Prepared for:
City of Oshkosh
Oshkosh, Wisconsin

Analysis of Brownfield Cleanup Alternatives

Mercury Marine Plant 24
449 Marion Road
Oshkosh, Wisconsin

AECOM, Inc.
August 2009
Document No.: 13090-002

AECOM

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August 3, 2009

Mr. Jon Peterson
US Environmental Protection Agency
77 West Jackson Boulevard, SE-4J
Chicago, Illinois 60604

Subject: Analysis of Brownfield Cleanup Alternatives, City of Oshkosh Brownfields Assessment Cleanup Grant, Mercury Marine Plant 24 Parcel, City of Oshkosh, Wisconsin -- AECOM Project No. 13090-005

Dear Mr. Peterson,

On behalf of the City of Oshkosh (City), AECOM, Inc. has prepared the attached Analysis of Brownfield Cleanup Alternatives (ABCA) for work conducted under the US Environmental Protection Agency (US EPA) Assessment Grant for Hazardous Substances awarded to the City.

The ABCA has been prepared to facilitate the US EPA Brownfields Cleanup Grant for the Mercury Marine Plant 24 parcel. This ABCA provides an overview of site conditions, site cleanup objectives, and provides a review of remedial options. In addition, this ABCA provides a green cleanup review of remedial options.

If you have any questions regarding the ABCA, please call Mr. Andrew Mott (920.235.0270). We appreciate your review of this document and support of the redevelopment efforts of the City.

Respectfully,

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1.0 Introduction

On behalf of the City of Oshkosh, Wisconsin (City), AECOM, Inc. (AECOM) has prepared this Analysis of Brownfield Cleanup Alternatives (ABCA) for the western portion of the Mercury Marine Plant 24 (MMP24) parcel located within the Marion Road/Pearl Avenue Redevelopment Area at 449 Marion Road in Oshkosh, Wisconsin (site). The Marion Road/Pearl Avenue redevelopment area is a former industrial riverfront corridor that essentially links the University of Wisconsin-Oshkosh campus to downtown Oshkosh. The Brownfield properties within the redevelopment area have significant redevelopment potential, but are hindered by the challenges related to environmental contamination and unsuitable nature of fill material to support surface features.

To attract redevelopment opportunities consistent with the prime location of the site, the US Environmental Protection Agency (EPA) has awarded a Brownfield Cleanup Grant to offset the expenses related to environmental management of subsurface soils and fill material. The EPA Brownfield Cleanup Grant will specifically be applied to the planned redevelopment of the site consisting of a senior living apartment complex. This private development will be located on the western half of the Mercury Marine parcel and includes 60 senior apartments and 60 underground parking stalls in a three-story structure. Supplemental surface parking will also be provided.

The remainder (east portion) of the MMP24 parcel is currently not planned for development, but conceptually is proposed to be developed into commercial, retail, and/or residential property. While most of the site will be sold to a private developer, a riverfront corridor will continue to be owned by the City and developed into a public pedestrian and bike path.

2.0 Site Description and History

2.1 Site Location and Description

The site is located at 449 Marion Road, Oshkosh, Wisconsin. The site encompasses approximately 2 acres (part of the approximately 6-acre MMP24 parcel) and is located in the Northeast 1/4 of the Southeast 1/4 of Section 23, Township 18 North, Range 23 East, in the city of Oshkosh, Winnebago County, Wisconsin. The site is generally level to gently sloping and currently vacant. Buildings at the site have been razed; however, the concrete slab-on-grade foundations and floors remain. The asphalt parking areas are still in place. Adjacent properties currently include industrial use and vacant parcels. The Fox River is adjacent south of the subject property. Location of the subject property is depicted on Figure 1.

2.2 Site History

A Phase I Environmental Site Assessment (Phase I ESA) was performed by AECOM on MMP24 parcel dated October 11, 2006, under a grant from the EPA Brownfields Economic Redevelopment Initiative. According to the Phase I ESA, the MMP24 parcel has been developed with industrial and manufacturing facilities since the mid-1800s. Specifically, the area of the proposed development was developed in the 1890s with the Radford Brothers Saw, Shingle, and Lathe Company. The site at that time was used for the storage of lumber. In the early 1900s, the Radford Brothers Company was replaced by the Oshkosh Candle Company, the manufacturer of candles, and the Cook & Brown Company bulk fuel tank farm. The bulk fuel storage was comprised of nine aboveground storage tanks (ASTs) ranging in size from approximately 1,000 to 5,000 gallons, including one approximately 10,000-gallon AST, and a pump house. The property along the river front of the Oshkosh Candle Company was used for storage of coal during this timeframe. In the early 1970s, the site was developed with a parking lot and boat docks along the Fox River. The site was owned by Kiekhaefer Aeromarine Company during this time period when it was purchased by the Mercury Marine Company (Mercury Marine) in the mid-1970s. Historically, the surrounding properties were used for both commercial and industrial purposes.

