:

Each RAA has been ranked on a scale of 1 to 10 for each remedy selection criteria. A score of one means that it does not meet the criteria (is worse). A score of 10 means that it meets the criteria fully (is better).

[a] The technology employed by this RAA has been effective at other PCC remediation projects, however, the extent of its effectiveness at this site would not be known until a pilot test was completed, and its effectiveness score has been lowered to reflect this uncertainty.

Table 5. RAA Cost Evaluation Summary
JELD-WEN of Oregon / Pelican Bay
Klamath Falls, Oregon

	RAA#1 MNA	RAA#2 MNA and Deed Restrictions	RAA#3 MNA, Deed Restrictions, and Fill In Discharge Pond	RAA#4 MNA, Deed Restrictions, and Bio-Reactive Trench	RAA#5 MNA, Deed Restrictions, and In Situ Oxidation	RAA#6 MNA, Deed Restrictions, and Existing GWET System (Inactive)	RAA#7 MNA, Deed Restrictions, and Existing GWET System (Active)	RAA#8 MNA, Deed Restrictions, and Expanded GWET System	RAA#9 Excavation	RAA#10 Soil Cover
CAPITAL COSTS										
MNA	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000		
Deed Restriction		$14,000	$14,000	$14,000	$14,000	$14,000	$14,000	$14,000		
Fill in the Discharge Pond			$270,000							
Bio-Reactive Trench				$530,000						
In Situ Chemical Oxidation					$192,000					
Re-Engineer Groundwater Extraction						$41,000	$41,000			
Expand Groundwater Extraction								$104,000		
Excavation									$23,000	
Soil Cover										$8,500
CAPITAL NET PRESENT WORTH	**$10,000**	**$24,000**	**$290,000**	**$550,000**	**$220,000**	**$65,000**	**$65,000**	**$130,000**	**$23,000**	**$9,000**
ANNUAL OPERATING COSTS										
Groundwater Monitoring	$10,000	$10,000	$12,000	$16,000	$16,000	$16,000	$16,000	$16,000		
Groundwater Extraction O&M						$0	$10,820	$15,480		
Monitoring and Certification										$740
Base Annual Operating Cost	$10,000	$10,000	$12,000	$16,000	$16,000	$16,000	$26,820	$31,480	$0	$740
Years of Operation	60	60	45	30	30	30	30	30	0	30
Rate of Return	7.5%	7.5%	7.5%	7.5%	7.5%	7.5%	7.5%	7.5%	7.5%	7.5%
OPERATION NET PRESENT WORTH	**$130,000**	**$130,000**	**$150,000**	**$190,000**	**$190,000**	**$190,000**	**$320,000**	**$370,000**	**$0**	**$9,000**
TOTAL NET PRESENT WORTH	**$140,000**	**$150,000**	**$440,000**	**$740,000**	**$410,000**	**$260,000**	**$390,000**	**$500,000**	**$23,000**	**$18,000**