Remedial Alternatives Screening Report

Penta Wood Products Superfund Site

Wisconsin Department of Natural Resources

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→ The Power of Commitment

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1. Introduction

1.1 Purpose of this report

GHD Services Inc. (GHD) prepared this Remedial Alternatives Screening Report (Report) for the Penta Wood Products Superfund Site (Site) in Siren, Wisconsin on behalf of Wisconsin Department of Natural Resources (WDNR). The Site location is shown on Figure 1.1, and the Site plan is shown on Figure 1.2. Residential well locations surrounding the Site are shown on Figure 1.3.

The overall objective is to determine and select a feasible remedial action for the Site. This remedial alternative screening is the first phase necessary to identify alternatives to be assessed as part of a subsequent, more detailed analysis.

Remedial alternatives included with this screening included:

- In-situ chemical oxidation
- Ozone injection
- Oxygen release compound injection
- Hydrogen peroxide injection
- Air sparging
- Biosparging
- Natural source zone depletion (NSZD) and monitored natural attenuation (MNA)

1.2 Scope and limitations

This report has been prepared by GHD for Wisconsin Department of Natural Resources and may only be used and relied on by Wisconsin Department of Natural Resources for the purpose agreed between GHD and Wisconsin Department of Natural Resources.

GHD otherwise disclaims responsibility to any person other than Wisconsin Department of Natural Resources arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

1.3 Outcomes and Objectives

The overall objective is to determine a feasible remedial action for the Site. As a first phase necessary to achieve this outcome, GHD and WDNR completed a remedial alternatives screening of potential future remedial actions to identify which alternative(s) are the most viable and may require further assessment as part of a subsequent, more detailed analysis.

The focus of this screening is limited to the LNAPL and associated PCP concentrations in groundwater. The screening did not include an assessment of remedial alternatives associated with potential contaminant concentrations remaining in the vadose zone, surface soil, or materials consolidated within the CAMU.

2. Background

This Section provides a background including remediation objectives and previous remedial actions.

2.1 Remediation Objectives

Remediation objectives specified in Section VIII of the ROD are provided below:

Pentachlorophenol and arsenic are the primary risk drivers at the site. Pentachlorophenol is present in soils down to groundwater, is a major component of the LNAPL, and is present in the groundwater plume. Arsenic is present primarily in surface soils and in wetland sediments.

Pentachlorophenol: *The remedial objective is to reduce the PCP content in soils and groundwater to achieve compliance with ch. NR 720, Wisconsin Administrative Code, and in groundwater to achieve compliance with PALs, as established in ch. NR 140, Wisconsin Administrative Code, within a reasonable period of time, by removing free phase LNAPL, and associated highly contaminated groundwater, remediating PCP in the soils, and monitoring the intrinsic remediation of PCP in groundwater. Provisions will be installed to reduce direct contact exposure potential during the remedy. Site erosion control systems will also be constructed.*

Arsenic: *Highly contaminated arsenic soils will be immobilized and considered with other arsenic contaminated soils (above background), and secured, to achieve compliance with ch. NR 720. Soil contaminated with arsenic and other metals will be managed to essentially eliminate the direct contact exposure route and to protect groundwater. Performance of the metals consolidation area will be monitored.*

Erosion Controls: *An Erosion Control Plan will be implemented and maintained to prevent physical transport of contamination off-site and to protect the cap and consolidated areas from damage. The erosion control measures will be periodically inspected and repaired as necessary.*

These remedial actions will prevent the potential for future human health and environmental risks associated with exposure to PCP, fuel oil components, and metals in the soil, sediment, and groundwater by: (1) removing the ongoing source of PCP to the groundwater; (2) reducing residual PCP/oil concentrations in the smear zone and vadose soils; (3) immobilizing the metals-contaminated soils; (4) eliminating the exposure pathway to the metals-contaminated soils; (5) eliminating the exposure pathway to PCP/oil-contaminated soils and sediments while they are biodegrading; (6) eliminating overland flow of contaminated materials to the wetland; and (7) restoring groundwater to PALs.

United States Environmental Protection Agency (USEPA) has stated that the above remediation objectives do not apply to soil and groundwater directly under the limits of the corrective action management unit (CAMU), which contains consolidated material removed during the initial remedial actions at the Site. In addition, USEPA has stated that the remediation objective to achieve compliance with the Preventative Action Limits (PALs) will be revised to require compliance with the Enforcement Standards (ESs) in ch. NR 140, Wisconsin Administrative Code. WDNR and GHD understand that an Explanation of Significant Differences (ESD), ROD Amendment, or other decision document are necessary to make these changes.

Section XII.A. of the ROD states:

Environmental monitoring will be used to determine if the selected final remedy will achieve remediation objectives within 30-40 years. If monitoring data demonstrates that the remediation objectives will not be met within this restoration timeframe, more aggressive remedial actions will be considered.

Conditions at the Site have changed significantly since a remedial alternative was selected in the ROD (1998) and subsequently implemented. Operation of the previous remediation system for more than 10 years contributed to changes in Site conditions. In addition, advances in science and technological understanding have changed approaches to LNAPL remediation and LNAPL site management. These significant changes provide justification for revising the remediation objectives currently specified in the ROD.

2.2 Previous Remedial Actions

In September 1998, the ROD was finalized specifying remedies to address contamination associated with soil and sediment, surface water, LNAPL and groundwater. The primary components of the selected remedy (Alternative 3 – Soil Consolidation and Cover, Bioventing, Groundwater and LNAPL Collection and Treatment, and Monitored Natural Attenuation of Groundwater) include:

- Building demolition
- Solidification of arsenic soils
- Consolidation and soil cover
- Biopad removal
- Erosion control measures
- Revegetation
- LNAPL removal
- Grossly contaminated groundwater treatment
- Bioventing construction
- Bioventing operation
- Monitored natural attenuation
- Institutional controls
- Environmental monitoring/maintenance
- Point-of-use carbon treatment or well replacement
- Five-year site reviews

The USEPA conducted a removal action during 1994 through 1996, including the following:

- Buildings were demolished and the remaining chemicals and sludge were disposed offsite
- Highly contaminated soil was excavated and disposed offsite
- Erosion control measures were implemented in 1998 to reduce washout of the contaminated wood debris from the lagoon into the wetlands

Extensive remedial actions have been conducted at the Site since the USEPA issued the ROD in November 1998, including the following:

- Soil and sediment excavation and consolidation in an onsite corrective management unit (CAMU)
- Bioventing
- Groundwater extraction and treatment
- LNAPL recovery
- Monitored natural attenuation of the remaining dissolved contaminant plume outside of the groundwater capture area

Initial operation of the remediation system started in October 2000. Due to the presence of emulsified oil in the extracted groundwater, additional pretreatment studies, design, and facility construction were conducted. The full treatment system operation, including additional pretreatment, began in March 2004 and operated through

August 2014. In 2010, three additional dual phase extraction wells were installed in an effort to accelerate cleanup activities.

The WDNR took over remediation system operations at the Site on September 1, 2014. During October 2014, the remediation system operation was modified to exclude the pretreatment portion of the system. In addition, LNAPL recovery was performed manually on a periodic basis.

The treatment system was modified 2015 to eliminate the need for pretreatment of extracted groundwater prior to discharge while still achieving overall system performance objectives. The system was shut down in December 2015 to start the temporary remediation system shutdown pilot study. Pilot study monitoring was conducted through 2019. Monitoring has continued on a semiannual basis. All pilot study results were documented in the Semiannual Report and Alternate Remedy Recommendation Report (GHD; March 2020). The recommended remedy included:

- Land use restrictions through institutional controls
- MNA – groundwater
- NSZD – LNAPL
- Environmental monitoring
- Modified performance standards
- Maintenance of cover and erosion control
- Alternative water supply
- Five-year reviews

The following actions were also recommended for the Site:

- Discontinue remediation system operation
- Implement MNA performance monitoring and evaluation
- Implement a contingency remedy in the event that the recommended remedy fails to perform as anticipated
- Modify Performance Standards
- Continue institutional controls

Following review of the pilot study results and recommendations, USEPA indicated that additional remedial actions may be necessary at the Site.

3. Conceptual Site Model

As part of this remedial alternatives screening, the Conceptual Site Model was updated based on the most recent data and information available for the Site. A traditional CSM includes:

- Site setting
- Release history
- Compounds of concern and cleanup goals
- Geology and hydrogeology
- Contaminant source/type and concentration
- Contaminant distribution and extent
- Exposure pathway and receptors

Elements of a LNAPL Conceptual Site Model were also included as part of this evaluation. A LNAPL Conceptual Site Model (LCSM) is a body of information describing aspects of the LNAPL and site setting necessary to satisfy the LNAPL remedial/management objectives (ASTM 2007, ITRC 2009). The LCSM is similar to a traditional Conceptual

Site Model, which includes the source, pathway, and receptor, but the emphasis in the LCSM is on the LNAPL. The LCSM is comprised of some or all of the following scientific and technological information:

- Site setting
- Release history
- Remedial history
- Hydrogeological information
- LNAPL physical (e.g., density and viscosity) and chemical properties (e.g., constituents)
- LNAPL spatial distribution (vertical and horizontal delineation)
- LNAPL mobility and body stability/migration information
- LNAPL recoverability information

3.1 Site Setting

The Site is an inactive wood treating facility located on Daniels 70 (former State Route 70) in Burnett County, Wisconsin. It is located approximately 78 miles northeast of Minneapolis, Minnesota, and 60 miles south of Duluth, Minnesota. The Village of Siren, Wisconsin, is approximately 2 miles east of the Site.