As a result of the Phase I ESA, the following recognized environmental conditions (RECs) and historical RECs were identified on the western portion of MMP24 parcel (additional RECs were identified on the eastern portion of the MMP24 parcel):

1) Petroleum hydrocarbon compounds were identified along the Marion Road right-of-way on the northwest side of the property during utility construction in April 2003. The contamination was attributed to the former Cook & Brown Company bulk fuel tank farm and Mercury Marine was subsequently identified as the responsible party because of their ownership of the property. A site investigation was performed in the approximate area of the candle plant and AST farm. The site investigation identified metals and petroleum contamination in the soil and groundwater in the center of the west parking lot. The Wisconsin Department of Natural Resources (WDNR) opened a case file (BRTTS No. 02-71-516785 and WDCOM No. 54901-4720-00-A) for the subject property related to the release identified during the Marion Road construction. The Wisconsin Department of Commerce issued site closure in 2008 with a soil and groundwater use restriction for the central portion of the site for residual petroleum-impacted soil and groundwater impacts.

2) Fill soils including sawdust, other wood products, and foundry sand are known to be present in this area of Oshkosh. The thickness of fill soils on the site ranges from 3 to 12 feet.

Following the Phase I, a Phase II Environmental Subsurface Assessment (Phase II ESA) was performed in May 2007.

2.3 Subsurface Assessment Findings

Five soil borings (MMSB-6 through MMSB-10) were advanced in the area of the proposed development in association with the May 2007 Phase II ESA. The soil borings were converted into monitoring wells for groundwater sampling. Locations of the soil borings and monitoring wells are depicted on the attached Drawing 2007-1.

Results of the soil borings indicate that fill soils apparently extend beneath the entire site and range from about 3 to 12 feet thick. The fill soils are comprised of a silt, sand, gravel, brick fragments, cinders, wood chips, wood timber, and coal. Fill soil thickness is depicted on Drawing 2007-2. Beneath the fill are natural deposits including silty clay, sandy clay, sandy silt, and silty clay with seams of coarse sand, coarse gravel, and peat. Depth to bedrock (dolomite) is estimated within 35 to 45 feet of the ground surface.

Groundwater was observed at a depth of 1.5 feet below ground surface (bgs) to 6.0 feet bgs. Groundwater generally flows to the north-northwest in the spring, summer, and fall. In the winter months, up-river dam levels are decreased causing lower water elevations in the Fox River system. As a result of the lower water elevation, groundwater flow can change to the south-southeast toward the Fox River.

Results of the Phase II ESA soil and groundwater sampling indicate the following:

- Lead and polynuclear aromatic hydrocarbons (PAHs) were detected in samples collected from the fill soil. Several PAH concentrations exceeded the State of Wisconsin generic direct contact non-industrial limit (for the upper 4 feet).

- There were volatile organic compound (VOC) (benzene, bromomethane, and/or naphthalene) detections above the Wisconsin NR 720 Groundwater Pathway limit in soil Borings MM-SB-9 and MM-SB-10.

- VOCs (benzene, 1,2-dichloroethane, and vinyl chloride) and PAHs were detected in the groundwater samples collected from the groundwater monitoring wells. Benzene exceeded the State of Wisconsin NR 140 groundwater quality standards in Monitoring Well MM-SB-7.

Soil and groundwater concentrations are summarized on attached Tables 1 and 3. Groundwater sampling field observations are summarized on Table 2.

2.4 Subsurface Assessment Conclusions

Based on results of the subsurface assessments, the concentration of lead and several PAH compounds represent a potential direct contact risk to human health. Additionally, VOCs (benzene, bromomethane, and/or naphthalene) were detected in several soil samples at concentrations that represent a potential risk to groundwater quality. Because of the elevated lead and PAHs, fill soils at the site should be managed as impacted material during site redevelopment and excess fill soils generated during redevelopment should be managed as solid waste. While not anticipated, fill materials may be considered a hazardous waste depending on specific chemical characteristics.

Groundwater quality is not expected to be impacted significantly and active groundwater remediation is not anticipated. If construction dewatering is necessary during redevelopment, discharge will be monitored and directed to the sanitary sewer.

3.0 Potential Exposure Pathways

3.1 Soil

Potential exposure pathways were evaluated by comparing analytical data collected at the site with Soil Cleanup Standards established under Chapter NR 720, Wisconsin Administration Code. These standards were established for the remediation of soil contamination, which result in restoration of the environment to the extent practicable; minimize harmful effects to the air, lands, and waters of the state; and are protective of public health, safety and welfare, and the environment. These soil cleanup standards apply to all remedial actions taken by responsible parties to address soil contamination after an investigation has been conducted at a site that is subject to regulation.

Soil cleanup standards are established based on one of the following controlling criteria:

1) Soil quality that would cause a violation of a groundwater quality standards;
2) An impact on soil quality or groundwater quality that would cause a violation of a surface water quality standard contained on Chapters NR 102 to 106,
3) Soil quality that would cause a violation of an air quality standard contained in Chapters NR 400 to 499, and
4) Soil quality that represents a risk to human health as a result of direct contact, including ingestion. The controlling criteria depend, in part, on the physical and toxilogical characteristics of the chemicals of concern. For the chemicals of concern identified at the site, non-industrial direct contact Residual Contaminate Levels (RCLs) were used as soil cleanup objectives for this site.

Based on soil analytical results from previous subsurface investigations at the site, a potential exposure pathway for direct contact exists at the site. Drawing 2007-3 indicates soil sample locations and corresponding soil analytical test results.

