EPA Region 5 Records Ctr.
249408

Proposed Plan for the Amendment to the Record of Decision (August 1, 1990) and the Explanation of Significant Differences (June 23, 2000) for the PCB Areas Operable Unit Crab Orchard National Wildlife Refuge Superfund Site, Marion, Illinois

INTRODUCTION

This proposed plan identifies the Preferred Alternative for addressing groundwater contamination at the PCB Areas Operable Unit (PCBOU) within the Crab Orchard National Wildlife Refuge Superfund Site, Marion, Illinois. It explains the United States Environmental Protection Agency (U.S. EPA) recommended change to the cleanup plan as previously specified in the Explanation of Significant Differences (ESD) signed on June 23, 2000 for the PCBOU. In addition, this Amendment includes summaries of other cleanup alternatives evaluated for use at this site. This document is issued by the U.S. EPA, which is the lead agency for implementing the cleanup activities required in the ROD, ESD, and this proposed amendment to the ROD for the PCBOU. The U.S. Department of the Interior/Fish and Wildlife Service (FWS), and the Illinois EPA are the support agencies. U.S. EPA, in consultation with the support agencies will select a final remedy for the site after reviewing and considering all information submitted during the 30-day public comment period. U.S. EPA, in consultation with the support agencies may modify the Preferred Alternative or select another response action presented in this Plan based on new information or public comments. Therefore, the public is encouraged to review and comment on all the alternatives presented in this proposed plan.

U.S. EPA is issuing this proposed plan as part of its public participation responsibilities under Section 300.435(c)(2)(ii) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This proposed plan summarizes information that can be found in greater detail in the Focused Feasibility Study (FFS) Report and other documents contained in the Administrative Record file for this site. U.S. EPA, FWS, and Illinois EPA encourage the public to review these documents to gain a more comprehensive understanding of the site and Superfund activities that have been conducted at this site.

SITE BACKGROUND

a. Site History:

The Crab Orchard National Wildlife Refuge (NWR) is located approximately 5 miles west of Marion, Illinois in Williamson County. It is near the center of the southern tip of the state, with the Mississippi River approximately 25 miles to the west and the Ohio River approximately 55 miles to the east. The Crab Orchard NWR (the refuge) currently comprises an area of approximately 43,500 acres of forested land, pine plantations, and cultivated lands. A portion of the refuge is set aside for industrial purposes. Three lakes are located within the refuge, including Crab Orchard Lake, a 7,000-acre man-made reservoir.

The Crab Orchard Site was included into the National Priorities List (NPL) in 1987. The FWS, an agency of the U.S. Department of the Interior (DOI) administers the refuge. Affected areas within the refuge are currently divided into seven separate operable units (OUs). These operable units are the Metals Areas OU, the Polychlorinated Biphenyls Areas OU, the Explosives/Munitions Manufacturing Areas OU, the Miscellaneous Areas OU, the Water Towers OU, the Additional and Uncharacterized Sites (AUSOU) and the Lake Monitoring OU.

b. Record of Decision (August 1990):

The PCB Areas Operable Unit (PCBOU) included four distinct sites which contained soil and sediment contaminated primarily with PCBs, lead, and cadmium. These sites were the Job Corps Landfill Site (Site 17), the Water Tower Landfill Site (Site 28), Area 9 Landfill (Site 32), and the Area 9 Building Complex (Site 33). U.S. EPA signed a Record of Decision (ROD) for the PCB OU in August 1, 1990. The ROD selected the excavation, treatment, and on-site disposal of soil and sediments contaminated with PCBs, lead, and cadmium at the PCBOU. Schlumberger Industries Inc. (Schlumberger), as the Settling Defendant under the terms of a Consent Decree (May 13, 1991) signed with U.S. EPA and DOI, conducted the cleanup activities required in the ROD. Approximately 117,000 tons of soil and sediments contaminated with PCBs with concentrations greater than 25 mg/kg were incinerated in an on-site thermal treatment unit. Soil contaminated with lead and cadmium with levels greater than 450 mg/kg and 10 mg/kg respectively, were stabilized/solidified, as necessary, to render them non-hazardous and disposed of in an on-site landfill. Soil and sediments contaminated with PCBs with levels less than or equal to 25 mg/kg were excavated, consolidated, and backfilled in an on-site repository. Schlumberger completed these cleanup activities in 1997.

In addition to the cleanup actions selected for the PCBOU, the 1990 ROD required that the groundwater at the cleaned up sites be monitored during and after construction of the remedial action. The purpose was to ensure that after completion of the remediation of the contaminated soils and sediments, the risk from all of the contaminants in the groundwater (measured at the source of contamination) above naturally occurring background levels shall not exceed any excess human health risk or any standard. If, at any time, groundwater at any of the remediated sites exceeds a 10^{-6} cumulative life-time cancer risk, or maximum contaminant levels (MCLs) for carcinogens, whichever is more stringent, and MCLs and maximum contaminant goals (MCLGs), or a hazard index of 1.0, whichever is more stringent for non-carcinogens, the ROD required U.S. EPA to determine additional remedial work to be performed at the PCBOU.

c. Explanation of Significant Differences (June 2000):

The groundwater monitoring activities conducted by Schlumberger indicated the presence of Trichloroethylene (TCE) and other chlorinated solvents at levels far exceeding their respective MCLs at Sites 32/33. Schlumberger conducted a groundwater investigation at Sites 32/33 in 1997 and 1998 and prepared a Groundwater Investigation and Focused Feasibility Study Report (GWI/FFS) to address groundwater contamination. Although TCE contamination was known to exist at the time of the ROD, the GWI discovered levels of TCE in groundwater as high as

66,000 parts per billion (ppb) or over 10,000 times the MCL of 5 ppb listed in the Safe Drinking Water Act. In addition to the TCE contamination, other chlorinated volatile organic compounds (CVOCs) including tetrachloroethene (PCE), Dichloroethene (DCE), and vinyl chloride were also discovered at levels above their respective MCLs. The GWI identified five separate known and potential CVOC source areas and associated groundwater plumes within the remediated sites 32/33. In June 2000, U.S. EPA issued an Explanation of Significant Differences (ESD) for the PCBOU and selected multiphase extraction (MPE) with limited phytoremediation and monitored natural attenuation as the appropriate remedial technology that was premised on source material removal. The remedy selected in the ESD was based on the assumption that the hydro-geological strata was similar in all of the source areas requiring remediation

BASIS FOR AMENDING THE ROD

Schlumberger conducted a Pre-Design investigation to further characterize the source areas at the PCBOU. The results of the investigation confirmed the presence of three major plumes in the groundwater. These are the plume near the Building I-1-23 area, the plume near the Buildings I-1-2/I-1-3 areas, and the plume under the Area 9 Repository. The investigation concluded that the hydro-geological strata near the Building I-1-23 area consisted of approximately 15 feet of an Upper Sand zone in between an Upper Clay and a Lower Clay zones, whereas near the Buildings I-1-2/I-1-3 Areas, the Upper Sand zone between the Upper and Lower Clay zones is either missing or discontinuous. The absence of the sand layer in the Building I-1-2/I-1-3 areas makes it difficult to achieve the remedial action objectives using the multiphase extraction technology without further enhancement. The physical differences among the separate CVOC source areas, and the expected difficulties in achieving the desired level or remediation effectiveness using MPE technology as specified in the ESD, were sufficiently significant to warrant reevaluation of remedial alternatives for the separate primary source areas. Amendment to the ROD/ESD is necessary and Schlumberger, as the Settling Defendant, prepared a FFS Report which reevaluates various alternatives to address groundwater contamination at the three major plume areas.