The Site property currently consists of approximately 82 acres that were actively used for wood treating activities. Forty undeveloped, forested acres were sold after the facility closed. The property is located in a rural agricultural and residential setting and is bordered to the east, west, and north by forested areas. Some of these areas are classified by the State of Wisconsin as wetlands. With the exception of an 8-acre parcel, Daniels 70 forms the southern property boundary.

The Site is situated on a hill with a 110-foot drop in elevation from the southern boundary to the northern boundary. A number of surface water bodies are present north and east of the Site. Doctor Lake and an unnamed lake are located 2,000 feet east and northeast of the Site, respectively. Approximately 2,140 acres of lakes, 94 acres of bogs, and 7,500 acres of wetland are located within a 4-mile radius of the Site. A wetland is located within 130 feet of the northern property boundary.

3.2 Release History

Contaminants were released to the subsurface during operation from 1953 to 1992. Raw timber was treated with a PCP and fuel oil solution or with a waterborne salt treatment chemical. The facility discharged wastewater from an oil/water separator through a gully into a lagoon located at the northeast corner of the property. Process wastes were discharged onto a wood-chip pile in the northwestern portion of the property. Beginning in the 1970s, WDNR observed several large spills, stained soils, fires, and poor operating practices. USEPA conducted a removal action during 1994 through 1996. Buildings were demolished and the remaining chemicals and sludge were disposed offsite. Highly contaminated soil was excavated and disposed offsite. Erosion control measures were implemented in 1998 to reduce washout of the contaminated wood debris from the lagoon into the wetlands. Thus, a substantial portion of the source was removed. As such, there has been no ongoing releases to drive further LNAPL migration at the Site for over 20 years. In addition, any residual LNAPL head that may have existed at the time of the previous actions would have long since dissipated or been eliminated through the various excavations and other remedial actions.

3.3 Compounds of Concern and Cleanup Goals

The Record of Decision (ROD) (USEPA, November 1998) identifies the following as compounds of concern (COCs):

- PCP
- Naphthalene
- Benzene, toluene, ethylbenzene, and xylenes (BTEX)

- Chloride
- Metals – arsenic, copper, iron, manganese, and zinc

The ROD also specifies the groundwater cleanup goals as the Preventative Action Limits (PALs) identified in Ch. NR 140, Wis. Adm. Code. WNDR requested to modify the cleanup goals from the PALs to the Enforcement Standards (ESs) as identified in Ch. NR 140 Wis. Adm. Code. The COCs and respective cleanup goals are summarized in Table 1 of the ROD.

3.4 Remedial History

Extensive remedial actions have been conducted at the Site since USEPA issued the ROD in November 1998, including the following:

- Soil and sediment excavation and consolidation
- Bioventing
- Groundwater extraction and treatment
- LNAPL recovery
- Monitored natural attenuation of the remaining dissolved contaminant plume outside of the groundwater capture area

Initial operation of the remediation system started in October 2000. Due to the presence of emulsified oil in the extracted groundwater, additional pretreatment studies, design, and facility construction were conducted. The full treatment system operation including additional pretreatment began in March 2004 and operated through August 2014. In 2010, three additional extraction wells were installed in an effort to accelerate cleanup activities.

WDNR took over remediation system operations at the Site on September 1, 2014. During October 2014, the remediation system operation was modified to exclude the pretreatment portion of the system. In addition, LNAPL recovery was performed manually on a periodic basis.

The treatment system was modified 2015 to eliminate the need for pretreatment of extracted groundwater prior to discharge while still achieving overall system performance objectives. The system was shut down in December 2015 to start the temporary remediation system shutdown pilot study.

Through all remedial actions, a substantial portion of the contaminant source has been removed. As such, there has been no ongoing releases to drive further LNAPL migration at the Site for over 20 years. In addition, any residual LNAPL head that may have existed at the time of the previous actions would have long since dissipated or been eliminated through the various excavations and other remedial actions.

3.5 Geology and Hydrogeology

The subsurface at the Site consists of unconsolidated soil and has been characterized with two aquifers, the unconfined aquifer (upper portion) and semi-confined aquifer (lower portion). The upper aquifer consists of sand and gravel with silt and clay to depths of 90 to 120 feet below ground surface. A glacial till, which separates the upper aquifer from the lower aquifer, consists of silt, silty sand, and sandy silts with gravel in a layer with thicknesses ranging between 3 to 45 feet. The till is present under most of the Site. The lower aquifer consists of sand and gravel. A general cross-section of the subsurface stratigraphy is shown on Figure 3.1.

The depth to groundwater is typically 100 feet or more from the ground surface. The general groundwater flow direction appears to be primarily toward the north-northwest based on measured groundwater elevations in wells at the Site, although there may be some radial groundwater flow directions away from the Site. The dissolved PCP concentration distribution indicates that some groundwater may flow toward the east-southeast. The general horizontal hydraulic gradient across the source area is estimated to be approximately 0.0005 foot per foot (ft/ft) under non pumping conditions.

3.6 LNAPL Physical and Chemical Properties

The LNAPL is lighter than water with a density of approximately 0.95 grams per cubic centimeter. The viscosity of the LNAPL was measured at 9.7 centipoise, which is within the typical range (i.e., same order of magnitude) for weathered diesel fuel and kerosene. The LNAPL is a 5- to 7-percent PCP solution in a No. 2 fuel oil carrier.

3.7 LNAPL Body and Dissolved PCP Plume Extent

The areal extent of LNAPL in wells is shown on Figure 3.2 and is approximately 2 acres in size. The vertical distribution of LNAPL is localized within the unconfined aquifer. Based on historical groundwater level fluctuations, the smear zone is anticipated to be approximately 7 feet thick at the groundwater table. The plots of the well gauging data over time (Charts 1 and 2, Long-Term Remedial Action Report, CH2M HILL, November 2014) indicate that the predominant LNAPL behavior (i.e., how LNAPL thickness in wells changes with fluctuations in water table depth) is consistent with unconfined conditions in that in-well LNAPL thickness decreases with a rising water table and vice versa. The LNAPL extent has been delineated and is approximately the same as the dissolved PCP plume exceeding concentrations of 1,000 ug/L. The LNAPL body has remained stable since shutdown of the remediation system in 2015.

The dissolved PCP plume was reduced at the Site through operation of the remediation system. The dissolved PCP plume with concentrations exceeding 1,000 micrograms per liter (µg/L) is approximately 3 acres in the unconfined (upper) aquifer and approximately 1 acre in the semi-confined aquifer and is limited to the immediate vicinity of the LNAPL. The dissolved PCP plume with concentrations exceeding 1 µg/L is currently approximately 7 acres in the unconfined (upper) aquifer and approximately 9 acres in the semi-confined (lower) aquifer. The dissolved plume has remained stable since 2015.

At the Site, the initial purpose of groundwater remediation was to aggressively dewater to recover LNAPL and increase the smear zone available to bioventing. This work has been completed. In terms of PCP dissolution from the source zone to groundwater, the rate of dissolved phase which partitions from the LNAPL is small enough that MNA is effective as a groundwater remedy.

The PCP plume hasnot migrated since shutdown of the remediation system, which indicates overall plume stability and supports that the operation of an active remediation system is not necessary to maintain this condition. Furthermore, microcosm testing and bio-trap study results demonstrate that dissolved PCP degrades naturally in the aerobic zone outside of the LNAPL area, which helps stabilize the plume, prevent migration, and limit plume extent. PCP degradation in the anaerobic zone (LNAPL source area) occurs at a slow rate. The rate that PCP partitions from the LNAPL is effectively balanced by the rate of natural degradation such that the contamination has demonstrated long-term stability within the property boundaries.

3.8 LNAPL Mobility and Body Stability

LNAPL migration is very unlikely to be occurring at the Site because there has not been an active LNAPL source to drive the migration in over 20 years. The stabilization of existing contamination was likely accelerated due to the significant amount of the original LNAPL source that was aggressively removed through operation of the remediation system. Most importantly, the stability of the LNAPL has been observed through site monitoring:

- The footprint of where LNAPL is observed in wells has remained stable (i.e., LNAPL has not been observed outside of the LNAPL area) during historical monitoring.
- The associated dissolved plume has also been observed to be stable in areal extent. This can only be the case if the same is true of the LNAPL source material (i.e., a migrating/expanding LNAPL zone would likewise exhibit a migrating/expanding dissolved plume).

Based on the presence of LNAPL in wells at the Site, the size of the LNAPL body has remained stable from the time prior to implementing the remedy, through more than 10 years of remediation system operation, and more than 7 years since shutdown of the active remediation system. The current size of the LNAPL body is approximately 2 acres and is limited to within the Site property boundaries.