3.2 Groundwater

Potential exposure pathways were evaluated by comparing analytical data collected at the site with Chapters NR 140 and NR 160 of the Wisconsin Administrative Code which establish groundwater quality standards for substances detected in or having a reasonable probability of entering the groundwater resources of the state. Two sets of standards are established: 1) enforcement standard (ES) and 2) Preventive Action Limit (PAL). The ES is a health-risk based concentration and when exceeded, usually results in further subsurface investigation, remedial action requirements, or monitoring. ES concentrations are generally based on federal drinking water quality standards. The PAL is typically established at 10% of the ES for substance with carcinogenic mutageneric or teratogenic properties. The PAL is established at 20% of the ES for substances of public health concern. Groundwater quality ES concentrations outlined in Chapter NR 140 represent groundwater cleanup criteria for this site.

Based on results of groundwater samples collected from monitoring wells installed on the former Mercury Marine property, benzene concentrations exceed groundwater cleanup objectives at two locations: Monitoring Wells MW-4 and MM-SB-7. These two monitoring wells are located in the east south-central portion of the property. Drawing 2007-4 indicates locations of the monitoring wells and corresponding groundwater analytical test results. Results of groundwater monitoring suggest that elevated concentrations of benzene are isolated to the area around the two monitoring wells and do not appear to be migrating off site or impacting surface water quality of the neighboring Fox River. Benzene concentrations appear to be stable or declining, and active groundwater remediation is not anticipated. Accordingly, this ABCA is limited to soil cleanup alternatives, with the understanding that by addressing impacted soil, the source of groundwater quality degradation will be mitigated and environmental closure can be granted.

3.3 Vapor Intrusion

Vapor intrusion or the migration of volatile chemicals from the subsurface into overlying buildings was evaluated for the site by comparing analytical data collected at the site with generic site specific screening levels (SSLs) calculated using the EPA Soil Screening Level website (http://risk.lsd.ornl.gov/epa/ssl1.htm). The EPA Risk Assessment Guidance website allows users to carry out algorithms to determine SSLs. The EPA website is linked to current toxicological data and chemical/physical properties for various compounds. EPA default values in the calculations were replaced with WDNR default values for non-industrial sites as outlined in WDNR guidance Document PUB-RR-682.

Analytical results from soil samples collected at the site do not indicate analyte levels in exceedance of generic SSLs for volatile inhalation. However, benzene concentrations in groundwater exceed cleanup objectives at two wells located in the east south-central portion of the property. The wells are located within 50 feet of the proposed building. The groundwater table has been measured at approximately 3 feet below the current ground surface in the two impacted wells.

Due to the presence of biodegradable materials (i.e. wood) encountered in the fill soils at the site, the potential exists for methane gas to be generated during decomposition. Methane levels were measured in on-site groundwater monitoring wells by AECOM using a four-gas meter. Methane was not detected in the gas samples collected. Based on benzene concentrations in the groundwater near the proposed building and the potential for methane gas accumulation, vapor barriers and/or a passive vapor extraction system should be installed below the proposed building during redevelopment activities.

4.0 Analysis of Soil Cleanup Alternatives

4.1 Site Redevelopment Plans

The City Redevelopment Authority has executed a final development agreement with Oshkosh River Development, LLC for the riverfront portion of Marion Road/Pearl Avenue including the former MMP24 property. Specifically, development plans for the site include a 60-unit senior living apartment complex. Conceptual redevelopment plans for the site are indicated on the attached drawings. Oshkosh River Development analyses anticipates initiating construction in October 2009.

The City proposes to implement corrective action concurrent with site redevelopment. In this manner, constructed features (i.e. buildings, parking areas, and landscape features) can be integral components of the remedy.

Four potential cleanup alternatives were selected for the site. These alternatives are subsequently discussed and EPA Citizen Guides, which provide general information on the different alternatives appended to this report.

4.2 Potential Cleanup Alternatives

4.2.1 No Action

The No Action Alternative would involve no remedial activities at the site and leave the site in its current condition. This alternative is not practical because it constrains and potentially eliminates any practical redevelopment of this property.

4.3 Off-Site Landfilling

The off-site landfilling alternative would involve the transfer of all impacted soil to an off-site licensed landfill. The impacted soil at the site would be excavated, temporarily stockpiled if necessary, loaded into trucks, and transported to a landfill. Backfill from off-site sources would be brought into the site to raise the grade following removal of impacted soils.

Under this alternative, the proposed building would be constructed over a conventional foundation. Building footings would be constructed to design depth and width along the perimeter and along load-bearing areas of the building footprint. All fill material generated during construction would be managed as a solid waste. Samples of fill would be collected and analyzed for waste characteristics, as necessary, to obtain landfill approval. Potential solid waste disposal facilities include Winnebago County Landfill or the Waste Management Valley Trail Landfill located in Berlin, Wisconsin.

4.3.1 On-Site Reuse with Performance Barriers and Limited Off-Site Landfilling

This alternative would involve reusing soil excavated during construction as fill material in other areas of the site, incorporating all alternative building foundation to reduce soil excavation, and utilizing performance barriers over impacted soils at the site to address direct contact concerns. It is anticipated that the excavation of impacted fill material will be primarily limited to the area below the proposed building to a depth of 3 feet below the current ground surface. The bulk of the remaining impacted soils is expected to be covered with imported fill material to raise grade of the site. Performance barriers would include the proposed senior apartment buildings, parking lot, and imported soil fill in landscaped areas. Performance barriers that do not consist of hardscape (pavement or building components) will be covered with an engineered barrier consisting of a geotextile warning layer, 6 inches of clean soil, and at least 6 inches of topsoil. The barriers would substantially reduce the potential for the public or site occupants to come into contact with the underlying impacted soil. Off-site landfilling may be required for excess impacted soils that would be excavated during construction and could not be reused on site due to space or structural suitability limitations.

