RECOMMENDATION REPORT
OPERABLE UNIT J
DULUTH, MINNESOTA

August 1995

Prepared for

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1.0 INTRODUCTION

A Detailed Analysis Report (DAR) (Geraghty & Miller, Inc., 1995) documented the evaluation and analysis of technologies and assembled remedial alternatives for the remediation of nonnative soils within Operable Unit J at the U.S. Steel (USS) Duluth Works Site (Site) in Minnesota (Figures 1-1, 1-2). The DAR was submitted to the Minnesota Pollution Control Agency (MPCA) for review in July 1995. This subsequent report recommends a remedial alternative based on the results of the detailed evaluation documented in the DAR, but without the benefit of MPCA comments on the DAR.

2.0 BACKGROUND

Operable Unit J is defined in the 1989 Record of Decision (ROD) as a zone of tar and tar-contaminated soil within the Coke Plant Settling Basin Management Area. The degree and extent of contamination has been defined by a Remedial Investigation (RI) conducted by Barr Engineering Company (1986). The RI report assessed the risk posed to human health and the environment by the occurrence of the contaminants and provided preliminary information necessary to evaluate potential remediation technologies and alternatives.

The 1989 ROD identified a slurry wall and cap containment system as the proposed remedial action alternative for Operable Unit J provided that the quality, thickness, and continuity of an underlying low-permeability layer could be demonstrated. In pursuing this alternative, USS conducted investigations in the Coke Plant Settling Basin; during however, USS was not able to demonstrate to the satisfaction of the MPCA that the geologic and hydrogeologic conditions in the Coke Plant Settling Basin were appropriate for the selected remedial action alternative. USS continues to disagree with the technical rationale that the MPCA has applied in rejecting the proposed slurry wall alternative.

USS is interested in completing the remedial actions as specified in the 1989 ROD at the Duluth Works site. At this time, Operable Unit J is the only operable unit that still requires remedy resolution. In an attempt to resolve the present disagreement between USS and the MPCA, USS retained Geraghty & Miller, Inc. in 1994 to conduct additional studies, including field investigation and laboratory treatability studies, to identify and evaluate appropriate remedial alternatives for Operable Unit J. The DAR was a result of those efforts.

Operable Unit J has been estimated to contain about 10,000 cubic yards of nonnative material (tar and tar-contaminated soil containing coke fines, flue dust, and mill scales). This tar was found to contain polynuclear aromatic hydrocarbon (PAH) levels as high as 11,000 milligrams per kilogram (mg/kg) carcinogenic PAHs (cPAHs) and 50,000 mg/kg non-carcinogenic PAHs (nPAHs) during the RI (Barr Engineering Company, 1986). The primary potential impact of the on-site contamination (PAH compounds) in Operable Unit J is to the St. Louis River. The potential migration pathway for those contaminants is surface-water flow to the St. Louis River by the stream flowing through the Coke Plant Settling Basin. The human exposure pathways of greatest concern are through ingestion of contaminated fish and dermal contact with or ingestion of contaminated soils. Currently, the dermal contact/ingestion pathway and potential migration pathway are not concerns because much of the contaminated soils are covered with clean soils, vegetation, or water, and Site access is limited.

Remedial Action Objectives (RAOs) for Operable Unit J have been established to protect human health and the environment from site-related constituents of concern (COCs). The RAOs are based on available data collected during site studies, primarily the Remedial Investigation Final Report (Barr Engineering Company, 1986). RAOs established by the ROD for Operable Unit J soils are still appropriate and include the following:

- Eliminate or minimize continued releases of COCs from tar and tar-contaminated soils and nonnative materials within Operable Unit J to the groundwater.

- Eliminate or minimize continued releases of COCs above target compound lists (TCLs) from tar and tar- contaminated soils and nonnative materials within Operable Unit J to the unnamed surface drainage that flows through the Coke Plant Settling Basin and into the St. Louis River.

- Control and prevent contact with exposed tar and tar-contaminated soil and nonnative material within Operable Unit J.

Seventeen remedial alternatives that satisfied these RAOs were developed by Geraghty & Miller and evaluated against the broad criteria of effectiveness, implementability, and cost. Four of the seventeen remedial measures were selected for detailed analysis in the DAR. The thirteen remedial measures that were rejected all incorporated excavation as a component of the remediation. Excavation of the contaminated soils within Operable Unit J could result in releases to groundwater and surface water. In addition, the cost for remedial measures that include excavation are excessive compared to the in-situ remedial measures that were retained.