Five monitoring wells (MW10S, MW18, MW19, MW20, and MW29) have contained measurable LNAPL at thicknesses of less than 1 foot. Of the eleven extraction wells at the Site, six extraction wells (EW02, EW03, EW04, EW07, EW11, and EW13) do not contain LNAPL at measurable thicknesses. Three extraction wells (EW05, EW12, and EW14) contain LNAPL thicknesses less than 1 foot. Two extraction wells (EW06 and EW10) contain LNAPL thicknesses greater than 1 foot. The portion of the LNAPL body where LNAPL thicknesses are greater than 1 foot is less than approximately 0.5 acre. It is noted that this discussion of in-well LNAPL thicknesses is provided for illustrative purposes only as it is well established that in-well thickness magnitudes are generally not reliable indicators of LNAPL mobility/recoverability, will generally not have any bearing on the stability of an old LNAPL body, and will have no correlation with risk. Once an LNAPL body stabilizes, it will typically remain so even if significant in-well LNAPL thicknesses are observed at points within the areal extent of LNAPL impacts.

3.9 LNAPL Recoverability

During operation of the system from 2004 through August 2014, approximately 42,000 gallons of LNAPL were reportedly recovered at the Site (Long-Term Remedial Action Report, CH2M HILL, November 2014). A decline curve analysis estimated a total recoverable LNAPL quantity of approximately 50,000 gallons. This provides another line of evidence that LNAPL was effectively recovered to a practical endpoint (i.e., to the maximum extent practicable). LNAPL recovery rates reportedly ranged between approximately 3,000 and 5,000 gallons per year (8 and 14 gallons per day) under aggressive remediation, although there is some question as to whether these rates were overestimated due to the way they were calculated historically (i.e., a fraction of the total fluids recovered was assumed to be LNAPL rather than specifically quantifying the volume of LNAPL). Regardless, based on a LNAPL body size/area of approximately 2 acres, this recovery rate was considered low at less than 10 gallons per day per acre. This low rate of recoverability was consistent with what would be expected for an old, viscous LNAPL, that has undergone years of natural losses and smearing, particularly where previous remedial actions treated a significant fraction of the most highly saturated soils (i.e., the most potentially mobile/recoverable LNAPL).

During 2013 and 2014, CH2M HILL conducted a LNAPL mobility and recoverability evaluation at the Site as documented in the LNAPL Mobility and Recoverability Report (CH2M HILL, October 2014). LNAPL recovery is no longer considered technically feasible or required to stabilize the LNAPL given its well-stabilized state and calculated LNAPL transmissivity values less than the ITRC minimum threshold required for recovery (0.1 to 0.8 square feet per day). The remediation system achieved LNAPL recovery to the maximum extent practicable since a practical science-based endpoint was met. This does not mean that no more LNAPL can be recovered, but it does mean that whatever may be recovered is likely to represent a negligible fraction of the largely residual LNAPL body and, therefore, ongoing recovery activities will not result in a beneficial change in conditions.

3.10 Exposure Pathways and Receptors

This criterion examines the risk remaining after the remediation has been conducted. Also, short term risks associated with each remedy are evaluated. To compare the remedial actions with respect to the overall protection of human health and the environment, each pathway of exposure is discussed below:

Residential Ingestion and Groundwater Use

Residential ingestion of contamination involves the inadvertent intake of contamination by persons living at or near the Site. Residual LNAPL and dissolved contamination is located within the Site property boundaries. Groundwater is not utilized as a potable water supply for the Site.

Groundwater was used as a non-potable water supply at the Site. Concentrations in the onsite supply well meet the ES. Institutional controls will be required to ensure that groundwater at the Site is not used as a drinking water source.

Groundwater sample analytical data indicate that groundwater at the nearby residential properties meets the ES. Six properties surrounding the site have private wells that supply drinking water to each respective residence. These wells are located at distances ranging from approximately 700 feet to 3,000 feet from the LNAPL source area at the Site. In addition, the private wells are screened at intervals ranging between approximately 30 feet and 200 feet below the LNAPL source interval at the Site. As a result, this exposure pathway is incomplete.

Residential Inhalation

Residential inhalation involves an evaluation of the potential for organic compounds to volatilize and migrate into buildings. The Site cannot be developed as a residential property. LNAPL would be reduced but some LNAPL would remain for many years. The potential for volatile organic compound (VOC) migration into any future onsite buildings outside of the CAMU is extremely low based on the presence of LNAPL at depths more than 80 feet below ground surface.

Future Construction Workers

The risk to future construction workers arises from potential dermal contact and/or inhalation of contaminants during construction activities. The most common post remediation construction activity would be the excavation for utilities or building foundations. The historical data demonstrates the LNAPL and the LNAPL smear zone are located more than 80 feet below the ground surface and poses no risk to future construction workers outside of the CAMU.

Ecological Risk

Ecological risk is associated with the release of contamination to the ground surface, wetlands or surface water. Given that the LNAPL is subsurface and is stable, there are no completed pathways to the ground surface, surface water or wetlands. The natural groundwater flow direction is primarily to the north-northwest. Groundwater monitoring data collected surrounding the LNAPL demonstrate that neither the LNAPL nor the dissolved constituents are migrating toward the wetland. Hence, the groundwater pathway to ecological receptors is not complete.

3.11 Institutional Controls

The WDNR has implemented Institutional Controls (ICs) at the Site in the form of Continuing Obligations (COs). COs are legal requirements designed to protect public health and the environment in regard to contamination that remains on a property, and COs still apply after a property is sold. The Long-Term Response Action Operation and Maintenance Plan (O and M Plan) – Addendum No. 1 (GHD; November 9, 2015) effectively serves as an Institutional Control Implementation and Assurance Plan (ICIAP).

4. Remedial Alternatives Screening

This section presents a screening of remedial alternatives based on a defined set of criteria.

4.1 Screening Criteria

This evaluation was conducted in general accordance with 40 CFR 300.430 by screening remedial alternatives against the following criteria:

- Effectiveness
- Implementability
- Cost
- Remediation timeframe

Effectiveness

This criterion focuses on the degree to which an alternative reduces toxicity, mobility, or volume through treatment, minimizes residual risks and affords long-term protection, complies with ARARs, minimizes short-term impacts, and how quickly it achieves protection. Alternatives providing significantly less effectiveness than other, more promising alternatives may be eliminated. Alternatives that do not provide adequate protection of human health and the environment shall be eliminated from further consideration.

Key criteria to be utilized to assess effectiveness will be whether the alternatives can achieve the ESs throughout the plume.

Implementability

This criterion focuses on the technical feasibility and availability of the technologies each alternative would employ and administrative feasibility of implementing the alternative. Alternatives that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period of time may be eliminated from further consideration.

Cost

The costs of capital and construction with remedy implementation to operate and maintain the alternatives were considered. In addition, long-term monitoring and associated costs will be necessary following remedy implementation. The cost estimates are intended to provide an order of magnitude comparison of the remedial alternatives based on consistent assumptions. Costs that are grossly excessive compared to the overall effectiveness of alternatives were considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, were eliminated. Long-term monitoring costs are difficult to estimate since they are largely dependent of remediation timeframe, which is difficult to establish (see below).

Timeframe

Approximately 23 years has passed since the ROD was issued in 1998. The ROD states that a reasonable period of time to achieve remediation objectives is 30 to 40 years. Therefore, remedial alternative screening considered whether objectives can be achieved within a timeframe of 7 to 17 years. Remediation timeframe is a significant unknown since developing time estimates depends largely on knowing actual contaminant quantities, homogeneous subsurface conditions, and consistent/predictable remediation rates.

4.2 Remedial Alternatives

USEPA directed WDNR to focus the screening on alternatives that will enhance aerobic degradation of LNAPL and PCP within the contaminant source zone. Overall, it is noted that WDNR and GHD do not agree with USEPA that more aggressive remedial action is warranted for this Site since aggressive remedial activities have already been implemented, the stability of remaining contaminants has been demonstrated, and institutional controls already mitigate potential exposures. WDNR endorses the effective use of resources through risk-based remedial strategy, and there are no unacceptable exposures associated with residual contamination currently at the Site and controls in place mitigate potential future exposures. However, WDNR proceeded with assessing the following potential options in the remedial alternative screening:

- In-situ chemical oxidation (ISCO)
- Ozone injection
- Oxygen release compound (ORC) injection
- Hydrogen peroxide injection
- Air sparging (AS)

– Biosparging

In addition, WDNR and GHD included NSZD/MNA as part of the screening on the basis that it will not be possible to evaluate the incremental benefit of other options without better understanding what is currently occurring naturally first (including a quantification of natural LNAPL degradation rates). In addition, NSZD/MNA will be relied on following implementation of any of the above active remedial options to ultimately achieve the remediation objectives, particularly with reducing contaminant concentrations in groundwater to meet the PALs throughout the entire plume since the microbial communities involved in NSZD will address LNAPL that the other techniques will not be able to access/affect (i.e., the efficiencies of the techniques above will be far less than 100%). Implementation of a more aggressive action would be delayed during the remedial design process and could be further delayed due to the timing of USEPA funding for remedial design/action, and Site-specific NSZD/MNA data would allow degradation rates to be estimated prior to a more aggressive remedial action.