Under this alternative, the building would be constructed over an alternative foundation, likely a deep pile or geopier foundation. As indicated on the fill Isopach map, there may be over 10 feet of fill in some areas below the building footprint. Use of an alternative foundation would allow most of the material to stay in place and the building would essentially span the impacted soil. The cost of the deep foundation exceeds that of the conventional foundation in the previous alternative; however, this cost is offset by the reduced volume of soil, which would require transportation and landfilling.

4.3.2 Ex-Situ Thermal Treatment and Solidification/Stabilization

The ex-situ thermal treatment and solidification/stabilization alternative would involve combining two remediation technologies to address the different types of contaminants identified at the site. Ex-situ thermal treatment technology consists of incinerating impacted soil that has been excavated from the site to treat organic contaminants. An air pollution control typically treats the incinerator off gases.

Because thermal treatment does not treat inorganic compounds (metals), the incinerated soil would also be required to undergo solidification/stabilization to address lead impacts detected at the site. Stabilization involves altering contaminants to a less harmful or less mobile state. Solidification binds the impacted soil to prevent future migration of contaminants. Treatability studies are generally required to determine if soils are compatible with these technologies.

Under this alternative, soil would be excavated from the site and transported to and stockpiled at on-site or nearby location for incineration. Impacted soil would be loaded into high temperature incinerator(s) for treatment. Incinerated soil would then be stockpiled for solidification/stabilization. The solidification/ stabilization process would include conveying the incinerated soil into a weight feeder, followed by a homogenizer where the soil would be mixed with water, followed by a pug mill where the soil would be mixed with a reagent. Treated soil would be would be reused on site as fill material.

4.4 Evaluation of Cleanup Alternatives

4.4.1 Evaluation Criteria

Potential cleanup alternatives to mitigate the risk to human health and environment due to chemical characteristics of the subsurface fill material present throughout the redevelopment site were comparatively evaluated based on the following criteria:

- Technical simplicity
- Effectiveness in protecting human health and the environment
- Cost of implementation including costs related to long-term monitoring or any operating and maintenance costs
- Implementation schedule

Each alternative was compared to the evaluating criteria and a numerical score assigned. Results of comparative scoring are summarized on Table 4. On the basis of technical simplicity, all alternatives rated equal with the exception of the ex-situ thermal treatment and solidification/stabilization alternative. In terms of effectiveness and protecting human health and the environment, the No Action Alternative rated lowest while the other three alternatives were equally effective. Arguably, ex-situ thermal treatment/stabilization and the use of performance barriers may not be as effective as off-site landfilling. Under the landfilling alternatives, impacted fill material would be excavated and removed from site; while with the other two alternatives, engineering controls or chemical treatment are being used to reduce direct contact and environmental risk while leaving material in place.

A summary of probable costs related to each of the other three cleanup alternatives is summarized on Table 5. Cost information presented on Table 5 is intended to be used for comparative purposes only and does not represent a formal budget to implement a specific alternative. Actual costs will depend on details of site development plans including grading plans, pavement plans, utilities, and landscaping. Economically, the No Action Alternative could be implemented for the least cost; however, from a broader perspective, without implementing corrective action, the former industrial property could not be redeveloped and the economic benefit related to improved property value and public access to the waterfront would not be realized. Costs are largely controlled by the volume of fill material that must be treated or landfilled at an off-site location. Based on the anticipated volume of soil generated under each cleanup alternative, on-site reuse of soil with performance barriers and limited off-site landfilling appears to be the least expensive alternative. That alternative includes implementing a cap maintenance plan to maintain the condition of the parking lot and other performance barriers. Cap maintenance plans for the purposes of environmental remediation should be consistent with building and grounds maintenance commonly practiced for a development such as this.

The anticipated schedule to implement each of the cleanup alternatives will depend, in part, on the volume of soil required to be excavated and transported off site or treated prior to reuse. We anticipate that off-site landfilling, which largely consists of mass excavation and backfilling, could be accomplished in less time than constructing performance barriers and limiting off-site landfilling. Excavation and landfilling would largely occur prior to any significant construction effort while performance barriers would be constructed concurrent with other site improvements. Ex-situ thermal treatment and solidification/stabilization is expected to take longer than excavation and landfilling due to the time required to mobilize specialty thermal and mixing equipment.

4.4.2 Green Remediation Criteria

Green Remediation is defined by the US EPA as the practice of considering all environmental effects of remedy implementation and incorporating options to maximize net environmental benefit of cleanup actions. Green Remediation focuses on establishing and utilizing management practices which consider the broader impact of proposed environmental mitigation, including societal benefits, while preserving the effectiveness of the selected remedy. The following six core elements of green remediation have been established by the US EPA:

1. Minimize total energy use and maximum use of renewable energy
2. Minimize air pollutants and greenhouse gas emissions
3. Minimize water use and impacts to water resources
4. Optimize future land use and enhance ecosystem
5. Reduce, reuse, and recycle materials of waste
6. Optimize sustainable management practices during stewardship

In general, these green remediation core elements have been established to evaluate the net environmental impact of remediation by recognizing collateral impact to air, water, land, and social systems. Potential management practices, which can be included as elements of proposed cleanup alternatives, are summarized on Table 6 along with the relative implementation difficulty and the corresponding relationship to each green remediation core element. As indicated on Table 6, there are several practices that could be employed or modified to enhance green remediation concepts. Some of these practices may influence other evaluation criteria such as technical practicability, effectiveness, cost, and implementation schedule. Occasionally, practices have competing influences on core elements and other evaluation criteria. For example, the use of low sulfur diesel fuel will reduce air emissions but may increase total energy usage and total project cost.