SITE CHARACTERISTICS

a. Site Geology

The Crab Orchard National Wildlife Refuge is located in Southern Illinois, just south and west of the city of Marion. The Refuge consists of approximately 43,500 acres of land primarily within Williamson County, extending west and south into Jackson, Union, and Johnson Counties. Crab Orchard Lake is the largest of several lakes within the Refuge. The western portion of the Refuge around Crab Orchard Lake is open to public use for recreational purposes, while the eastern portion of the Refuge is a wildlife sanctuary that is closed to general public access. Land around the eastern portions of Crab Orchard Lake is also used for industrial purposes.

The construction of Crab Orchard Lake was completed in 1940 as part of The Crab Orchard Project for Land Utilization. The dam that impounds the waters of Crab Orchard Creek and its tributaries, creating Crab Orchard Lake reservoir, is located at the extreme western end of the

lake and has a spillway elevation of 405 feet M.S.L. Crab Orchard Lake is approximately 9 miles long and varies in width from approximately 1.5 miles in the west near the dam to approximately 0.5 mile in the eastern end. The resulting surface area of the lake is 6,965 acres with a watershed drainage area of 72,525 acre-feet. The average water depth varies over the area of Crab Orchard Lake from approximately 2 to 9 feet with a maximum depth of 30 feet. The majority of the northern boundary of the PCBOU area terminates at a bay on Crab Orchard Lake.

b. Site Geology:

(1) Unconsolidated Sediment

The site is underlain by Recent and Quaternary unconsolidated deposits ranging from 30 to 100 feet thick. The unconsolidated deposits consist of the following units, listed in order from the ground surface downward.

Upper Clay

The Upper Clay occurs from the ground surface to depths of approximately 25 feet bgs beneath most of the site, but thins to approximately 15 feet in the north near Crab Orchard Lake. The Upper Clay consists of weakly bedded, mottled brown and gray silty clays and clayey silts, with occasional silty sand seams and lenses. Many boring logs indicate structure within the Upper Clay, including laminar bedding or alternating 2- to 3-inch beds of finer and coarser material within the clay and silt, especially in the lower half of the unit beneath the Area 9 Repository. Vertical to sub-vertical fractures have been observed throughout this unit. The calculated hydraulic conductivity of this unit is on the order of 10^{-4} to 10^{-6} cm/s, which is consistent with a silt or loess. The general composition and structure of the Upper Clay indicates that it is a weathered loess deposit, possibly underlain in some locations by slackwater lake deposits.

Upper Sand

The Upper Sand occurs at elevations between approximately 380 feet and 400 feet above mean sea level (MSL) and varies in thickness from 1 to 2 feet in the southern part of the site to approximately 20 feet in the western part and 15 feet in the northwestern part. The Upper Sand is possibly absent in the southeastern and central portions of the site, where the Lower Clay rises above approximately 400 feet MSL. Composition of the Upper Sand ranges from a clayey sand to a well-graded sand. In some locations, fine layering within the Upper Sand is noted in the boring logs, and there is a general coarsening downward sequence at most locations. This unit is consistent with either a glacio-lacustrine or a glacial outwash deposit.

Lower Clay

The Lower Clay occurs between elevations of approximately 340 feet MSL and 410 feet MSL, with the higher elevations in the southern and south-central portions of the site. The upper surface of the Lower Clay unit is eroded to form hills and valleys, with upper surface elevations

varying from 380 feet to 410 feet MSL. This unit ranges in composition from a silty clay to a clayey silt and contains a trace to little fine sand and angular gravel. The gravel content includes fragments of weathered sandstone and coal. The Lower Clay has a very uniform color and texture with no depositional structures noted. Vertical to sub-vertical fracturing is common at the top of the Lower Clay. At some drilling locations, sandy interbedding was noted within the upper 20 feet of the Lower Clay. These sand lenses appear to be discontinuous and are not present beneath much of the site. The Lower Clay is representative of Illinoisan glacial till.

Lower Sand

The Lower Sand, where present, occurs immediately above the bedrock surface. The top of the Lower Sand occurs at approximately 340 to 350 feet MSL. This unit ranges from 10 to 20 feet thick in the northern portion of the site beneath Crab Orchard Lake to approximately 2 feet thick in the southwestern portion and is not present in the southern and southeastern portions where the bedrock surface rises above approximately 350 feet MSL. The Lower Sand is consistently logged as a silty sand, and is consistent with a glacial outwash deposit.

(2) Site Bedrock

The bedrock surface below Williamson County consists of Pennsylvanian rocks. These rocks are predominantly weak shales, but include thin (less than 25 feet thick) limestones, sandstones, and coal beds. The Pennsylvanian rocks generally have low porosity and permeability and yield small amounts of water through interconnected pores, fractures, and joints.

Bedrock encountered during groundwater investigations at the PCBOU was described as a gray fine-grained micaceous sandstone, and drilling logs indicate that it is competent and well cemented. The sandstone has been identified as a part of the Carbondale Formation.

Topographically, the top of the bedrock surface slopes to the north and west toward Crab Orchard Lake. Bedrock elevations range from approximately 400 feet MSL in the southern and southeastern portions of the site to approximately 320 to 340 feet MSL in the northern and western portions of the site, respectively.

(3) Geology in VOC Source Areas

Although the geology encountered at each individual VOC source area can generally be described as above, each source area has distinct geologic features, as summarized below.

Building I-1-2/I-1-3 Area

Bedrock is very shallow in this area, generally within 30 feet of the ground surface near Building I-1-2, sloping downward to the north, east, and west.

The Lower Sand unit does not exist in this area due to the shallow bedrock.

The Upper Sand zone does not exist in northern, western, and southern portions of this area. The Upper Sand pinches out against the Lower Clay where the Lower Clay rises above approximately 405 feet MSL.

The easternmost extent of the Upper Sand zone at this VOC source area is near the western side of Building I-1-2, and the unit thickens to approximately 20 feet to the west near Highway 148.

Building I-1-23 Area

The Upper and Lower Sand zones are both present in this area. Bedrock occurs at approximately 100 feet below ground surface (bgs).

The upper surface of the Lower Clay zone appears to have an incised channel running from south to north through the source area.

The Upper Sand varies in thickness from 7 feet on the edges of the channel in the Lower Clay to nearly 20 feet in the center. The Upper Sand also appears to thin to the south of the Building I-1-23 Area.

Area 9 Repository

The Repository fill material ranges in thickness up to approximately 35 feet and is underlain by the Upper Clay zone.

Bedrock occurs at approximately 100 feet below original ground surface beneath the Repository.

The Upper Sand zone is not present beneath the Area 9 Repository.

The lower portions of the Upper Clay zone at the Repository indicate lacustrine features such as finely banded silts and clays, varves, and occasional sandy lenses.

Building I-1-36A Area

The Upper Sand zone is present beneath the entire Building I-1-36A area, and ranges in thickness from 8 to 18 feet.

The Upper Sand zone appears to thin slightly to the north.

South of Area 9 Repository

The Upper Sand zone appears to be continuous beginning approximately 250 feet south of the Repository and continuing to the south, and is not continuous to the north toward the Repository.

The Upper Sand zone thins to the west.

The Lower Clay surface rises in elevation from south to north to approximately 390 feet MSL in the north.