The four remedial measures retained for detailed analysis include the following: Slurry Wall Containment, Slurry Wall Containment with Bioventing, Stabilization/Solidification, and Funnel-and-Gate. To obtain additional information and define the key site-specific remedial design parameters for the detailed alternatives analysis, a Sampling and Analysis Plan that included field and laboratory activities was submitted to the MPCA (Geraghty & Miller, Inc., 1994). In a letter dated December 29, 1994, the MPCA approved the Sampling and Analysis Plan and concurred that a more detailed analysis of the four alternatives was appropriate.

To better characterize the physical and chemical characteristics of the subsurface native and nonnative materials within Operable Unit J (Figure 1-2), field and laboratory activities were performed from February through March 1995. The information resulting from these efforts was used to define the site-specific design parameters to be used in the detailed analysis of the four remedial technologies previously deemed as potentially most appropriate and cost-effective for Operable Unit J. The additional field and laboratory studies consisted of the tasks outlined below:

- Soil boring installation to specifically define the stratigraphy of Operable Unit J to greater depths than had been performed previously and to obtain soil samples for analytical, compatibility, and treatability testing.

- Monitoring well and piezometer installation to further define the subsurface hydrology of Operable Unit J and obtain groundwater samples for analytical testing.

- Slurry wall compatibility testing to determine the compatibility of the contaminants with bentonite slurry walls.

- Biological treatability testing to determine the subsurface biodegradation potential at the Site.

- Stabilization/solidification testing to determine the feasibility of stabilizing/solidifying the contaminated zone with a cement, cement kiln dust, quick lime, or fly ash additive. The study was conducted parameterically to determine the most appropriate reagent.

- Groundwater analytical testing to define the contaminant levels and geochemistry. This information was used to evaluate the feasibility of in-situ groundwater treatment, and if feasible, which alternative was most appropriate.

- Native soil hydraulic conductivity testing to determine the suitability of native soils for CERCLA-cap construction.

The key conclusions of the field and laboratory studies are detailed in the summary that follows:

- The nonnative materials within Operable Unit J are generally immobile in their present state. A total analysis of a soil/tar composite sample from

Operable Unit J identified levels of cPAHs as high as 55,000 mg/kg and nPAHs as high as 244,000 mg/kg (cPAHs and nPAHs are defined from lists presented in Table 2 of the 1986 Barr Engineering RI report). Toxicity Characteristic Leaching Procedure (TCLP) analyses of the same sample did not detect cPAHs, and the sum of nPAHs was approximately 15 milligrams per liter (mg/L). Multiplying the nPAH concentration of 15 mg/L by the 20 times dilution factor of a TCLP analysis to relate it to a concentration in soil results in a leachable soil concentration of only 300 mg/kg. This provides one indication that the nonnative materials in Operable Unit J are remaining immobile. Under TCLP conditions, leachable cPAHs were not detected and the sum of leachable and nPAHs was 3 orders of magnitude less than detected in the total soil/tar composite sample.

- As a second indication of the immobility of the nonnative materials, soil samples collected from borings inside the limits of Operable Unit J and underlying the nonnative materials had low contaminant concentrations (330 micrograms per kilogram [μg/kg] to 4,500 μg/kg) as compared to the nonnative materials that contained 55,000 mg/kg cPAHs and 244,000 mg/kg nPAHs. Additionally, soil samples collected from borings along the perimeter of Operable Unit J and within the confining unit were free of tar-related contaminants.

- Finally, groundwater samples collected from temporary wells within the limits of Operable Unit J contained relatively low levels of contaminants. No cPAHs were detected, and the sum of nPAHs detected ranged from 66 micrograms per liter (μg/L) to 420 μg/L. The proximity of the nonnative coal-tar materials to the groundwater sampling locations and resulting contaminant concentrations support the conclusion that the target components within the nonnative materials are generally immobile.

- A laterally extensive clay layer with a sufficiently low hydraulic conductivity was identified around the perimeter and beneath Operable Unit J at a depth greater than that of the 25-foot depth previously proposed as a remedial option. In addition, volatile organic compound (VOC) and semivolatile organic compound (SVOC) analyses indicated that this confining unit is free of tar-related contaminants. These results indicate that the Site contains a competent, contaminant-free confining layer suitable for the construction of vertical slurry wall barriers.

- Stabilization/solidification mix reagents that achieved acceptable unconfined compressive strengths and reduced the leachability of the nonnative material in Operable Unit J were identified. Benzene is the only contaminant in the raw mix not passing TCLP. The TCLP benzene concentration was reduced in the successful stabilization/solidification mixes to a level more than an order of magnitude below the TCLP standard of 0.5 mg/L.

- Favorable environmental conditions and the presence of substantial total heterotrophic microorganisms were identified. However, the overall effectiveness of intrinsic aerobic bioremediation of the tar and tar-contaminated soils will be limited because the primary contaminants remain insoluble.