Green remediation criteria were also evaluated utilizing a sustainability metric evaluation tools. The US Air Force's Sustainable Remediation Tool (SRT) was used to compare remediation approaches on the basis of sustainability metrics. The tool allows users to estimate sustainability metrics for specific remedial action technologies. The SRT quantifies carbon dioxide emissions to the atmosphere, energy consumption, and safety/accident risk. An AECOM developed sustainability tool (LDW) was used to evaluate the thermal treatment technology. The LDW tool similarly quantifies air emissions, safety/accident risk, and energy consumption.

Both the SRT and LDW tools utilize similar computational approaches. Estimated carbon dioxide emissions are calculated from emissions factors for specific equipment and processes along with estimated activity data such as hours of operation. These worksheets include emissions factors and activity data for three different types of sources; Stationary Internal combustion, Stationary external combustion and mobile combustion. Safety/accident risk results are based on workplace accident rates provided by the U.S. Department of labor (Industry Injury and Illness Data, 2007 – Supplemental News Release Table SNR05). Energy consumption results are based on the average heating value for diesel fuel and the amount of diesel fuel consumed during each activity. Results of the sustainability metric evaluation are summarized in Table 7 and details are provided in Appendix B of this report.

Results of the sustainability metric evaluation (Table 7) along with the qualitative evaluation summarized in Table 6 were used to score each of the green remediation core elements relative to proposed corrective action alternatives. These comparative scores are provided in Table 4. As indicated in Table 4, the green remediation criteria are weighted such that collectively, the green remediation criteria have the same influence as each of the other feasibility criteria.

4.4.3 Comparative Results

As discussed previously, the No Action Alternative is not considered practical because it does not prepare the site for redevelopment or achieve the objectives of the City and other stakeholders.

The off-site landfilling alternative would remove the bulk of the impacted soil from the site, thereby reducing risk to the public and environment. A licensed landfill (Winnebago County Landfill) is located approximately 5 miles north of the site. The proximity of the landfill to the site reduces trucking costs and associated air emissions from the trucks. Disadvantages of off-site landfilling the entire mass of impacted soils at the site include high costs, fugitive air emissions during operations, and potential community concerns regarding trucking large quantities of impacted soil through downtown Oshkosh.

The on-site reuse with performance barriers and limited off-site landfilling alternative would address hazards to the public and environment at the site. This alternative would reduce soil excavation and off-site landfilling activities, thereby reducing air emissions. Performance barriers will be required to address direct contact issues with the impacted soils. These barriers will require future maintenance.

The ex-situ thermal treatment and Solidification/Stabilization alternative would address hazards to the public and environment at the site. The disadvantages of this alternative include high costs and relatively long implementation time. Thermal treatment is generally more cost-effective when treating hazardous waste, which has not been identified at the site.

4.5 Recommended Cleanup Alternative

The on-site reuse with performance barriers and limited off-site landfilling alternative is the preferred remedy for achieving environmental closure at the MMP24 property due to the effectiveness, implementation feasibility, green remediation rating, and cost. This alternative consists of managing as much of the impacted fill material on site as practical and disposing the remainder of the material at a licensed solid waste landfill. A key element of this alternative is the use of an alternative foundation for the proposed structures; a foundation that would allow most of this material to remain in place. This foundation system will have the greatest impact to limit the volume of solid waste removed from the site. Additionally, site grading plans, utility plans and paving plans should be prepared recognizing the characteristics of the fill materials. Landscaping berms, stormwater infiltration areas, and other greenspace areas should incorporate the fill material to the extent practical. Utility corridors should include barriers where they enter and exit the site to control potential vapor migration through the granular backfill. To the extent the fill material can be used as structural fill, it should be considered to raise grades below parking areas and other proposed pavement.

The use of performance barriers, alternative foundations and limited landfilling supports the core elements of green remediation largely because components of the environmental remedy leverage site improvements and infrastructure needs of the new development. Additionally, there are several management practices that could be employed under the selected remedy, which support the green remediation core elements with little impact on cost and effectiveness. Management practices which will be considered when implementing corrective action include: Imposing idle restrictions on construction equipment, planning trucking routes to limit noise disturbance in residential neighborhoods, sequencing work to reduce material handling, covering stockpiles for dust control, and limiting construction dewatering.