Lacustrine features are common in the lower portion of the Upper Clay zone in this location.

c. Groundwater Flow:

(1) Regional Hydrogeology

Regionally, the shallowest groundwater occurs within the unconsolidated glacio-lacustrine deposits that mantle the bedrock surface throughout much of Southern Illinois. Groundwater is often encountered within 20 feet of the ground surface. Shallow groundwater contours are a subdued reflection of the ground surface topography, with groundwater flowing from areas of high ground surface elevation to discharge areas at lower elevations, such as streambeds or lakes.

Water-bearing sand and gravel units within the glacial and lacustrine deposits of Southern Illinois are common but are generally thin. Groundwater yields from these units are not adequate for municipal supplies. In areas within the vicinity of the site, some thin scattered sand and gravel deposits provide adequate yield for farm and domestic water supplies.

The water-yielding characteristics of the Pennsylvanian bedrock are highly variable. In Williamson County, sandstone aquifer yields are adequate for domestic supplies throughout most of the county. The groundwater in these rocks becomes highly mineralized with depth, and production wells are rarely installed more than 200 to 300 feet into the bedrock. Domestic supplies from the sandstone aquifers are easily obtained at depths ranging from 50 to 80 feet.

(2) Groundwater Occurrence and Flow at the PCBOU

Generally, the groundwater table at the site is a subdued reflection of the topography, with flow northward toward Crab Orchard Lake. Groundwater flow within the clay units has a significant downward component, except in locations of groundwater discharge near surface water, while flow within the sand units is predominantly horizontal.

Upper Sand/Upper Clay

Groundwater is generally encountered from 1 foot to 15 feet below ground surface (bgs) in the Upper Clay zone at the site. The one exception is beneath the Area 9 Repository, where groundwater occurs approximately 21 to 25 feet below the top of the Repository (approximately 1 to 5 feet below the original pre-Repository ground surface elevation). Groundwater elevations at most monitoring well locations fluctuate approximately 3 to 8 feet during the year.

Shallow groundwater beneath the site generally flows northward toward Crab Orchard Lake but is affected locally by surface water drainage ways and by the Area 9 Repository. In the Building I-1-2 area, shallow groundwater flows radially away from a local groundwater high. A majority of the groundwater flow from this area is easterly, toward the East Swale, and westerly, toward the Heron Flats impoundment area located west of Highway 148. Horizontal hydraulic gradients in the Building I-1-2 area range from 0.003 to 0.006.

In the Building I-1-23 area, groundwater flows primarily northward toward Crab Orchard Lake, with a lesser component of flow to the northeast toward the Area 9 Repository. A groundwater mound is present beneath the Area 9 Repository. This causes shallow groundwater to flow to the east toward the Center Swale (located immediately adjacent to the Repository) and to the north toward Crab Orchard Lake. Horizontal hydraulic gradients in the Building I-1-23 area range from 0.004 to 0.006. Horizontal hydraulic gradients at the Area 9 Repository range from 0.01 to 0.02.

Lower Sand Unit

Groundwater in the Lower Sand unit flows to the north toward Crab Orchard Lake. The horizontal hydraulic gradient in the Lower Sand ranges from 0.0004 to 0.0005.

Over most of the site, the piezometric head in the Lower Sand is generally 1 to 3 feet lower than the head in the Upper Sand, indicating a downward potential. However, near Crab Orchard Lake, this is reversed, indicating an upward potential as groundwater discharges to the lake.

Groundwater Hydraulic Characteristics

In the Upper Clay, the calculated hydraulic conductivities range from 1.4×10^{-6} to 7.7×10^{-4} cm/s, with a geometric mean of 4.6×10^{-5} cm/s. These conductivity values are consistent with values reported for silt and loess of 10^{-7} to 10^{-3}cm/s.

In the Upper Sand, the calculated hydraulic conductivities range from 1.3×10^{-5} cm/s to 4.4×10^{-3} cm/s, with a geometric mean of 3.0×10^{-4} cm/s. These conductivity values are consistent with values reported for a silty sand or fine sand.

Hydraulic tests of sand seams within the Lower Clay showed consistent hydraulic conductivity values on the order of 10^{-6} cm/s. The calculated hydraulic conductivity for these sand lenses is an order of magnitude below the range expected for a silty sand and is generally more consistent with that of a glacial till.

In the Lower Sand, calculated hydraulic conductivities generally range from 9.4×10^{-4} to 4.1×10^{-3} cm/s, with a geometric mean of 1.9×10^{-3} cm/s. These values fall within the observed range for a silty sand of 10^{-5} to 10^{-2} cm/s documented in literature.

Vertical Flow

Vertical gradients are downward over most of the site, including at each of the identified VOC source areas. However, upward gradients are present near Crab Orchard Lake, where groundwater discharge to the lake is occurring. There are also vertical upward gradients immediately below and adjacent to the lower reaches of the swales and intermittent streams (where the swales and streams approach larger surface water bodies), where groundwater is discharging to surface water. One exception is the area downgradient to the west of Building I-1-2. At this location, there is still a downward component of groundwater flow, which suggests that the discharge area is still further to the west, near Heron Flats, on the western side of Highway 148.

d. Surface Water:

Surface water drainageways are present at several locations at the site. In the southwestern portion of the site, an intermittent stream that appears to originate near Buildings I-1-2/I-1-3 flows westerly toward Highway 148, passes beneath Highway 148 through a culvert pipe, and discharges into the Heron Flats impoundment area on the western side of the highway. The Center Swale originates on the eastern side of the main building complex and runs northeasterly along the eastern and southern sides of the Area 9 Repository before discharging to Crab Orchard Lake. The West Swale runs northward from the vicinity of Building I-1-23 and discharges to Crab Orchard Lake. The East Swale runs northward along the entire eastern boundary of the site and discharges to Crab Orchard Lake. The swales and the intermittent stream are often dry in their upper reaches, except following rainfall events. The lower reaches appear to be receiving groundwater inflow and are flowing over much of the year.

e. Groundwater/Surface Water Relationship:

Although often there is no standing or flowing water in the surface water drainageways at the site, the sediment in the lower reaches of the swales is often moist. This may indicate that groundwater is discharging to the lower reaches of the swales but at a rate that will not result in flowing water. It appears that the lower reaches of the swales and the intermittent stream are zones of groundwater discharge during most, if not all, of the year.

f. Groundwater Contaminant Sources and Plumes:

Volatile organic compounds, particularly PCE; TCE; cis-1,2-DCE; and vinyl chloride, make up the majority of the constituents detected in groundwater. Petroleum-related VOCs (e.g., benzene and toluene) have also been detected sporadically across the site. In addition, several less soluble chlorinated organic compounds (trichlorobenzene and dichlorobenzene) have been detected in groundwater samples from the VOC source areas near Buildings I-1-2 and I-1-23, and in the vicinity of Building I-1-36A.

VOC plumes within the Upper Sand zone extend from 500 feet to over 1,000 feet downgradient from each of the primary source areas. The distribution of VOCs in the groundwater plumes at the site is controlled largely by the hydraulic gradients in the shallow flow system; however, the transport of VOCs from the source areas is also dependent on the geology. In areas where the Upper Sand zone is not present or is discontinuous, VOCs have been transported shorter distances than in areas where the Upper Sand is continuous.