4.2.1 In-Situ Chemical Oxidation

ISCO is an effective method for destroying localized high concentrations of a wide range of organic compounds, particularly benzene. In an oxidation reaction, the oxidizing agent breaks the carbon bonds in the compounds and converts them into nonhazardous or less toxic compounds, primarily carbon dioxide and water. Commonly used oxidizing reagents include potassium permanganate ($KMnO_4$), Fenton's Reagent (hydrogen peroxide in a solution of ferrous salts), catalyzed sodium persulfate, and ozone.

$KMnO_4$, Fenton's Reagent, and catalyzed sodium persulfate are effective when delivered in an aqueous solution and react with a wide range of organic compounds. These oxidants are readily available in large quantities. ISCO is Site-specific, and successful treatment is typically depends on the effectiveness of the system being able to deliver sufficient amounts of oxidant to the impacted soil and groundwater and making sufficient "contact" and subsequent transport of the oxidant within the soil and groundwater. The treatment performance is dependent to a great extent on the soil chemistry. A critical factor in the evaluation of ISCO treatment is determining the dosages of oxidant that are required to effectively oxidize the hydrocarbon compounds present (referred to as stoichiometric demand) as well as the competing reactions. The competing reactions are typically caused by the presence of natural organic materials such as humates and fulvates, as well as reduced metal species. The consumption of oxidants by these non-target compounds is defined as natural oxidant demand (NOD). In order to determine the optimum dosage, treatability studies are required. Large quantities of oxidizing chemicals require regulated handling and pose health and safety concerns. Chemical oxidation may cause mobilization of metals, possible formation of toxic by-products, heat, gas, and biological perturbation.

$KMnO_4$ does not exhibit a high solubility and requires a large delivery volume. Fenton's Reagent is effective for the treatment of VOCs. However, the Fenton's Reagent reaction is exothermic, and the heat generated can cause volatilization of the VOCs. It also requires a pH of 5-pH units and ferrous sulfate catalyst. Base catalyzed sodium persulfate can be injected at concentrations up to 30-percent. It can oxidize a wide range of organic compounds including VOCs and will continue to oxidize organic material for up to a month.

4.2.1.1 Effectiveness

ISCO can achieve significant reduction in dissolved contaminant concentrations but would not be effective in directly treating LNAPL. The oxidation reaction occurs in the aqueous phase only; therefore, when oxidant is injected, only dissolved phase impacts would be treated. Since LNAPL is present in equilibrium with the groundwater, once concentrations decrease in the dissolved phase, some LNAPL will solubilize and groundwater concentrations will increase. In this way LNAPL is treated little by little as it is dissolved; however, it would take many years and repeated injections of oxidant to have a significant effect on groundwater concentrations and levels of LNAPL. Given that the PCP is dissolved in the LNAPL, concentrations of PCP would not decrease until appreciable amounts of the LNAPL had dissolved and been oxidized. Given the high contaminant concentrations at the Site and presence of LNAPL, large quantities of oxidants would be required and in the short- to medium-term, the effectiveness of this remedy would be very low.

4.2.1.2 Implementability

This technology requires injection points screened at appropriate intervals and at sufficient density throughout the target area to be treated. Given the depth of the contaminants at more than 100 feet, injections wells would be costly to install. The density of injection points typically require a spacing of less than 50 feet. Given that the source area is approximately 2 acres in size, a minimum of 80 injection points would be necessary. There are not sufficient wells within the source area to be utilized for injection. Additionally, if the monitoring wells were used as injection wells, the installation of additional monitoring wells would likely be required to assess the success of treatment.

Given the need to install wells at great depth and the need for repeated oxidant injections over a long period of time the implementability of this remedy would be low.

4.2.1.3 Cost

The cost for ISCO was estimated by assessing capital costs, remedy implementation costs, and long-term monitoring costs as summarized in Table 4.1. The total ISCO cost estimate is approximately $18 million, which does not include a contingency.

4.2.1.4 Remediation Timeframe

Following pre-design, design, and construction phases, injections would be required on an annual basis for a minimum of 10 years to achieve substantial source reduction. NSZD/MNA would ultimately be required to treat residual source material and subsequently achieve the remedial objectives of the ROD. Additional time would be required for natural degradation and attenuation to achieve objectives.

4.2.2 Ozone Injection

Ozone sparging systems remove contaminants by chemically oxidizing contaminated water in situ. Ozone injection includes injecting ozone into the subsurface to destroy VOCs and semi-volatile organic compounds (SVOCs) by converting the contaminants into carbon dioxide and water. This technology requires injection points screened at appropriate intervals and at sufficient density throughout the target area to be treated Ozone generators typically produce ozone as a mixture with oxygen. The ozone can be applied to a site using vertical sparge wells. Ozone is more soluble in water than pure oxygen and will disperse through the aquifer as it rises from the subsurface injection point. Heat and VOC vapors can be generated from the chemical oxidation reactions that occur. Vapor control equipment may be needed to capture the contaminants that are volatilized. Ozone treatment will also assist in the biodegradation of contaminants due to the oxygen that it provides, which can be used for microbial growth. Ozone will oxidize both petroleum hydrocarbons and PCP. Ozone is very corrosive, special equipment and handling are required.

4.2.2.1 Effectiveness

As with ISCO described above, oxidation reaction with ozone occurs in the aqueous phase only; therefore, a similar mechanism and timeframe of dissolution of LNAPL into the aqueous phase would be necessary for treatment. Given that the PCP is dissolved in the LNAPL, concentrations of PCP would not decrease until appreciable amounts of the LNAPL had dissolved and been oxidized. Given the high contaminant concentrations at the Site and presence of LNAPL, ozone sparging for a long period of time would be required and in the short to medium term, the effectiveness of this remedy would be low.

4.2.2.2 Implementability

This technology requires ozone sparge points screened at appropriate intervals and at sufficient density throughout the target area to be treated. Given the depth of the contaminants at more than 100 feet, injections wells would be costly to install. The density of injection points typically require a spacing of less than 50 feet. Given that the source area is approximately 2 acres in size, a minimum of 80 injection points would be necessary. Existing monitoring wells could not be used for ozone sparging since they are not constructed of materials appropriate for the highly corrosive ozone. Given the need to install wells at great depth, the implementability of this remedy would be moderately low.

4.2.2.3 Cost

The cost for ozone injection was estimated by assessing capital costs, remedy implementation costs, and long-term monitoring costs as summarized in Table 4.2. The total ozone injection cost estimate is approximately $7 million, which does not include a contingency.

4.2.2.4 Remediation Timeframe

Following pre-design, design, and construction phases, ozone sparging would be required for a minimum of 10 years to achieve substantial source reduction. NSZD/MNA would ultimately be required to treat residual source material and subsequently achieve the remedial objectives of the ROD. Additional time would be required for natural degradation and attenuation to achieve objectives.

4.2.3 Oxygen Release Compound Injection

ORC injection includes injecting a solid peroxide material that dissolves in water slowly over time and as it dissolved it the peroxides break down and release oxygen. In this way ORC is a source of “slow release” oxygen to enhance biodegradation under aerobic conditions. ORC is injected as a slurry and cannot be injected using injection wells but requires injection by direct push technology to push it into soil and groundwater. ORC will release oxygen for up to a year before reinjection is required.

4.2.3.1 Effectiveness

Both petroleum hydrocarbons and PCP degrade under aerobic conditions, however like chemical oxidation, biodegradation mediated by ORC would occur in the aqueous phase and would reduce groundwater concentrations and cause LNAPL to occur little by little over time. Given that the PCP is dissolved in the LNAPL, concentrations of PCP would not decrease until appreciable amounts of the LNAPL had dissolved and biodegraded. Given the high contaminant concentrations at the Site and presence of LNAPL, repeated injections of ORC would be required over many years and in the short to medium term, the effectiveness of this remedy would be low.

4.2.3.2 Implementability

It is not possible to inject ORC by direct push at the depths required therefore this technology is not implementable at all.

4.2.3.3 Cost

Costs were not estimated since this technology cannot be implemented.

4.2.3.4 Remediation Timeframe

Remediation timeframe was not estimated since this technology cannot be implemented.

4.2.4 Hydrogen Peroxide Injection

Hydrogen peroxide injection includes injecting hydrogen peroxide which would break down to oxygen and water and therefore release oxygen into the treatment area to enhance aerobic biodegradation. Hydrogen peroxide breaks down quickly and does not persist in the subsurface therefore frequent injections would be required to maintain aerobic conditions.

4.2.4.1 Effectiveness

Both petroleum hydrocarbons and PCP degrade under aerobic conditions; however, like chemical oxidation, biodegradation mediated by hydrogen peroxide would occur in the aqueous phase and would reduce groundwater concentrations and cause LNAPL to occur little by little over time. Given that the PCP is dissolved in the LNAPL, concentrations of PCP would not decrease until appreciable amounts of the LNAPL had dissolved and biodegraded. Hydrogen peroxide is also an oxidant that oxidizes organic matter. Give the high level of organic matter (LNAPL) in the treatment area the hydrogen peroxide would breakdown almost instantly upon injection and would not persist long enough to sustain biodegradation. High concentrations of hydrogen peroxide could not be injected because hydrogen peroxide is toxic to microorganisms at high levels which would inhibit biodegradation. Given the high contaminant concentrations at the Site and presence of LNAPL, hydrogen peroxide would have little effect on biodegradation and the effectiveness of this remedy would be low.