Tables

TABLE 1
SOIL ANALYTICAL RESULTS
PROPOSED SENIOR APARTMENTS
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

	Generic RCLs			Inhalation of Volatiles Soil Screening Levels	NR 746 Soil Screening Levels	GP-4		GP-5		GP-6		GP-7		GP-8		GP-9		GP-10		MM-SB-6	MM-SB-9	MM-SB-10	
	Direct Contact Pathway		Groundwater			2-4'	6-8'	0-2'	4-6'	0-4'	4-6'	0-2'	4-6'	0-4'	4-5'	0-4'	4-6'	0-2'	6-8'	2.5-4.5'	5-7'	2.5-4.5'	10-12'
						Fill	Silt/Clay	Fill	Silt	Fill	Silt/Clay	Fill	Fill/Silt/Clay	Fill	Silt	Fill	Fill/Clay	Fill	Clay	Fill	Clay	Fill	Clay
Parameters	Non-Industrial	Industrial	Pathway			3/18/04	3/18/04	3/18/04	3/18/04	3/18/04	3/18/04	3/18/04	3/18/04	3/18/04	3/18/04	3/18/04	3/18/04	3/18/04	3/18/04	5/23/07	5/23/07	5/23/2007	5/23/2007
Metals (mg/kg)																							
Lead	50 [E]	500 [E]	--		--	**79.0** [A]	8.46	31.6	**440** [A]	41.9	**63.0** [A]	21.9	11.4	34.7	**195** [A]	**156** [A]	19.5	19.4	15.0	NA	NA	NA	NA
Detected VOCs (µg/kg)																							
Benzene	1,100 [E]	52,000	5.5 [E]	170	8,500	ND	ND	**45.2** [C]	ND	ND	ND	ND	ND	ND	ND	ND	ND	**40.1** [C]	ND	<10	<10	<10	<10
Bromobenzene	--	--	--	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	32.4	453	148	62.3
Bromomethane	21,900	1,430,000	4.0	4000	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<17	**87.1** [C]	<17	**27.1** [C]
sec-Butylbenzene	--	--	--	--	--	ND	ND	ND	ND	ND	442	ND	ND	ND	801	ND	69.9	ND	ND	<19	<19	<19	<19
Butylbenzene	--	--	--	--	--	ND	ND	ND	ND	ND	980	28.5	ND	ND	1,260	ND	70.7	39.0	ND	<22	<22	<22	<22
Chloroethane	--	--	--	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<24	<24	98.5	83.7
Ethylbenzene	1,560,000	102,000,000	2,900 [E]	2,200,000	4,600	ND	ND	63.9	ND	38.0	ND	ND	ND	ND	132	ND	ND	953	ND	<13	<13	<13	<13
Isopropylbenzene	--	--	--	--	--	ND	ND	ND	ND	207	2,270	203	ND	ND	399	227	316	227	ND	<13	<13	<13	<13
Isopropyltoluene	--	--	--	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	874
Naphthalene	60,000 [E]	4,000,000 [E]	400 [E]	68,000	2,700	111	ND	216	ND	273	**2,350** [C]	133	ND	47.7	ND	215	53.5	**543** [C]	ND	234	<7.0	77.6	<7.0
Propylbenzene	--	--	--	--	--	ND	ND	ND	ND	ND	333	ND	ND	ND	831	ND	51.8	50.7	ND	<12	<12	<12	<12
Toluene	1,250,000	81,800,000	1,500 [E]	8,200,000	38,000	173	ND	272	ND	235	ND	142	ND	212	ND	217	ND	408	ND	53.3	<12	62.1	<12
1,2,4-Trimethylbenzene[1]	782,000	51,100,000	7573	--	--	50.9	ND	97.8	ND	96.1	ND	33.5	ND	ND	123	78.1	ND	239	ND	<15	<15	32.9	26.1
1,3,5-Trimethylbenzene[1]	782,000	51,100,000	3520	--	--	ND	ND	30.0	ND	41.9	ND	ND	ND	ND	ND	32.2	ND	83.6	ND	<14	<14	<14	<14
Xylenes, total	3,130,000	204,000,000	4,100 [E]	280,000	42,000	162	ND	331	ND	246	ND	34.0	ND	ND	94.4	196	ND	737	ND	39	<34	88.4	<34
Detected PAHs (µg/kg) [F]																							