The contaminants in groundwater are dominated by chlorinated solvents, especially TCE, DCE, and PCE. Of these contaminants, TCE is present at the highest concentrations over most of the site. Contaminants occur mainly within the Upper Clay and Upper Sand zones; groundwater within the underlying Lower Clay and Lower Sand zones generally shows nondetectable concentrations. The conceptual model for transport of contaminants at the site is that VOC source residuals are slowly releasing dissolved VOCs into the groundwater; the dissolved VOCs then migrate vertically downward from the source zones (which are predominantly within the Upper Clay) through the Upper Clay into the Upper Sand zone. The high permeability of the Upper Sand zone relative to the Lower Clay zone results in groundwater flow that is primarily horizontal. Although there is a significant downward gradient from the Upper Sand to the Lower Sand over much of the site, the low permeability of the Lower Clay confining unit restricts the downward flow of groundwater and contaminants to the Lower Sand zone.

The permeable Upper Sand zone is the primary pathway for lateral contaminant migration in groundwater at the site. TCE and related compounds occur in groundwater plumes that extend up to 1,000 feet or more from the source areas in the Upper Sand zone. The general absence of contaminants in the Lower Sand zone indicates that, despite the existence of relatively strong downward gradients over portions of the site, contaminants have not reached the Lower Sand. Investigation data indicate that the process responsible for this attenuation is likely to be biodegradation of the chlorinated solvents within the upper strata, which is limiting the migration of contaminants into the Lower Clay and the Lower Sand units.

The concentrations of TCE observed in groundwater within the primary VOC source areas indicate the likely presence of VOC source mass at all of the source areas in the form of non-aqueous phase liquid (NAPL) residuals. The presence of NAPL residuals presents significant limitations on the potential effectiveness of remedial alternatives for the VOC source areas, and results in lengthy time periods required to achieve the groundwater Cleanup Standards specified in the Consent Decree - Scope of Work for Remedial Design/Remedial Action, for all of the remedial alternatives evaluated for the PCBOU.

(1) Descriptions of Individual Plumes

<u>Buildings I-1-2/I-1-3</u>

Based on the soil chemistry data, there appear to be two separate, but nearby, VOC source areas in the Building I-1-2 area. One source area is located directly east of Building I-1-2, just south of the former location of a manufacturing building. The second source is located just east of

Building I-1-3, north of the former building. The two source areas, although separate, form one plume to the east and one plume to the west of the combined Buildings I-1-2/I-1-3 area.

These two plumes of VOCs extend downgradient to the east and west of the Buildings I-1-2/I-1-3 source areas. The orientations of these plumes are consistent with the groundwater flow pattern in the area. Transport of contaminants to the north and south appears to be very limited in extent. A groundwater divide effectively splits the groundwater flow at the source areas to the east and west. In addition, the Upper Sand zone appears to be absent to the north and to the east of Buildings I-1-2/I-1-3. This also contributes to the limited groundwater flow from the Buildings I-1-2/I-1-3 source areas to the north or south.

The primary VOC constituents detected in groundwater wells nearest to the Building I-1-2 source area are TCE and DCE. However, a tentatively identified compound (TIC), 1,1,2-trichloro-1,2,2-trifluoroethane (Freon113), has also been detected in groundwater in this source area. In addition, historical data indicate the presence of significant concentrations (on the order of 10 to 100 ppb) of trichloro-, dichloro-, and monochloro- benzenes. These compounds have low water solubility (19 ppm to 500 ppm) compared to TCE (1,100 ppm) and DCE (6,400 ppm), and are generally restricted to the immediate source area.

Investigation data indicate the importance of the Upper Clay as the primary source of VOCs leaching downward into the Upper Sand zone in this area, although the Upper Sand is not present throughout this source area. Downgradient to the west, groundwater within the Upper Clay contains low to nondetectable VOC concentrations, while groundwater from the Upper Sand in the same location contains significant VOC concentrations. The data indicate that, while the highest VOC concentrations occur within the shallow fine-grained sediment (Upper Clay) in the source area, lateral transport of VOCs occurs primarily within the Upper Sand, and downgradient areas of the Upper Clay are not impacted.

The VOC plume to the west of Building I-1-2 is of a greater extent, and contains higher VOC concentrations, than the plume to the east. The difference in VOC distribution is explained by the geology in this local area. The Upper Sand thickens to the west, which allows significant transport of contaminants, but appears to be discontinuous to the east, which limits lateral transport in that direction. As a result, the VOC plume to the east extends only approximately 800 feet downgradient toward the East Swale, while to the west total VOC concentrations on the order of 2,000 Cg/L persist more than 1,300 feet downgradient of the source area. Transport of VOCs to the west is toward the intermittent stream and low-lying area on the east side of Highway 148. However, no significant concentrations of VOCs have been detected in groundwater at the low-lying area near the highway.

Building I-1-23

Concentrations of VOCs on the order of 66,000 ppb extend in the groundwater plume from the Building I-1-23 source area northward (downgradient) to Crab Orchard Lake. Similar to the Building I-1-2 source area, the primary VOC constituents detected in groundwater nearest to this

source area are PCE, TCE, and DCE; however, significant concentrations of chlorobenzene, and much lower concentrations of trichlorobenzene, have also been detected at the Building I-1-23 source area. As in the Building I-1-2 plume, trichloro- and monochloro-benzenes have not been detected in the plume originating at the Building I-1-23 area.

The vertical distribution of VOCs within the Building I-1-23 source area saturated zone is very similar to that observed in the Building I-1-2 source area. Shallow groundwater within the Upper Clay zone shows total VOC concentrations one order of magnitude higher than groundwater at the same location within the Upper Sand. Unlike the Building I-1-2 area, however, total VOC concentrations in the Upper Sand and the Upper Clay in the groundwater near Crab Orchard Lake are very similar. This is the result of upward vertical gradients in the immediate vicinity of Crab Orchard Lake that cause upward movement of impacted groundwater from the Upper Sand, through the Upper Clay, and discharge to the West Swale and to Crab Orchard Lake.

Area 9 Repository

A plume of VOCs extends eastward from beneath the Area 9 Repository toward the Center and East Swales, and some migration of VOCs has occurred to the north toward Crab Orchard Lake. The distribution of contaminants emanating from soil beneath the Area 9 Repository is explained by the local water table configurations and by the geology. A groundwater mound is present beneath the Repository during much of the year, causing groundwater to flow both to the north toward Crab Orchard Lake and to the east toward the Center and East Swales. The thin and clay-rich nature of the Upper Sand beneath the Repository greatly reduces (by adsorption) the transport of VOCs away from the source area, particularly to the north where the deposit becomes very clayey. The transport of VOCs that does occur is primarily to the east, where the Upper Sand is thicker and of lower clay content. Therefore, it is believed that the Area 9 Repository plume discharges to the Center and East Swales.

The primary VOC constituents detected include PCE, TCE, and DCE. Few to no trichloro-, dichloro-, or monochloro-benzenes have been detected in groundwater at the Area 9 Repository. Concentrations of PCE and its degradation products are highest within the source area. TCE, DCE, and vinyl chloride are transported downgradient of the source area, but unlike the VOC plumes from the other source areas at the site, the concentrations of these compounds generally decrease in downgradient locations. The decrease of biodegradation products in the downgradient areas of the plume is the result of relatively low groundwater flow velocities in the vicinity of the Area 9 Repository. Low flow velocity limits the transport of PCE source material downgradient, thus reducing concentrations of biodegradation products in these areas.

Only low to non-detected concentrations of VOCs have been detected in the Upper Sand to the northeast of the Area 9 Repository. Variations in groundwater chemistry at this location appear to be the result of variations in the groundwater flow direction and possibly seasonal water table fluctuations. No VOCs have been detected in the Upper Sand east of the East Swale, and only a trace of TCE has been detected at the water table well at the same location. The groundwater chemistry data, in addition to the upward hydraulic gradients, indicate that groundwater flowing

east from the Area 9 Repository is discharging to the East Swale. No significant groundwater contamination extends east of the East Swale.