4.2.4.2 Implementability

This technology requires injection points screened at appropriate intervals and at sufficient density throughout the target area to be treated. Given the depth of the contaminants at more than 100 feet, injections wells would be costly to install. The density of injection points typically require a spacing of less than 50 feet. Given that the source area is approximately 2 acres in size, a minimum of 80 injection points would be necessary. There are not sufficient wells within the source area to be utilized for injection. Additionally, if the monitoring wells were used as injection wells, the installation of additional monitoring wells would likely be required to assess the success of treatment.

Given the need to install wells at great depth and the need for repeated oxidant injections over a long period of time the implementability of this remedy would be low.

4.2.4.3 Cost

The cost for hydrogen peroxide injection was estimated by assessing capital costs, remedy implementation costs, and long-term monitoring costs as summarized in Table 4.3. The total hydrogen peroxide injection cost estimate is approximately $16 million, which does not include a contingency.

4.2.4.4 Remediation Timeframe

Following pre-design, design, and construction phases, hydrogen peroxide injections would be required for a minimum of 10 years to achieve substantial source reduction. NSZD/MNA would ultimately be required to treat residual source material and subsequently achieve the remedial objectives of the ROD. Additional time would be required for natural degradation and attenuation to achieve objectives.

4.2.5 Air Sparging

Air sparging (AS) includes air injection below the groundwater table to volatilize VOCs and SVOCs and increase the dissolved oxygen concentration to promote natural aerobic biodegradation. Typically, volatilized contaminants are subsequently recovered with soil vapor extraction (SVE) above the groundwater table.

AS is accomplished by introduction of air below the groundwater and below the level of contamination. As the air rises through the soil, it volatilizes the contaminants in the vadose zone where they can be collected and treated through vapor extraction. The air may be heated to enhance vaporization of less volatile, higher boiling contaminants. AS is a well-understood technology that has been applied at many sites. It is applicable to sites that have high concentrations of contaminants present. As the concentrations decrease, it becomes less effective and may take an extended period to reach cleanup levels.

4.2.5.1 Effectiveness

Sparging is most effective in permeable soil (i.e., sand and gravel). Sparging is not effective for LNAPL treatment due to limited contact that occurs between the injected air and contaminants. The weathered petroleum hydrocarbons and the PCPs are also not very volatile, and even if contact was achieved very little volatilization and extraction via vapor of these compounds would occur. In addition, sparging could mobilize residual LNAPL. Therefore, the effectiveness of this technology is very low.

4.2.5.2 Implementability

Implementability of sparging was not evaluated due to lack of effectiveness.

4.2.5.3 Cost

Cost of sparging was not estimated due to lack of effectiveness.

4.2.5.4 Remediation Timeframe

Remediation timeframe would be comparable to NSZD/MNA.

4.2.6 Biosparging

In situ biodegradation (aerobic or anaerobic) is a treatment process whereby the compounds of concern are metabolized into nonhazardous compounds by naturally occurring microorganisms. The microorganisms utilize the hydrocarbons as a source of carbon and energy. Site conditions can be manipulated to enhance in situ biodegradation processes and speed up degradation rates of site hydrocarbons. In this process, several techniques can be applied to enhance biodegradation of the hydrocarbons, such as:

i) Injection of air, oxygen, oxygen release compound (ORC), or magnesium, calcium, or hydrogen peroxide to enhance biodegradation of the hydrocarbons under aerobic conditions

ii) Nutrient supplementation with suitable sources of nitrogen and phosphorus to enhance biodegradation of contaminants by indigenous microbial population

In situ biosparging involves injection of pressurized gases into the subsurface at very low flow rates to enhance biodegradation. Oxygen or air is injected to enhance aerobic biodegradation. Injection of oxygen is controlled such that vapors are not generated or accumulated in the vadose zone.

4.2.6.1 Effectiveness

Both petroleum hydrocarbons and PCP degrade under aerobic conditions; however, most biodegradation mediated by bioisparging would occur in the aqueous phase and would reduce groundwater concentrations and cause LNAPL treatment to occur little by little over time. There is also some evidence that biosparging can create aerobic conditions in the LNAPL itself and that some biodegradation of the LNAPL can occur. Given that the PCP is dissolved in the LNAPL, concentrations of PCP would decrease as LNAPL dissolves and biodegrades as well as degrade directly in the LNAPL as LNAPL degrades. Given the high contaminant concentrations at the Site and presence of LNAPL, biosparging would need to be performed for a long period of time to achieve reduction of the LNAPL and PCP mass; therefore, the effectiveness of this remedy would be moderately low.

4.2.6.2 Implementability

This technology requires injection points screened at appropriate intervals and at sufficient density throughout the target area to be treated. Given the depth of the contaminants at more than 100 feet, injections wells would be costly to install. The density of injection points typically require a spacing of less than 50 feet. Given that the source area is approximately 2 acres in size, a minimum of 80 injection points would be necessary. There are not sufficient wells within the source area to be utilized for injection. Additionally, if the monitoring wells were used as injection wells, the installation of additional monitoring wells would likely be required to assess the success of treatment.

Given the need to install wells at great depth and the need for biosparging over a long period of time the implementability of this remedy would be low.

4.2.6.3 Cost

The cost for biosparging was estimated by assessing capital costs, remedy implementation costs, and long-term monitoring costs as summarized in Table 4.4. The total biosparging cost estimate is approximately $7 million, which does not include a contingency.

4.2.6.4 Remediation Timeframe

Following pre-design, design, and construction phases, biosparging would be required for a minimum of 10 years to achieve substantial source reduction. NSZD/MNA would ultimately be required to treat residual source material and subsequently achieve the remedial objectives of the ROD. Additional time would be required for natural degradation and attenuation to achieve objectives.

4.2.7 NSZD/MNA

LNAPL biodegradation is referred to as Natural Source Zone Depletion (NSZD) while biodegradation of associated dissolved plumes is referred to as monitored natural attenuation (MNA). The rate of LNAPL biodegradation (NSZD) depends on many factors, including the availability and type of electron acceptors present in the soils and groundwater to enable microbial and/or enzymatic activity[1]. The degradation of LNAPL will generally proceed anaerobically via methanogenesis, producing methane (CH_4) and carbon dioxide (CO_2), with CH_4 subsequently oxidized to CO_2 via an exothermic process in the vadose zone. Since gaseous CO_2 will be the ultimate product of LNAPL mineralization, rates of LNAPL degradation can be estimated by measuring the near surface flux of CO_2 at sites with petroleum hydrocarbon impacts and isolating the portion of the CO_2 that is petrogenic (as opposed to that which is produced by other natural processes such as plant respiration). In general, the confirmation of methanogenic conditions (O_2 depletion, CH_4 and/or CO_2 production) in the vadose zone as well as in groundwater represent complimentary lines of evidence of NSZD activity.

Significant advances in the science, understanding and remedial approach to LNAPL have been made since the ROD was prepared. In 2009, the ITRC established guidance on NSZD which recognizes that residual LNAPL can and in most cases will remain within the formation and is compatible with MNA for groundwater remediation. Under a NSZD remedy, it is recognized that the threat of migration is no longer present.

MNA is a remedial approach that relies on natural subsurface mechanisms that are classified as either destructive or nondestructive. In certain circumstances, MNA can be sufficiently protective of human health and the environment. Biodegradation is the most important in situ destructive mechanism, while non-destructive mechanisms include sorption, dispersion, dilution, and volatilization. However, MNA has its inherent limitations and can be slow, making the timeframe for completion relatively long. In order to support successful implementation of MNA at any given site, the United States Environmental Protection Agency (USEPA) recommends that the site be thoroughly characterized and scientific evidence provided to demonstrate that the degradation of the site hydrocarbons is occurring at rates sufficient to be protective of human health and the environment. Multiple lines of evidence are needed to support the occurrence of MNA, including:

- Documented loss of hydrocarbons at the field scale
- Geo-chemical analytical data
- Direct lab and field microbiological evidence for microbial biodegradation

4.2.7.1 Effectiveness

NSZD and MNA are effective over time for depletion of LNAPL and associated dissolved phase plumes. At sites where a large amount of LNAPL is present, a long time period may be required to reach remedial goals. More active remedial technologies do not usually result in significantly faster cleanup timeframes than the NSZD/MNA approach. Since this method is as effective as more active remedial methods, the effectiveness of this method would be

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[1] ITRC (Interstate Technology & Regulatory Council). *Evaluating Natural Source Zone Depletion at Sites with LNAPL*. LNAPL-1. Washington, D.C.: Interstate Technology & Regulatory Council, LNAPL Teams. April 2009.

moderate. . Further, NSZD studies have shown that on the order of 1,000 gallons per acre per year of LNAPL depletion is typically achieved via NSZD processes. At the Site, the LNAPL area is approximately 2 acres, which means that up to 2,000 gallons/year of LNAPL could conceivably be depleted by natural processes. Therefore, NSZD can have similar effectiveness of active remedies at the Site.