Acenaphthene	900,000	60,000,000	38,000	--	--	1,830	ND	429	ND	ND	830	ND	ND	ND	1,240	568	349	845	ND	<58.6	<6.4	<5.4	<6.4
Acenaphthylene	18,000	360,000	700	--	--	561	ND	ND	ND	ND	**1,640** [C]	ND	ND	ND	**8,340** [C]	254	ND	ND	ND	<82.3	<9.0	<7.6	<8.9
Anthracene	5,000,000	300,000,000	3,000,000	--	--	399	ND	ND	ND	ND	2,460	ND	200	76.4	819	ND	269	ND	ND	<39.9	<4.4	25	<4.3
Benzo(a)anthracene	88	3,900	17,000	--	--	**1,180** [A]	ND	**113** [A]	ND	**110** [A]	**698** [A]	ND	76.4	69.6	**218** [A]	**227** [A]	ND	**150** [A]	ND	<51.1	<5.6	40.1	<5.6
Benzo(a)pyrene	8.8	390	48,000	--	--	**706** [AB]	ND	**53.3** [A]	ND	**326** [A]	**406** [AB]	**48.3** [A]	7.74	**47.8** [A]	**75.2** [A]	**210** [A]	**13.8** [A]	**79.0** [A]	ND	**58** [A]	<3.2	**66.2** [A]	<3.1
Benzo(b)fluoranthene	88	3,900	360,000	--	--	**890** [A]	ND	58.7	ND	70	**201** [A]	ND	ND	ND	ND	**204** [A]	ND	**106** [A]	ND	**88.5** [A]	<2.9	**90.8** [A]	<2.8
Benzo(ghi)perylene	1,800	39,000	6,800,000	--	--	545	ND	ND	ND	176	304	ND	ND	ND	ND	186	ND	ND	ND	<49.9	<5.5	52.6	<5.4
Benzo(k)fluoranthene	880	39,000	870,000	--	--	496	ND	ND	ND	178	657	ND	ND	ND	ND	124	ND	ND	ND	49.8	<4.0	78	<3.9
Chrysene	8,800	390,000	37,000	--	--	977	ND	ND	ND	ND	6,720	ND	**8,910** [A]	ND	ND	168	ND	122	ND	176	<3.2	133	<3.1
Dibenzo(a,h,)anthracene	8.8	390	38,000	--	--	**683** [AB]	ND	ND	ND	ND	**326** [A]	ND	ND	ND	**17.6** [A]	**21.8** [A]	ND	**177** [A]	ND	<33.7	<3.7	<3.1	<3.7
Fluroanthene	600,000	40,000,000	500,000	--	--	1,980	ND	275	ND	ND	7,010	234	373	125	4,130	253	1,140	727	ND	<32.4	<3.6	201	<3.5
Fluorene	600,000	40,000,000	100,000	--	--	ND	ND	ND	ND	ND	2,540	ND	301	ND	4,250	ND	413	ND	ND	<41.1	<4.5	13.8	<4.5
Indeno(1,2,3-cd)pyrene	88	3,900	680,000	--	--	**631** [A]	ND	ND	ND	ND	ND	ND	ND	ND	**103** [A]	**229** [A]	ND	ND	ND	46.2	<3.0	56.8	<3.0
1-Methylnaphthalene	1,100,000	70,000,000	23,000	--	--	453	ND	590	173	203	16,200	463	990	153	11,700	401	1,240	2,360	ND	106	<5.1	29.4	<5.0
2-Methylnaphthalene	600,000	40,000,000	20,000	--	--	1,600	ND	716	219	292	12,000	414	1,170	ND	4,570	594	ND	1,860	ND	117	<5.6	39.5	<5.6
Naphthalene	20,000	110,000	400	--	--	ND	ND	142	ND	ND	**1,420** [C]	ND	ND	ND	ND	153	ND	**507** [C]	ND	68.7	<6.3	<5.3	<6.2
Phenanthrene	18,000	390,000	1,800	--	--	1,040	ND	275	ND	ND	**5,290** [C]	172	259	ND	**3,000** [C]	167	747	575	ND	<51.1	<5.6	167	<5.6
Pyrene	500,000	30,000,000	8,700,000	--	--	1,270	ND	746	ND	ND	2,260	ND	ND	ND	840	186	361	387	ND	<35.2	<3.9	12.8	<3.8
GRO (mg/kg)	--	--	100	--	--	<5.59	<6.23	7.95	21.9	<5.59	**330** [C]	22.6	<6.99	<5.96	**484** [C]	10.2	30.7	13.7	<7.04	NA	NA	NA	NA
DRO (mg/kg)	--	--	100	--	--	**106** [C]	<6.23	**406** [C]	87.5	**470** [C]	**3930** [C]	**723** [C]	NA	34.7	**195** [C]	**156** [C]	19.5	19.4	15.0	NA	NA	NA	NA