Building I-1-36A

The primary VOC constituents detected in groundwater in the vicinity of Building I-1-36A are PCE, TCE, and DCE. Low concentrations of several dichlorobenzene compounds have also been detected. VOCs in groundwater in the area of Building I-1-36A form a plume, which extends first easterly toward the Center Swale, where it merges with a plume originating south of the Area 9 Repository, and then north and eastward toward the East Swale and Crab Orchard Lake. Here, the VOC plume from the direction of BuildingI-1-36A merges with the Area 9 Repository plume to the east of the Repository. Eastward transport of VOCs from the area of Building I-1-36A is aided by intermittent recharge from the Center Swale. Near Building I-1-36A, there is also a northerly component to the flow system that causes low VOC concentrations at the perimeter of the Building I-1-36A plume to merge with the Building I-1-23 plume. The western extent of VOC concentrations in groundwater in the area upgradient of Building I-1-36A is uncertain; however, the presence of low concentrations of dichlorobenzenes in the shallow groundwater on the western side of BuildingI-1-36A suggests that the source area is nearby.

South Side, Area 9 Repository

A plume, designated the South Side plume, appears to originate from a separate source area located to the south of the Area 9 Repository and to the east of the Center Swale.

The primary VOC constituents within this plume are PCE, TCE, and DCE, similar to the other site source areas. Unlike the other source areas, trichloro-, dichloro-, and monochloro-benzenes were not detected in the groundwater samples. However, carbon tetrachloride (CTET) was detected within the Upper Sand unit. Like the chlorobenzene compounds, CTET is relatively insoluble in water. Its presence in groundwater at these locations and its absence elsewhere at the site indicates that this plume has a separate source area located near the southern side of the Area 9 Repository.

The South Side plume merges with the Building I-1-36A plume (from the west) and extends to the northeast toward the eastern side of the Area 9 Repository, following the trend of the Center Swale. Here it merges with the Area 9 Repository plume. The combined VOC plume is then transported to the east and north, where it emerges as surface water in the East Swale, which then flows into Crab Orchard Lake.

PAST AND CURRENT SITE RISKS

At the time of the 1990 ROD, there were four sites (Sites 17, 28, 32, and 33) contaminated with PCBs, lead, and cadmium. For a complete description of site risks due to these contaminants, see the 1990 ROD. Remedial actions to cleanup the above contaminants were completed in 1997.

As stated earlier, the GWI Report identified the presence of TCE and other CVOCs in the groundwater in both the Upper Clay and Upper Sand zones in the vicinity of Buildings I-1-23 and I-1-2/I-1-3. Schlumberger, as the Settling Defendant, is presently conducting an investigation and a risk assessment to determine, if the occupants of the nearby Site 33 buildings are being exposed to indoor air concentrations of chemicals of concern from soil vapor intrusion at unacceptable levels. This proposed plan does not address any potential health risks due to soil vapor intrusion. If the risk assessment concludes that there is a potential threat to the occupants of these buildings due to soil vapor intrusion, U.S. EPA will determine additional remedial measures, as appropriate.

REMEDIAL ACTION OBJECTIVES

40 CFR 300.430(a)(1)(iii)(F) of the National Contingency Plan (NCP) states:

> "EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site. When restoration of ground water to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated ground water, and evaluate further risk reduction."

The State of Illinois has determined that the contaminated aquifer is a Class I Potable Groundwater Resource. Although the groundwater at this location is currently not used for drinking water purposes, the potential future groundwater use is for drinking water purposes. The Remedial Action Objectives are as follows:

- Restore contaminated groundwater at Sites 32/33 to Drinking Water Standards to the extent practicable
- Reduce or control, to the extent practicable, the impact of subsurface sources of volatile organic compounds on the groundwater quality.

SUMMARY OF REMEDIAL ALTERNATIVES

As stated earlier, there are three distinct plume areas namely, the Building I-1-23 Area, Buildings I-1-2/I-1-3 Areas, and the Area 9 Repository. All alternatives, with the exception of the No Action alternative include groundwater monitoring. The following includes a brief description of various components of the remedial alternatives included in this proposed plan. Detailed description of these components can be found in the FFS Report (Revision 3) for the PCB OU.

<u>Groundwater Extraction and Treatment</u> component of the remedial alternatives includes the pumping and treating of groundwater in the Upper Sand aquifer.

<u>Permeable Reactive Barrier (PRB)</u> component of the remedial alternatives includes the construction of a continuous barrier consisting of a mixture of zero-valent iron (ZVI) and sand immediately downgradient of the CVOC plume. The reactive zone of the PRB containing the

ZVI would be placed across the full depth of the Upper Sand zone, from the top of the lower clay to the bottom of the Upper Clay. As the groundwater flows through the PRB under natural gradients, the dissolved VOCs would be destroyed by chemical reactions with the ZVI.

Multiphase Extraction with Pneumatic Fracturing component of the remedial alternatives includes multiphase extraction (MPE) wells with enhancement by pneumatic fracturing to treat the VOC sources within the Upper Clay zone. The Upper Sand zone would also be treated with MPE wells. MPE is an in-situ technology that uses a high-vacuum pump(s) to extract liquid and vapor simultaneously from the subsurface through the extraction wells.

Phytoremediation component of alternatives includes planting of phreatophytic trees, including cottonwood, poplar, or willow, near the lake for phytoremediation of the shallow groundwater.

Engineered Wetland component of the alternatives includes a constructed engineered wetland treatment zone within a portion of the existing Crab Orchard Lake bay to intercept the VOC-impacted groundwater where it currently discharges into the bay, and to treat the discharging groundwater and surface water runoff that passes through the drainage swales to reduce VOC concentrations to nondetectable levels before water enters the main body of the lake.

Alternative concentration limits (ACLs) component are used in lieu of drinking water standards. ACLs will be established by developing baseline groundwater quality levels for the shallow aquifer near the groundwater/surface water interface within the plume discharge area, and then employing an analytical method to determine what level of groundwater contamination would constitute a statistically significant increase in VOC concentrations at selected points of compliance for groundwater quality. If future groundwater monitoring confirms a statistically significant increase in the contaminant concentrations, the need for further remedial action would be evaluated.

In-Situ Reductive Dechlorination includes the addition of a substrate into the source area soil and groundwater to stimulate the in-situ destruction of VOCs in both the Upper Sand and Upper Clay through biological reductive dechlorination.

Electrical Resistive Heating (ERH) technology is a thermally enhanced soil vapor extraction (SVE) technique that targets both contaminated soil and groundwater. This alternative involves the use of electrical current transmitted through the contaminated soil zones in the Upper Clay and Upper Sand, using a large number of metal electrodes to heat the groundwater to the boiling point, with removal of the resulting steam and hot soil vapor using a soil vapor extraction system, and processing/treatment of the extracted steam/water/vapor for removal of VOCs.

Monitored Natural Attenuation component of the remedial alternatives includes regular periodic monitoring of groundwater and surface water to assess the attenuation of contaminant plumes via natural chemical, physical, and biological processes. The monitoring data are evaluated to determine if the groundwater contaminant plumes are stable or receding, and to determine the rate of change of the VOC concentrations.

Institutional Controls component of the remedial alternatives prohibits the installation of potable water wells until the groundwater is restored to the drinking water standards.