4.2.7.2 Implementability

This method does not involve the installation of injection wells at depth but may require the installation of additional monitoring wells and/or the assessment of biodegradation and NSZD rates. An MNA assessment would involve the calculation of biodegradation rates based on monitoring data and the NSZD assessment may require carbon dioxide e-flux testing or testing of biogenic heat. The implementability of this technology is high and Site-specific evidence of this activity already exists.

4.2.7.3 Cost

The cost for NSZD/MNA was estimated by assessing capital costs, remedy implementation costs, and long-term monitoring costs as summarized in Table 4.5. The total NSZD/MNA cost estimate is approximately $6 million, which does not include a contingency.

4.2.7.4 Remediation Timeframe

NSZD/MNA would be required for a minimum of 40 years to achieve substantial source reduction and subsequently to achieve the remedial objectives of the ROD.

5. Conclusions

The remedial alternatives screening was completed for the following active remedies:

- ISCO
- Ozone injection
- ORC injection
- Hydrogen peroxide injection
- Air sparging
- Biosparging
- NSZD/MNA

Air sparging lacks effectiveness, and ORC injection cannot be implemented. The effectiveness and implementability of the remaining active remedial alternatives were low primarily because LNAPL would not be directly treated and are not required to mitigate potential exposures. NSZD can have similar effectiveness of active remedies at the Site. Since all active remedial alternatives will require long-term monitoring and NSZD/MNA to ultimately achieve remedial objectives, all remediation timeframes are comparable and will be more than 30 years. Costs of active remedial alternatives beyond NSZD along are estimated to range between approximately $7 and $18 million. Costs for NSZD/MNA are estimated to be approximately $6 million.

Based on the remedial alternatives screening and conceptual site model, NSZD/MNA is the most viable approach as the final remedy for the Site. It is already occurring and acknowledgement may prevent the allocation of significant additional resources to implement other alternatives that will not be greatly increase protectiveness or provide additional risk mitigation benefit.

Figures

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Feet

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Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983 HARN
Grid: NAD 1983 HARN WISCRS Burnett County Feet

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PENTA WOOD PRODUCTS SUPERFUND SITE
SIREN, WISCONSIN

SITE LOCATION

Project No. **11222418-02**
Revision No. **-**
Date **03/29/2022**

FIGURE 1.1

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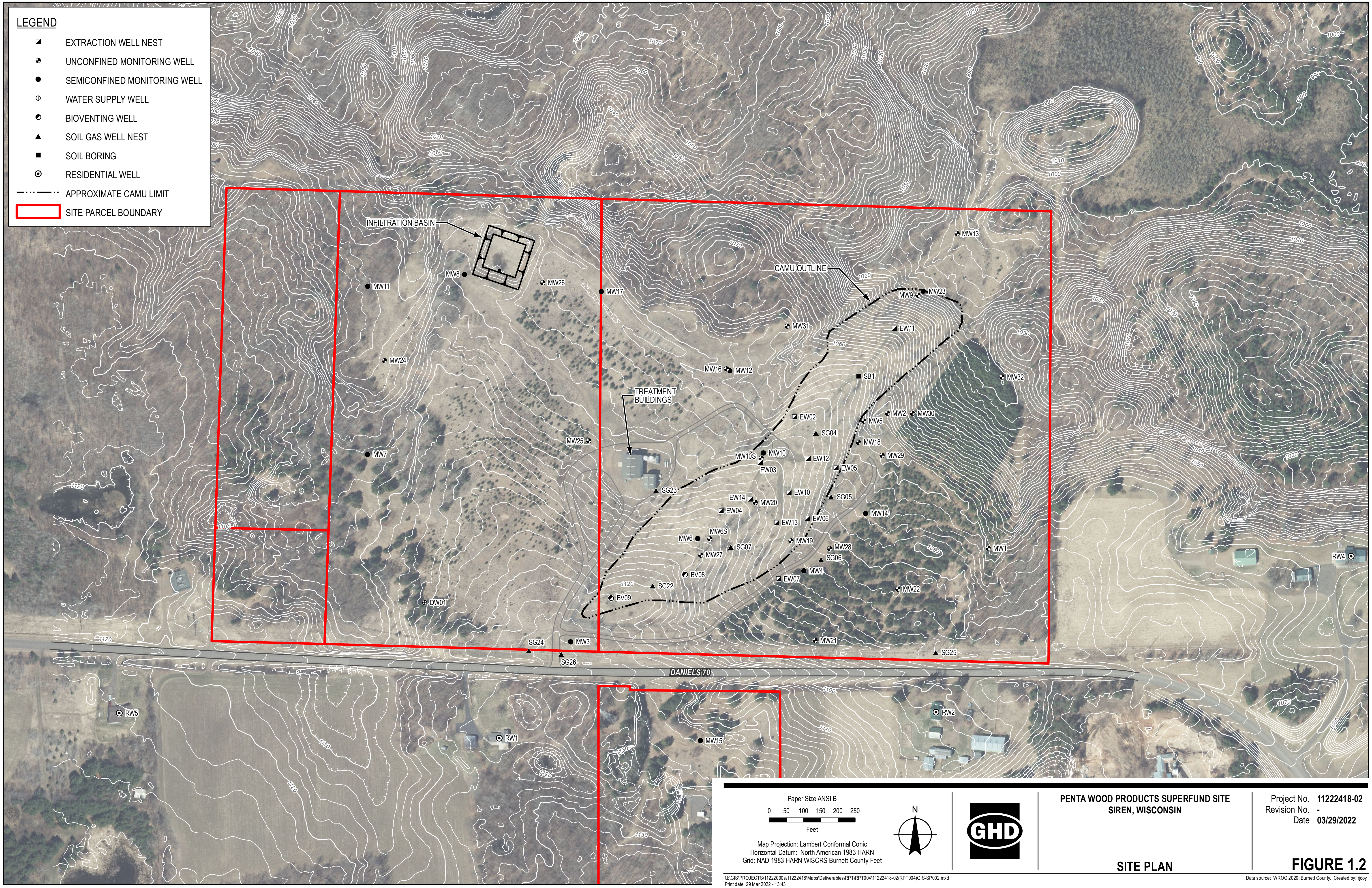

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PENTA WOOD PRODUCTS SUPERFUND SITE
SIREN, WISCONSIN

SITE PLAN

Project No. **11222418-02**
Revision No. **-**
Date **03/29/2022**

FIGURE 1.2

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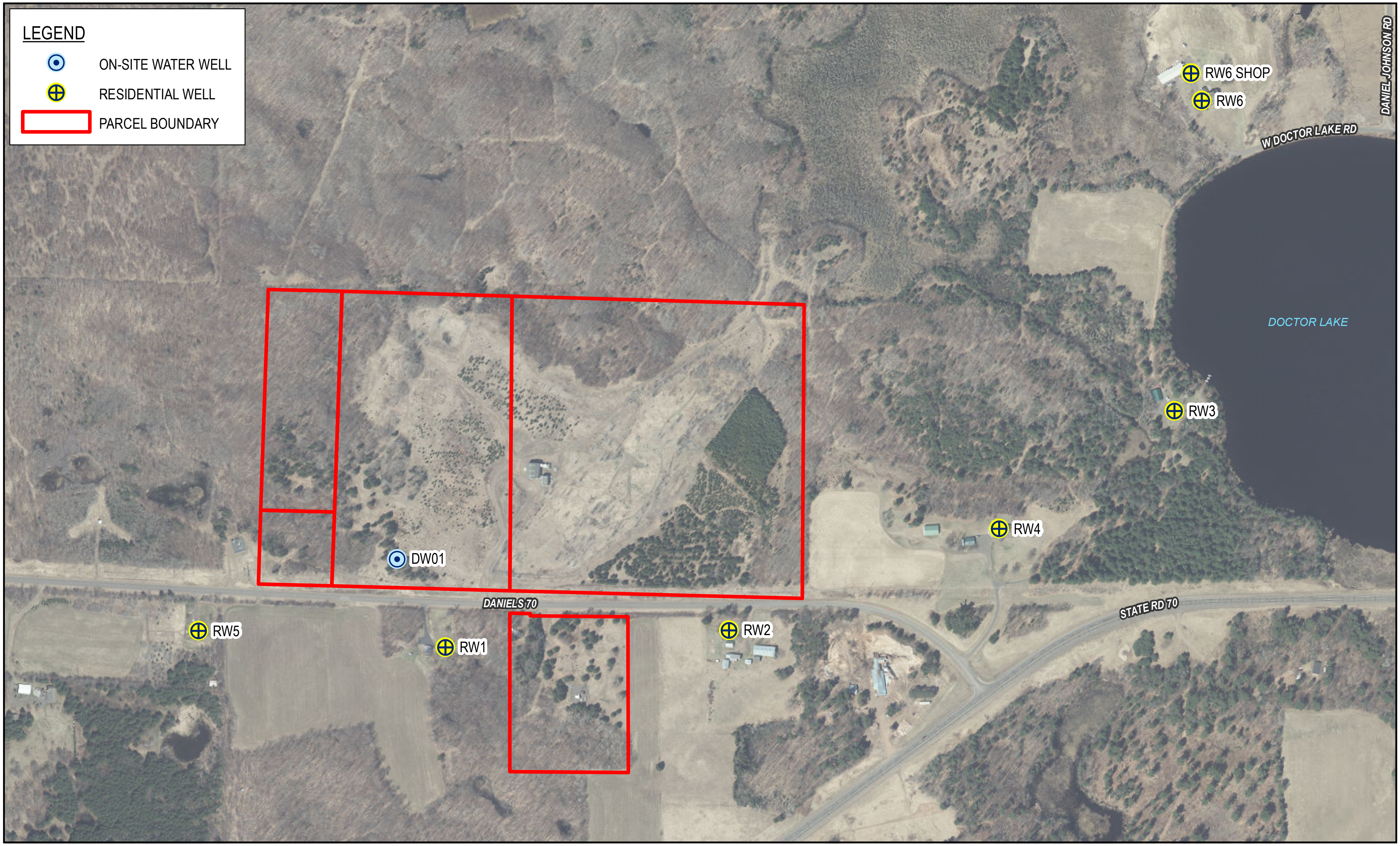