- The presence of a suitable confining layer for keying in slurry walls and the prevailing low groundwater contaminant concentrations suggest that a successful funnel-and-gate remedial system is implementable.

- On-site borrow sources were identified that contained clay materials with hydraulic conductivities ranging from 1.3×10^{-7} centimeters per second (cm/sec) to 8.4×10^{-9} cm/sec. The hydraulic conductivity of the native material from all of the soil borrow locations tested suggest that the borrow source clay could be used as the primary barrier layer in a CERCLA-compliant cap.

The treatability study data repeatedly indicated that the nonnative materials in Operable Unit J are generally immobile in their existing state. While capping and institutional controls are components of each of the four active remedial alternatives evaluated in the DAR, a remedial alternative consisting solely of these measures was not retained for detailed analysis because it initially was not believed that such an alternative was capable of satisfying the site RAOs and because this alternative does not actively address potential groundwater releases. However, based on the treatability data, releases to groundwater are not a limitation because the materials are generally immobile in their existing state, thus, a capping alternative is likely capable of satisfying the RAOs. Although capping and institutional controls would prevent direct contact with residual materials and significantly reduce future potential impacts to other environmental media, thereby becoming a feasible strategy, only the four alternatives previously approved for evaluation by the MPCA were subjected to detailed analysis in the DAR. The detailed analyses were conducted according to the MPCA Site Response guidance documentation. The four alternatives were evaluated individually and comparatively against a broad range of evaluation criteria. The criteria used to assess the appropriateness of the remedial alternatives were long-term effectiveness, implementability, short-term risk, total present worth cost, and community acceptance. A summary of the DAR comparative analysis is provided in Table 2.1.

While each of the four remedial alternatives evaluated provides protection of human health and the environment, and although no formal recommendation was given in the DAR, Stabilization/ Solidification and Slurry Wall Containment were identified as the alternatives that provide the highest cost-benefit in satisfying the Operable Unit J RAOs. Slurry Wall Containment with Bioventing was discounted from a cost-benefit standpoint because it does not provide significantly greater protection to human health and the environment than Slurry Wall Containment alone. Funnel-and-Gate was discounted because it focuses on the relatively insignificant impacts to groundwater; furthermore, this technology relies on treating groundwater after it is impacted rather than preventing such impacts. Slurry Wall Containment satisfies the RAOs and protects human health and the environment for costs that are expected to be less than Stabilization / Solidification; however, it does rely on an indefinite-term operation and maintenance commitment to manage groundwater which results in some uncertainty with respect to the overall implementation cost of this alternative. The permanence of Stabilization/Solidification and its lack of an indefinite-term operation and maintenance commitment were identified as distinct advantages over Slurry Wall Containment.

3.0 ALTERNATIVE SELECTION

The remedial alternative that is recommended for implementation at Operable Unit J is Stabilization/Solidification. The detailed evaluation demonstrated that Stabilization/Solidification has distinct advantages over the other alternatives, outweighing the potentially lower implementation costs. Stabilization/Solidification is a permanent remedy that immobilizes the tar and tar-contaminated soils at the time the alternative is implemented and does not require an indefinite-term operation and maintenance commitment. The specific advantages offered by Stabilization/Solidification result in the highest cost-benefit of the four alternatives subject to detailed analysis.

3.1 DESCRIPTION

Stabilization/Solidification will incorporate a soil additive to stabilize and solidify the coal tar and contaminated soils through a thorough in-situ mixing process. The potential for the success of this alternative was demonstrated in the treatability study. Based on the results of this study, the additive will presumably be a combination of cement and cement kiln dust, but will be further evaluated and defined during the design phase. This additive will be incorporated in-situ to limit the solubility and, in turn, the mobility of the contaminants. The curing of the stabilized material will form a soil-like material (solidification) or coated material (stabilization), depending upon the final additive that will entrap the contaminants within its structure. Contamination will be immobilized inside the resulting mass, thereby eliminating future access to the surface-water and groundwater environments.

3.2 DESIGN CRITERIA

The following design criteria will be used in preparing plans and specifications for implementation of the remedy:

- The stabilization/solidification additive will tentatively be a combination of cement and cement kiln dust. Based on the treatability study, the final mass will contain approximately 10 percent cement and 20 percent cement kiln dust.

- A conceptual layout of the mixing footprint is depicted on Figure 3-1.

- Stabilization/solidification will occur to a maximum elevation of 595 feet above mean sea level across Operable Unit J, this elevation is several feet below the base of the tar and tar-contaminated nonnative material (Figure 3-2).