The following remedial alternatives are in addition to the "No Action" alternative which is required under NCP to establish a baseline for comparison of the effectiveness of the remedial alternatives. The "No Action" alternative is considered ineffective at achieving the remedial action objectives of bringing the groundwater to beneficial uses or to reduce/control the impact of subsurface sources of the VOCs on the groundwater quality. The alternatives are numbered to correspond with numbers in the FFS Report.

Building I-1-23 Source Area and Plume:

Alternative A1 – Excavation (within 10 mg/kg CVOC contour in the Upper Clay zone), Groundwater Extraction and Treatment, Phytoremediation, and Institutional Controls

Alternative A2 – Excavation (within 1 mg/kg CVOC contour in the Upper Clay zone), Groundwater Extraction and Treatment, Phytoremediation and Institutional Controls

Alternative B – Excavation (within 10 mg/kg CVOC contour in the Upper Clay zone), Permeable Reactive Barrier, Phytoremediation and Institutional Control

Alternative C - Multiphase Extraction with Pneumatic Fracturing, Groundwater Extraction and Treatment, Phytoremediation and Institutional Control

Alternative D - Excavation (within 10 mg/kg CVOC contour in the Upper Clay zone), Phytoremediation including Engineered Wetland, Alternate Concentration Limits, and Institutional Controls
Alternative E - Phytoremediation including Engineered Wetland, Alternate Concentration Limits, and Institutional Controls

Alternative F - Excavation (within 10 mg/kg CVOC contour in the Upper Clay zone), In-Situ Reductive Dechlorination, Phytoremediation including Engineered Wetland, Alternate Concentration Limits, and Institutional Controls

Alternative G – Electrical Resistive Heating in source areas within an estimated 1 mg/kg CVOC zones through the full depth of Upper Clay and Upper Sand zones, Phytoremediation, and Institutional Controls

Buildings I-1-2/I-1-3 Source Area and Plume:

- Alternative A - Limited Excavation, Multiphase Extraction with Pneumatic Fracturing, and Institutional Controls
- Alternative B – Permeable Reactive Barrier and Institutional Controls

- Alternative C - Alternate Concentration Limits and Institutional Controls
- Alternative D – Excavation (within the 10 mg/kg VOC contour), Alternate Concentration Limits, and Institutional Controls
- Alternative E - Excavation (within the 10 mg/kg VOC contour), In-Situ Reductive Dechlorination with Pneumatic Fracturing, Alternate Concentration Limits, and Institutional Controls
- Alternative F – Electric Resistive Heating (within 10 mg/kg CVOC contour) and Institutional Controls

Area 9 Repository Source Area and Plume:

Alternative A - Phytoremediation and Monitored Natural Attenuation

Alternative B - Phytoremediation and Alternative Concentration Limits

EVALUATION OF ALTERNATIVES

a. Evaluation Criteria

EPA's evaluation of remedial alternatives is based on the nine criteria set forth in the National Contingency Plan (NCP), 40 CFR Part 300. These criteria are described below.

A remedial alternative is first judged in terms of the threshold criteria of protecting human health and the environment and complying with Applicable or Relevant and Appropriate Requirements (ARARs). If a proposed remedy meets these two criteria, it is then evaluated against the balancing and modifying criteria in order to arrive at a final recommended alternative.

Threshold Criteria

1. Overall protection of human health and the environment: USEPA determines whether an alternative adequately protects human health and the environment from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site.

2. Compliance with ARARs: USEPA evaluates whether an alternative attains applicable or relevant and appropriate requirements under federal environmental laws and state environmental or facility siting laws or provides grounds for invoking a waiver.

Balancing Criteria

3. Long-term effectiveness and permanence: USEPA considers the ability of an alternative to maintain protection of human health and the environment over time, and the reliability of such protection.

4. Reduction of contaminant toxicity, mobility, or volume through treatment: USEPA evaluates the degree to which an alternative uses treatment to address the principal threats posed by the site.

5. Short-term effectiveness: USEPA considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.

6. Implementability: USEPA considers the technical and administrative feasibility of implementing the alternative, such as relative availability of goods and services.

7. Cost: USEPA estimates an alternative's capital and O&M costs and calculates the present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollars.

Modifying Criteria

8. State acceptance: USEPA considers any concerns the state has raised with respect to the preferred alternative, other alternatives or with ARARs or ARAR waivers.

9. Community Acceptance: USEPA considers which components of the alternatives interested persons in the community support, have reservations about, or oppose.

c. Application of the Evaluation Criteria to the Cleanup Alternatives

As part of the evaluation process, each alternative is evaluated against the nine criteria outlined above. This process of alternative evaluation is discussed in detail in the FFS Report. The proposed plan briefly summarizes the outcome of this evaluation with the goal of identifying the alternative that best meets the nine criteria.

Building I-1-23 Source Area and Plume:

1. Overall Protection of Human Health and the Environment:

All of the alternatives, with the exception of the "No Action" alternative are protective of human health and the environment. All of the alternatives A through G include phytoremediation and institutional controls to prohibit installation of potable water wells until groundwater is restored to drinking water standards.

Alternative A2 provides the most assurance that human health and the environment will continue to be protected over the duration of the remedy. Under Alternative A2, Excavation (within 1 mg/kg CVOC contour in the Upper Clay), Groundwater Extraction and Treatment, Phytoremediation and Institutional Controls, the bulk of the soil contamination in the Upper Clay will be removed. The groundwater extraction and treatment system will consist of extraction

wells installed to capture groundwater contamination in the Upper Sand zone and an above groundwater treatment system to remove and treat contaminants from the extracted groundwater. At the downgradient edge of the plume, Poplar Trees, representing the Phytoremediation component of the remedy, will be planted to capture any residual groundwater contamination near the lake. As the final component of the remedy, Institutional Controls will be used to prevent future use of groundwater at the site.

By hydraulically controlling the plume over the duration of the remedy, only Alternatives A1 and Alternative A2 will prevent any further migration of the groundwater plume, adding a level of protection to human health and the environment that is not achieved with the other alternatives. Alternative A2 includes excavation of contaminated soils to the 1 mg/kg CVOC contour, resulting in a greater percentage of the source material being removed under Alternative A2 in comparison to Alternative A1.

Alternatives B, C, and G will take a much longer time-frame than Alternative A2 to meet the remedial action objective of bringing the groundwater to the drinking water standards. Alternatives D, E, and F will not achieve drinking water standards within a reasonable time frame since these alternatives include alternate concentration limits in lieu MCLs.

2. Compliance with ARARs:

All of the alternatives, with the exception of Alternatives D, E, and F, will meet the ARARs identified in the FFS Report. Alternatives D, E, and F include Alternate Concentration Limits and will need a waiver of the MCLs.

Based on the groundwater modeling results presented in the FFS Report, all of the Alternatives with the exception of Alternatives A2 and G, will take more than 100 years to meet the remedial objective of bringing the groundwater to drinking water standards.

By excavating most of the contaminated soil in the Upper Clay zone, Alternative A2 will remove approximately 97% of the NAPLs in the Upper Clay. NAPLs in the Upper Sand zone will be removed within 11 years of groundwater extraction and treatment and the remaining NAPLs in the Upper Clay zone will be removed within 14 years after excavation of the contaminated soil. Groundwater will be restored to drinking water standards within 40 years.

Based on the calculations presented in Appendix B of the FFS Report, the NAPL and sorbed VOC mass in the Upper Sand would be fully removed within approximately three years after the start of ERH treatment, and the NAPL and sorbed VOC mass would be fully removed from the Upper Clay in approximately 65 years from the start of treatment. Groundwater standards would be met over the entire plume area within approximately 75 years.