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PENTA WOOD PRODUCTS SUPERFUND SITE
SIREN, WISCONSIN

RESIDENTIAL WELL LOCATIONS

Project No. **11222418-02**
Revision No. **-**
Date **03/29/2022**

FIGURE 1.3

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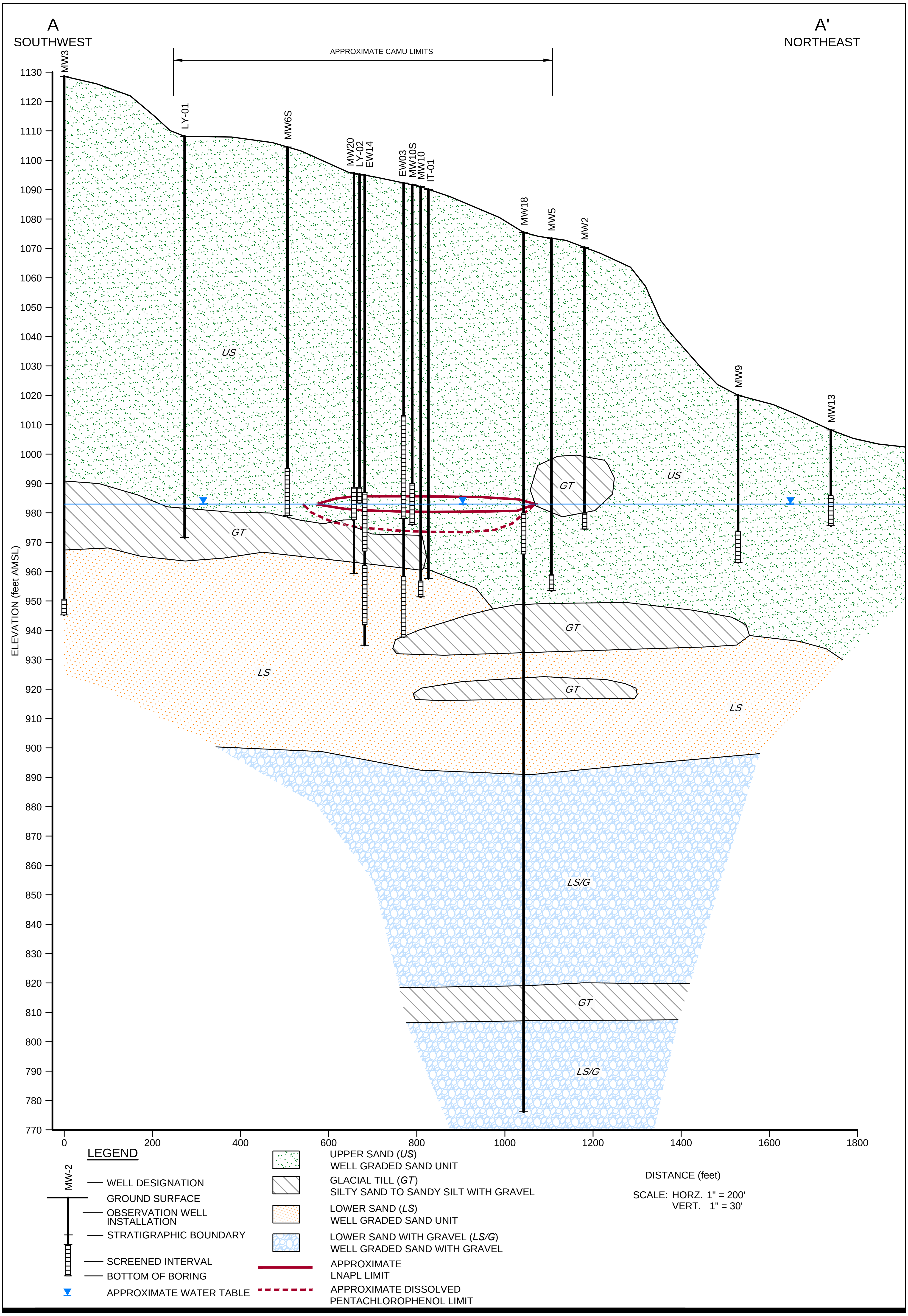

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PENTA WOOD PRODUCTS SUPERFUND SITE
SIREN, WISCONSIN

GENERAL CROSS-SECTION

Project No. **11222418**
Date **March 2022**

FIGURE 3.1

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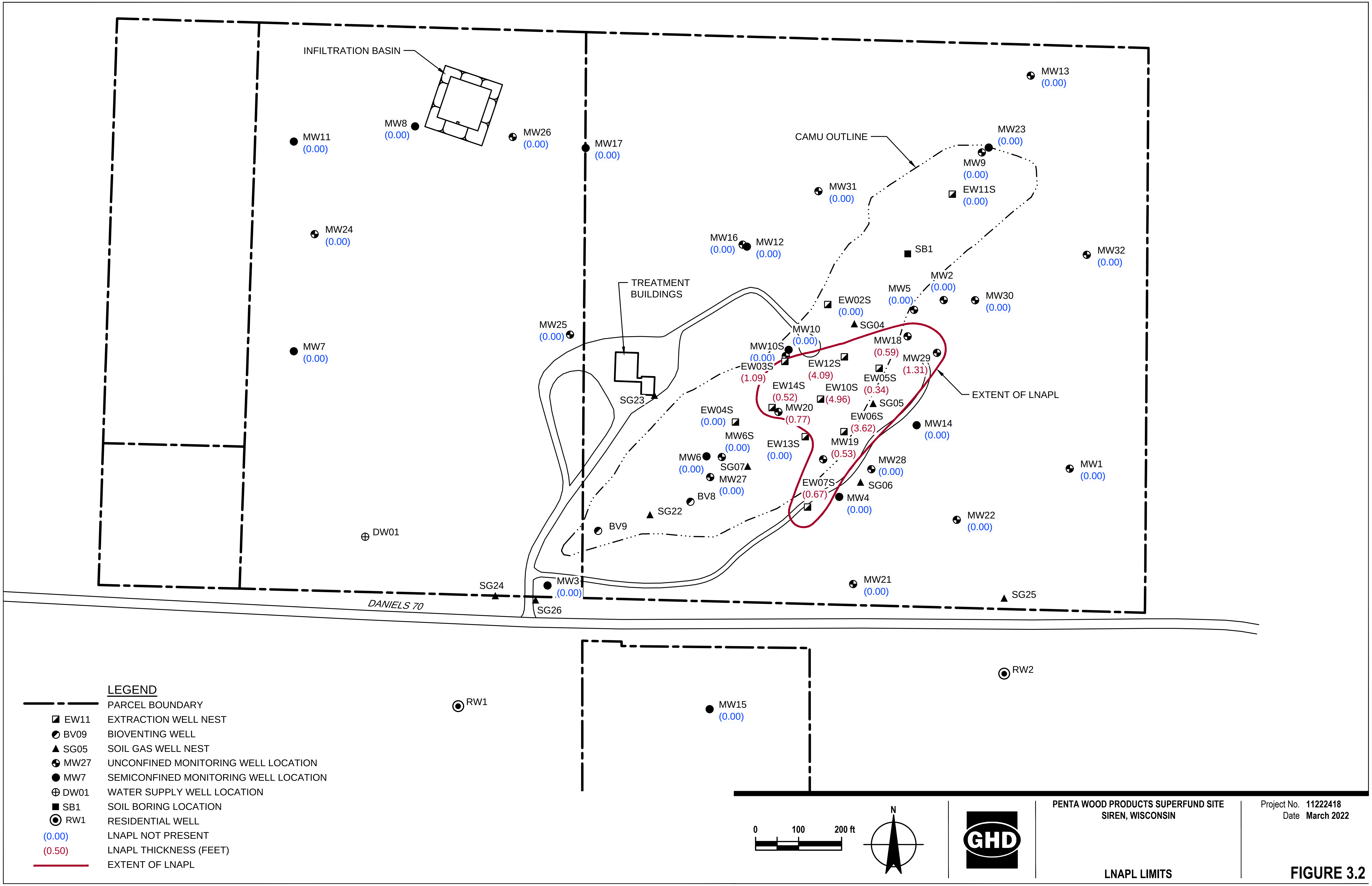

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PENTA WOOD PRODUCTS SUPERFUND SITE
SIREN, WISCONSIN

Project No. **11222418**
Date **March 2022**

LNAPL LIMITS

FIGURE 3.2

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DATA SOURCE: KEMPER AND ASSOCIATES, INC. SURVEY DATED MAY 2016 (WISCONSIN BURNETT COUNTY COORDINATE SYSTEM NAD83, 1996).