- The unnamed creek channel will be stabilized and protected to ensure it does not meander through Operable Unit J during construction or post-construction. This surface water diversion structure will be designed to withstand the 100-year, 24-hour recurrence interval storm event.

- The final stabilized/solidified mass will achieve a TCLP benzene concentration of less than the federal standard of 0.5 parts per million (ppm). Benzene was the only constituent in the soil/tar composite sample subject to treatability testing that failed the TCLP prior to stabilization/solidification.

- A cap will be designed and installed that will reject a minimum of 90 percent of the precipitation, and will consist of four layers: a vegetated protective layer, a sand drainage layer, a low-permeability clay barrier layer, and a grade-adjusting fill layer (Figure 3-3).

- The final site grade will maintain a radial 3 to 5 percent minimum slope to prevent erosion and surface-water ponding. Perimeter side slopes will be no steeper than three (horizontal) to one (vertical).

3.3 IMPLEMENTATION

A conceptual layout of the mixing footprint is depicted on Figure 3-1. Prior to initiating stabilization/solidification of the tar and tar-contaminated soils in Operable Unit J, site modifications will be constructed to stabilize the stream channel, protect the working area against flooding, and provide a suitable working platform from which the construction equipment for the stabilization/solidification process can operate. The stream channel will, if necessary, be diverted by building berms and lined with riprap to prevent it from meandering into Operable Unit J during construction and post-construction. The working platform will consist of a soil berm with compacted structural fill and faced with riprap on the stream channel side to provide a dry, stable work surface and to protect the work area from flooding and erosion.

Following completion of a suitable section of the working platform, a test plot area approximately 12 feet by 12 feet (the exact dimensions will be defined during the design phase), within Operable Unit J will be stabilized/solidified to demonstrate field mixing techniques and effectiveness. The test plot will be performed with the same or similar equipment as will be used for full-scale stabilization/solidification for the remainder of Operable Unit J. After 28 days of curing time, samples will be collected from the test plot and tested by TCLP methods. Successful stabilization/solidification will result in a TCLP benzene concentration less than the 0.5 ppm standard.

After the preparation activities and test plot demonstration are complete, stabilization/solidification of the remainder of Operable Unit J will commence. Large-diameter (i.e., larger than 3 feet) auger mixing equipment with off-gas control will be used to incorporate the cement additive and cement kiln dust to the appropriate depth. Construction methods and additive amounts used will be equivalent to those used in the successfully demonstrated test plot. Construction activities for both the test plot and entric unit stabilization / solidification will be documented and certified in a final construction report.

Stabilization / solidification of Operable Unit J will likely proceed from the working platform across the unit with each recently mixed and stabilized area acting as the platform for equipment during successive mixing events. Bulking in the stabilization area will tend to raise the overall grade of Operable Unit J. If necessary, soil will be used to achieve a final grade elevation over the 100-year, 24-hour flood elevation in the bordering stream.

Following complete stabilization/solidification of Operable Unit J, the site will be capped. The cap will consist of four layers, in successive order: a vegetated protective layer, a sand drainage layer, a low-permeability clay barrier layer, and a grade-adjusting fill layer (Figure 3-3). Surface vegetation will be established to control surface-water run-off and erosion. The drainage layer will be designed and constructed to direct infiltration laterally to prevent head build-up on the barrier layer. A fill layer will be incorporated beneath the barrier layer if the treated surface does not result in a uniform foundation for the barrier layer and, as stated previously, to achieve minimum flood elevations. A 3 to 5 percent slope to prevent erosion and surface-water ponding will be incorporated. Perimeter side slopes will be no steeper than 3 (horizontal) to 1 (vertical). Gas control under the cap will not be required because the contaminants will be stabilized within the matrix, effectively eliminating volatilization.

3.4 SCHEDULE

Following MPCA approval of the Stabilization/Solidification remedial alternative, the response action will be implemented in the steps outlined below, as in the proposed schedule.

Project Phase	**Date**
Design	Winter 1995
MPCA Design Approval	Spring 1996
Bidding	Spring 1996
Construction	Summer/Fall 1996
Stream Stabilization and Site Grading	
Test Plot	
Stabilization/Solidification	
Cap Construction	
Project Closeout	Fall 1996

REFERENCES

Barr Engineering Co., 1986, Remedial Investigation Final Report, U.S.S. Duluth Works Sites.

Geraghty & Miller, 1994, Sampling & Analysis Plan, Operable Unit J, U.S. Steel Duluth Works, Duluth, Minnesota.

Geraghty & Miller, 1995, Detailed Analysis Report, Operable Unit J, Duluth, Minnesota.

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