3. Long-Term Effectiveness and permanence

All of the alternatives, with the exception of the No Action alternative, include Phytoremediation or Phytoremediation with Engineered Wetland as a component of the remedy. Phytoremediation will be effective in achieving limited long-term effectiveness by reducing the volume of contaminated groundwater and the mass of chlorinated VOCs discharging to the Crab Orchard Lake or other surface water locations. Alternatives A1, A2, B, C, D, F, and G which include excavation and/or groundwater treatment as components of the remedy, will provide long-term effectiveness and permanence.

Although all of these alternatives provide long-term effectiveness and permanence, the remediation benefits will not be permanent until all of the NAPL mass had been removed from the Upper Clay by natural processes which will take more than 100 years. Alternative G, which includes the ERH technology will provide long-term effectiveness and permanence by bringing the groundwater to beneficial use in approximately 65 years. Alternative A2 provides the greatest degree of long-term effectiveness and permanence since most of the source material including NAPL mass will be removed in the Upper Clay zone and groundwater extraction and treatment in the Upper Sand zone will restore the groundwater to drinking water standards within the shortest time frame of 40 years compared to other alternatives.

4. Reduction of toxicity, mobility, and volume through treatment:

All of the alternatives are capable of achieving some reduction in the toxicity, mobility and volume of contamination through treatment. If successful, Alternatives B and F would likely result in the greatest reduction in toxicity because the contaminants would be broken down in the environment to non-toxic molecules. Alternatives A1 and A2 provide the greatest likelihood that the mobility of the contaminants would be reduced because any groundwater contamination remaining after source removal would be captured by groundwater extraction wells.

Regarding the volume of treatment, given the uncertainties in the mass of contamination at the site, it is difficult to determine to what degree each alternative would be successful in removing the remaining volume of soil and groundwater contamination at the site. Alternatives with a soil excavation component (A1, A2, C, D and F) would likely remove more soil contamination by volume. Alternative A2, soil excavation to the 1 mg/kg CVOC contour would remove the greatest amount of soil contamination by volume.

5. Short-Term Effectiveness:

Alternatives that include an excavation component would likely have the greatest short-term effectiveness. This includes A1, A2, B, D and F. This is because excavation would involve a quick reduction in mass removal and thus be effective over the short-term. The short-term effectiveness of Alternative E would likely be the lowest. Phytoremediation takes several growing seasons to become effective making the short-term effectiveness of this alternative low.

6. Implementability:

Alternatives A1 and A2 would probably be the easiest alternatives to implement. Excavation is straightforward and groundwater extraction is the most commonly applied remedial technology for groundwater contamination. Alternative G would likely be the hardest alternative to implement because it is a new treatment technology with large construction requirements. Treatment technologies like Permeable Reactive Barriers (Alternative B), Pneumatic Fracturing (Alternative C), In-situ Reductive Dechlorination (Alternative F) and Electrical Resistive Heating (Alternative G) also require specialized knowledge and training to implement.

7. Cost:

The estimated capital, annual O&M, and present worth cost for each of the alternatives has been calculated for comparative purposes and is presented in Table 1.

Table 1
Summary of Estimated Costs for Each Alternative

	Total Capital Cost	Total Cost	Total Present Worth Cost
A1	$830,000	$5,182,000	$3,719,000
A2	$2,747,000	$5,688,000	$4,914,000
B	$2,276,000	$5,836,000	$4,415,000
C	$1,319,000	$5,809,000	$4,352,000
D	$1,074,000	$3,062,000	$2,391,000
E	$706,000	$2,740,000	$2,046,000
F	$1,410,000	$3,564,000	$2,908,000
G	$2,930,000	$4,322,000	$3,837,000

Alternative E has the lowest total present worth cost and Alternative A2 has the highest. This is because Alternative E includes no removal of source material and limited operation and maintenance costs while alternatives A1 and A2 include a much longer projected period of operation and maintenance costs. Alternative G has the highest capital costs.

8. State Acceptance:

Illinois Environmental Protection Agency (IEPA, as a support agency, may concur with the preferred remedy selected by U.S. EPA.

9. Community Acceptance:

U.S. EPA will accept oral and written comments on this proposed plan during the public meeting on April 5, 2006 and in writing throughout the 30-day public comment period that runs from March 27, 2006 through April 25, 2006

Buildings I-1-2/I-1-3 Source Area and Plume:

1. Overall Protection of Human Health and the Environment:

All of the alternatives, with the exception of the "No Action" alternative, would provide adequate protection of human health and the environment by reducing the COCs through treatment, engineering controls, and/or Institutional Controls. Alternative F would provide the greatest degree of overall protectiveness by restoring the groundwater to drinking water standards within a reasonable time frame of approximately 80 years. All of the other alternatives would take much longer time frames (over 100 years) to restore the groundwater to beneficial use.

2. Compliance with ARARs:

All of the alternatives, with the exception of the "No Action" alternative, and Alternatives C, D, and E, would meet the ARARs identified in the FFS Report. Alternatives C, D, and E, which include Alternate Concentration Limits, would need a waiver of the MCLs.

Based on the groundwater modeling results, all of the alternatives with the exception of Alternative F, will take more than 100 years to bring the groundwater to beneficial use. Alternative F will restore groundwater to drinking water standards in approximately 80 years.

3. Long-Term Effectiveness and permanence:

Alternatives A, B, D, E, and F would be effective in the long term by reducing contaminant concentrations in groundwater. Alternative F provides the greatest degree of long term effectiveness and permanence since this alternative restores the groundwater to beneficial use within a much shorter time frame than the other alternatives.

4. Reduction of toxicity, mobility, and volume through treatment:

Alternatives A, B, E, and F use treatment to reduce toxicity, mobility, and volume of contaminants in the groundwater. Alternative F would be the most effective alternative at

reducing the toxicity, mobility, and volume of contaminants in a much shorter time frame (approximately 80 years) than all other alternatives (over 100 years).

5. Short-Term Effectiveness:

Alternative D would present the highest level of potential exposure of workers to VOCs during implementation than under other alternatives. This would be due to the potential exposures to the steam, hot water, hot soil vapor, condensate containing VOCs, and electrical hazards that would be present during operation of the ERH system. Under Alternatives A, D, and E, there would be a slightly higher risk of exposure of the general public to VOCs during transport of the contaminated soil for off-site disposal. Under alternative B, there would be short term exposure of the workers to VOCs during installation of the permeable reactive barriers. Precautions will be taken during excavation and off-site disposal of contaminated soil, construction of the extraction wells, installation of the permeable reactive barriers (Alternative B), and during the construction phase of the ERH system (Alternative F), to eliminate any risk to the public and the workers from potential health risks. Based on the groundwater modeling simulations, Alternatives E and F are expected to provide significantly greater and more rapid groundwater quality improvement than the other alternatives.

6. Implementability:

Of the three alternatives that provide significant CVOC source mass removal or destruction (Alternatives A, E, and F), Alternative E (excavation and in-situ reductive dechlorination) would be easier to implement than Alternative A (MPE) or Alternative F (ERH) at the source area. Treatment technologies like Permeable Reactive Barriers (Alternative B), Multi-phase extraction (Alternative A), In-situ Reductive Dechlorination (Alternative E) and Electrical Resistive Heating (Alternative F) also require specialized knowledge and training to implement.

7. Cost:

The estimated capital, annual O&M, and present worth cost for each of the alternatives has been calculated for comparative purposes and is presented in Table 2.