Tables

Table 4.1

Cost Estimate
In-Situ Chemical Oxidation
Penta Wood Products Superfund Site
Siren, Wisconsin

Description	Units	Unit Price	Quantity	Cost
Capital Costs				
Drilling and Well Installation	Well	$ 10,000	80	$ 800,000
Well Boxes	Box	$ 300	80	$ 24,000
Waste Characterization and Disposal	LS	$ 10,000	1	$ 10,000
Oversight	Hr	$ 200	300	$ 60,000
Subtotal				$ 894,000
Engineering	Percent	20%		$ 178,800
Bonds and Insurance	Percent	3%		$ 26,820
Mob/Demob	Percent	1%		$ 8,940
Permitting	Percent	2%		$ 17,880
Health and Safety	Percent	1%		$ 8,940
Construction Facilities and Temporary Controls	Percent	2%		$ 17,880
Reporting	Percent	2%		$ 17,880
Subtotal				$ 277,140
Total Capital Cost				**$ 1,171,140**
Remedy Implementation Costs				
Labor and Expenses	Yr	$ 150,000	1	$ 150,000
Oxidant and Activator	Well	$ 16,000	80	$ 1,280,000
Analytical	Sample	$ 250	20	$ 5,000
Reporting	LS	$ 10,000	1	$ 10,000
Subtotal				$ 1,445,000
Total Remedy Implementation Cost	Yr	$ 1,445,000	10	**$ 14,450,000**
Long-Term Monitoring Costs				
Labor, Expenses, and Reporting	Yr	$ 140,000	20	$ 2,800,000
Total Long-Term Monitoring Cost				**$ 2,800,000**
Total Remedy Cost Estimate				**$ 18,421,140**
Contingency	Percent	30%		$ 5,526,342

Table 4.2

Cost Estimate
Ozone Injection
Penta Wood Products Superfund Site
Siren, Wisconsin

Description	Units	Unit Price	Quantity	Total
Capital Costs				
Drilling and Well Installation	Well	$ 10,000	80	$ 800,000
Well Boxes	Box	$ 300	80	$ 24,000
Trenching and piping	Foot	$ 60	2000	$ 120,000
Surface Restoration	LS	$ 10,000	1	$ 10,000
Electrical Service	LS	$ 5,000	1	$ 5,000
Waste Characterization and Disposal	LS	$ 10,000	1	$ 10,000
Equipment Installation	LS	$ 100,000	1	$ 100,000
Ozone Generator	LS	$ 500,000	1	$ 500,000
Installation Oversight	Hr	$ 200	600	$ 120,000
Subtotal				$ 1,689,000
Engineering	Percent	20%		$ 337,800
Bonds and Insurance	Percent	3%		$ 50,670
Mob/Demob	Percent	2%		$ 33,780
Permitting	Percent	2%		$ 33,780
Health and Safety	Percent	1%		$ 16,890
Construction Facilities and Temporary Controls	Percent	3%		$ 50,670
Reporting	Percent	2%		$ 33,780
Subtotal				$ 557,370
Total Capital Cost				**$ 2,246,370**
Remedy Implementation Costs				
Labor and Expenses	Yr	$ 150,000	1	$ 150,000
Electricity	Month	$ 2,000	12	$ 24,000
Analytical	Sample	$ 250	20	$ 5,000
Reporting	LS	$ 10,000	1	$ 10,000
Subtotal				$ 189,000
Total Remedy Implementation Cost	Yr	$ 189,000	10	**$ 1,890,000**
Long-Term Monitoring Costs				
Labor, Expenses, and Reporting	Yr	$ 140,000	20	$ 2,800,000
Total Long-Term Monitoring Cost				**$ 2,800,000**
Total Remedy Cost Estimate				**$ 6,936,370**
Contingency	Percent	30%		$ 2,080,911

Table 4.3

Cost Estimate
Hydrogen Peroxide Injection
Penta Wood Products Superfund Site
Siren, Wisconsin

Description	Units	Unit Price	Quantity	Total
Capital Costs				
Drilling and Well Installation	Well	$ 10,000	80	$ 800,000
Well Boxes	Box	$ 300	80	$ 24,000
Waste Characterization and Disposal	LS	$ 10,000	1	$ 10,000
Oversight	Hr	$ 200	300	$ 60,000
Subtotal				$ 894,000
Engineering	Percent	20%		$ 178,800
Bonds and Insurance	Percent	3%		$ 26,820
Mob/Demob	Percent	1%		$ 8,940
Permitting	Percent	2%		$ 17,880
Health and Safety	Percent	1%		$ 8,940
Construction Facilities and Temporary Controls	Percent	2%		$ 17,880
Reporting	Percent	2%		$ 17,880
Subtotal				$ 277,140
Total Capital Cost				**$ 1,171,140**
Remedy Implementation Costs				
Labor and Expenses	Yr	$ 230,000	1	$ 230,000
Oxidant and Activator	Well	$ 4,500	80	$ 360,000
Analytical	Sample	$ 250	20	$ 5,000
Reporting	LS	$ 10,000	1	$ 10,000
Subtotal				$ 605,000
Total Remedy Implementation Cost	Yr	$ 605,000	20	**$ 12,100,000**
Long-Term Monitoring Costs				
Labor, Expenses, and Reporting	Yr	$ 140,000	20	$ 2,800,000
Total Long-Term Monitoring Cost				**$ 2,800,000**
Total Remedy Cost Estimate				**$ 16,071,140**
Contingency	Percent	30%		$ 4,821,342

Table 4.4

Cost Estimate
Biosparging
Penta Wood Products Superfund Site
Siren, Wisconsin

Description	Units	Unit Price	Quantity	Total
Capital Costs				
Drilling and Well Installation - Biosparge Wells	Well	$ 10,000	80	$ 800,000
Well Boxes	Box	$ 300	80	$ 24,000
Trenching and AS piping	Foot	$ 40	2000	$ 80,000
Surface Restoration	LS	$ 10,000	1	$ 10,000
Electrical Service	LS	$ 5,000	1	$ 5,000
Waste Characterization and Disposal	LS	$ 10,000	1	$ 10,000
Equipment Installation	LS	$ 100,000	1	$ 100,000
Blower Unit	LS	$ 250,000	1	$ 250,000
Installation Oversight	Hr	$ 200	600	$ 120,000
Subtotal				$ 1,399,000
Engineering	Percent	20%		$ 279,800
Bonds and Insurance	Percent	3%		$ 41,970
Mob/Demob	Percent	2%		$ 27,980
Permitting	Percent	2%		$ 27,980
Health and Safety	Percent	1%		$ 13,990
Construction Facilities and Temporary Controls	Percent	3%		$ 41,970
Reporting	Percent	2%		$ 27,980
Subtotal				$ 461,670
Total Capital Cost				**$ 1,860,670**
Remedy Implementation Costs				
Labor and Expenses	Yr	$ 150,000	1	$ 150,000
Electricity	Month	$ 2,000	12	$ 24,000
Analytical	Sample	$ 250	20	$ 5,000
Reporting	LS	$ 10,000	1	$ 10,000
Subtotal				$ 189,000
Total Remedy Implementation Cost	Yr	$ 189,000	10	**$ 1,890,000**
Long-Term Monitoring Costs				
Labor, Expenses, and Reporting	Yr	$ 140,000	20	$ 2,800,000
Total Long-Term Monitoring Cost				**$ 2,800,000**
Total Remedy Cost Estimate				**$ 6,550,670**
Contingency	Percent	30%		$ 1,965,201

Table 4.5

Cost Estimate
NSZD/MNA
Penta Wood Products Superfund Site
Siren, Wisconsin

Description	Units	Unit Price	Quantity	Total
Capital Costs				
MNA Assessment	LS	$ 30,000	1	$ 30,000
NSZD Studies	LS	$ 120,000	1	$ 120,000
Subtotal				$ 150,000
Engineering	Percent	20%		$ 30,000
Mob/Demob	Percent	2%		$ 3,000
Health and Safety	Percent	3%		$ 4,500
Subtotal				$ 37,500
Total Capital Cost				**$ 187,500**
Long-Term Monitoring Costs				
Labor, Expenses, and Reporting	Yr	$ 140,000	40	$ 5,600,000
Total Long-Term Monitoring Cost				**$ 5,600,000**
Total Treatment Cost				**$ 5,787,500**
Contingency	Percent	30%		$ 1,736,250

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