Table 2 Summary of Estimated Costs for Each Alternative			
	Total Capital Cost	Total Cost	Total Present Worth Cost
Alternative A	$1,935,000	$3,763,600	$3,257,000
Alternative B	$1,783,000	$7,059,500	$4,692,000
Alternative C	$77,000	$1,821,500	$1,237,000
Alternative D	$902,000	$2,647,430	$2,062,000
Alternative E	$1,753,000	$3,613,600	$3,084,000
Alternative F	$3,030,000	$4,414,600	$3,930,000

Alternative C has the lowest total present worth cost and Alternative B has the highest. This is because Alternative C includes no removal of source material and limited operation and maintenance costs while Alternative B includes high capital costs with a much longer projected period of operation and maintenance costs. Alternative F has the highest projected capital costs but because the alternative focuses heavily on contaminant removal, total operation and maintenance costs are less, making the present worth cost of this alternative lower than Alternative B.

8. State Acceptance:

Illinois Environmental Protection Agency (IEPA, as a support agency, may concur with the preferred remedy selected by U.S. EPA.

9. Community Acceptance:

U.S. EPA will accept oral and written comments on this proposed plan during the public meeting on April 5, 2006 and in writing throughout the 30-day public comment period that runs from March 27, 2006 through April 25, 2006

Area 9 Repository Source Area and Plume:

1. Overall Protection of Human Health and the Environment:

Both Alternatives A and B include Phytoremediation and Institutional Controls to prohibit installation of potable water wells until groundwater is restored to drinking water standards. Both the alternatives are protective of human health and the environment.

2. Compliance with ARARs:

The time frame to bring groundwater to drinking water standards is greater than 100 years under both these alternatives. Alternative B includes the use of Alternate Concentration Limits and will need a waiver of the MCLs.

3. Long-Term Effectiveness and permanence:

Both alternatives would provide the same degree of long-term effectiveness and permanence through the natural attenuation process, phytoremediation, and institutional controls.

4. Reduction of toxicity, mobility, and volume through treatment:

Both alternatives would provide the same degree of reduction in the toxicity, mobility, and volume of the site contaminants by allowing natural processes to breakdown the contamination into harmless by products. The phytoremediation component of both these alternatives would provide further reduction in volume, mobility, and toxicity through phytoremediation of the VOCs by the trees and prairie grasses.

5. Short-Term Effectiveness:

Both alternatives present a very low short- or long-term risk to the community, workers, and the environment during implementation. The existing natural attenuation process is effectively controlling the VOC source area impacts. Therefore, the time required for the vegetation planted for phytoremediation to reach maturity will not impair the short-term effectiveness.

6. Implementability:

The Monitored Natural Attenuation component of Alternative A and the Phytoremediation component of both Alternatives A and B are readily implementable.

7. Cost:

The estimated capital, annual O&M, and present worth cost for each of the alternatives has been calculated for comparative purposes and is presented in Table 3.

Table 3
Summary of Estimated Costs for Each Alternative

	Total Capital Cost	Total Cost	Total Present Worth Cost
Alternative A	$199,400	$1,854,800	$1,322,400
Alternative B	$174,800	$1,708,300	$1,210,300

8. State Acceptance:

Illinois Environmental Protection Agency (IEPA, as a support agency, may concur with the preferred remedy selected by U.S. EPA.

9. Community Acceptance:

U.S. EPA will accept oral and written comments on this proposed plan during the public meeting on April 5, 2006 and in writing throughout the 30-day public comment period that runs from March 27, 2006 through April 25, 2006

SUMMARY OF THE PREFERRED ALTERNATIVE

Building I-1-23 Source Area and Plume

The Preferred Alternative for the Building I-1-23 Source Area and Plume is Alternative A2, which includes Excavation (within 1 mg/kg CVOC contour in the Upper Clay zone), Groundwater extraction and Treatment, Phytoremediation, and Institutional Controls.

The preferred alternative was selected over other alternatives because it is expected to bring the groundwater to MCLs within a relatively shorter time frame of approximately 40 years with a short-term pump and treat duration of only 11 years. Based on the FFS Report, the total present worth cost of this alternative is $4,914,000. Although other alternatives cost less than the preferred alternative, based on groundwater modeling results, the time frame for all other alternatives to bring the groundwater to the drinking water standards is longer than 100 years, unless these alternatives included a long-term pump and treatment technology.

Excavation of VOC-contaminated material to the 1 mg/kg VOC contour in the Upper Clay zone would remove most of the NAPLs in the Upper Clay zone. After the excavation component of the remedy is complete, soil and groundwater samples at the Building I-1-23 Source Area and Plume are collected for the purpose of conducting a new groundwater modeling to arrive at a more accurate time frame for bringing groundwater to MCLs. An extraction well system will be installed to remove dissolved VOC source mass from the Upper Sand zone. Groundwater extraction will continue for only 11 years at which point all the NAPL mass is expected to be removed in the Upper Sand zone. It is expected that the rate of VOC mass removal closely matches the predictions made based on the results of the new groundwater modeling simulations. Five years after the extraction system is in place, U.S. EPA will evaluate the progress of VOC mass removal in the Upper Sand zone. If it is determined that it would take a significantly longer time frame than 11 years to remove NAPL mass in the Upper Sand zone, U.S. EPA will reevaluate the cleanup action at this plume area and may stop further extraction of groundwater in the Upper Sand zone and consider issuing a technical impracticality waiver.

Phytoremediation component of this preferred alternative includes the planting of phreatophytic trees, including poplar, or willow, near the lake for phytoremediation of the shallow groundwater. Institutional Controls prohibit the installation of potable water wells until the groundwater is restored to drinking water standards.

Building I-1-2/I-1-3 Source Area and Plume

The Preferred Alternative for the Building I-1-2/I-1-3 Source Area and Plume is Alternative F, which includes Electric Resistive Heating (within 10 mg/kg CVOC contour) and Institutional Controls.

This preferred alternative was selected over other alternatives because it is expected to restore the groundwater to drinking water standards within a relatively shorter time frame (approximately 80 years) than all other alternatives which are predicted to take significantly longer than 100 years based on the groundwater modeling results. Based on the FFS Report, the total present worth cost of this alternative is $3,930,000.

Area 9 Repository Source Area and Plume:

The Preferred Alternative for the Area 9 Repository Source Area and Plume is Alternative A, which includes Phytoremediation and Monitored Natural Attenuation.

Based on existing data, the Area 9 plume is being degraded by natural processes. Also, the Area 9 plume is not migrating very far downgradient of the source area. Therefore, the natural attenuation process together with phytoremediation and Institutional controls will provide the necessary protection of human health and the environment with the assurance that ongoing monitoring can be used to evaluate the success of this alternative.

Based on the information available at this time, U.S. EPA, IEPA, and FWS believe the preferred remedies would be protective of human health and the environment, would comply with ARARs, would be cost effective, and would utilize permanent solutions and alternate treatment technologies to the maximum extent practicable. Because the remedies, with the exception of the monitored natural attenuation, would treat the source materials constituting principal threats, the remedy also would meet the statutory preference for the selection of a remedy that involves treatment as a principal element. The preferred remedies can change in response to public comments or new information.

COMMUNITY PARTICIPATION

U.S. EPA, IEPA, and FWS provide information regarding the cleanup of the PCBOU within the Crab Orchard National Wildlife Refuge Superfund Site to the public through public meetings on April 19, 2006, the Administrative Record file for the site, and announcements published in Marion Daily Republican and Southern Illinoisan Newspapers. U.S. EPA, IEPA, and FWS

encourage the public to gain a more comprehensive understanding of the site and the Superfund activities that have been conducted at the site.