Notes:

DRO = Diesel Range Organics
GRO = Gasoline Range Organics
VOCs = Volatile Organic Compounds
PAHs = Polynuclear Aromatic Hydrocarbons
[1] Standards are for 1,2,4- and 1,3,5-Trimethylbenzene combined.
[A] Parameter exceeds NR 720 Generic RCL for Non-Industrial Direct Contact.
[B] Parameter exceeds NR 720 Generic RCL for Industrial Direct Contact.
[C] Parameter exceeds NR 720 Generic RCL for Groundwater Pathway.
[D] Parameter exceeds NR 746 Table 1 Soil Screening Levels
[V] Parameter exceeds Soil Screening Levels for Inhalation of Volatiles
[E] Generic RCL is established under NR 720 or NR 746
[F] Generic RCLs provided in *Soil Cleanup Levels for PAHs Interim Guidance* , WDNR RR-5 1997
-- No Generic RCL established.
Generic RCLs not included in Wisconsin Administrative Code or Guidance are calculated from the US EPA Soil Screening Level Web Page and the default values contained in *Determining Residual Contaminant Levels using the EPA Soil Screening Level Web Site* WDNR PUB-RR-682 on May 12, 2006

TABLE 2
GROUNDWATER FIELD DATA
PROPOSED SENIOR APARTMENTS
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

Date	Well I.D.	Ground Surface Elevation (Feet)	TPVC Elevation (Feet)	Screen Interval (Feet below grade)	Screen Interval Elevation (Feet)	Depth to Water below TPVC (Feet)	Groundwater Elevation (Feet)	Temp (C)	pH (Units)	Conductivity (umhos/cm)	Color	Odor
06/18/07	MM-SB-6	750.35	752.57	5 -15'	745.35 - 735.35	5.35	747.22	19.6	7.2	1330	N/A	None
07/26/07						5.69	746.88	--	--	--	--	--
08/09/07						5.73	746.84	--	--	--	--	--
08/27/07						5.57	747.00	21.2	6.63	1155	Colorless	None
12/17/07						6.05	746.52	10.7	6.6	1467	Lt. Grey	None
06/10/08						5.05	747.52	15.4	6.72	785	Lt. Brown	None
06/18/07	MM-SB-7	750.49	752.82	5 - 15'	745.49 - 735.49	5.90	746.92	15.2	7.0	1150	Lt. Grey	Petroleum
07/26/07						5.88	746.94	--	--	--	--	--
08/09/07						5.94	746.88	--	--	--	--	--
08/27/07						4.90	747.92	19.2	6.95	1255	--	Slight Petroleum
12/17/07						6.28	746.54	10.7	6.83	1423	Dark Grey	Petroleum
06/10/08						5.15	747.67	13.4	6.75	1343	Lt. brown	Medium to Strong
06/18/07	MM-SB-8	751.66	753.89	5 - 15'	746.66 - 836.66	6.55	747.34	17.2	6.85	1147	Dark Grey	Musty
07/26/07						7.04	746.85	--	--	--	--	--
08/09/07						7.07	746.82	--	--	--	--	--
08/27/07						6.05	747.84	--	--	--	--	--
12/17/07						7.40	746.49	--	--	--	--	--
06/10/08						6.22	747.67	--	--	--	--	--
06/18/07	MM-SB-9	752.23	751.92	5 - 15'	747.23 - 737.23	4.20	747.72	18.1	6.8	1580	Colorless	None
07/26/07						4.59	747.33	--	--	--	--	--
08/09/07						4.63	747.29	--	--	--	--	--
08/27/07						3.97	747.95	--	--	--	--	--
12/17/07						5.37	746.55	--	--	--	--	--
06/10/08						3.90	748.02	--	--	--	--	--
06/18/07	MM-SB-10	750.72	752.96	5 - 15'	745.72 - 735.72	5.57	747.39	17.3	6.8	1200	Colorless	Musty
07/26/07						6.11	746.85	--	--	--	--	--
08/09/07						6.14	746.82	--	--	--	--	--
08/27/07						5.95	747.01	19.5	6.85	1230	--	None
12/17/07						6.45	746.51	9.7	6.83	1443	Lt. Grey	None
06/10/08						5.52	747.44	--	--	--	--	--
07/26/07	MW-1	751.89	751.55	3 - 13'	748.55 - 738.55	4.71	746.84	--	--	--	--	--
08/09/07						4.81	746.74	--	--	--	--	--
08/27/07						3.80	747.75	--	--	--	--	--
12/17/07						5.16	746.39	--	--	--	--	--
06/10/08						3.51	748.04	--	--	--	--	--
07/26/07	MW-2	751.69	751.30	3 - 13'	748.30 - 738.30	4.42	746.88	--	--	--	--	--
08/09/07						4.43	746.87	--	--	--	--	--
08/27/07						NM	NM	--	--	--	--	--
12/17/07						4.85	746.45	--	--	--	--	--
06/10/08						3.53	747.77	--	--	--	--	--
07/26/07	MW-3	751.13	750.90	3 - 13'	747.90 - 737.90	3.99	746.91	--	--	--	--	--
08/09/07						4.11	746.79	--	--	--	--	--
08/27/07						3.76	747.14	--	--	--	--	--
12/17/07						4.67	746.23	--	--	--	--	--
06/10/08						3.23	747.67	--	--	--	--	--
07/26/07	MW-4	750.42	750.08	2.5 - 12.5'	747.58 - 737.58	3.36	746.72	--	--	--	--	--
08/09/07						3.22	746.86	--	--	--	--	--
08/27/07						NM	NM	--	--	--	--	--
12/17/07						3.51	746.57	--	--	--	--	--
06/10/08						2.56	747.52	--	--	--	--	--

Notes:
-- = Not Sampled
N/A = Not Available

TABLE 3
GROUNDWATER ANALYTICAL RESULTS
PROPOSED SENIOR APARTMENTS
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

		Metals (µg/L)		**VOCs (µg/L)**		
		Arsenic	Lead	Benzene	1,2-Dichloroethane	Vinyl chloride
NR 140 Standards	**ES**	**10**	**15**	**5.0**	**5.0**	**0.2**
	PAL	1.0	1.5	0.5	0.5	0.02
MW-1	6/25/2004	NA	NA	<0.5	<0.5	<0.217
	8/26/2004	NA	<0.005	<0.5	<0.5	<0.217
	11/15/2004	NA	NA	<0.5	<0.5	<0.217
	5/9/2005	NA	ND	<0.34	<0.387	<0.306
	9/20/2005	NA	<0.005	<0.572	<0.587	<1.25
	11/30/2005	NA	<0.005	<0.572	<0.587	<1.25
	3/24/2006	NA	NA	<0.2	<0.5	<0.2
MW-2	6/25/2004	NA	NA	<0.5	<0.5	<0.217
	8/26/2004	NA	<0.005	<0.5	<0.5	<0.217
	11/15/2004	NA	NA	<0.5	<0.5	<0.217
	5/9/2005	NA	ND	<0.34	<0.387	<0.306
	9/20/2005	NA	<0.005	<0.572	<0.587	<1.25
	11/30/2005	NA	<0.005	<0.572	<0.587	<1.25
	3/24/2006	NA	NA	<0.2	<0.5	<0.2
MW-3	6/25/2004	NA	NA	<0.5	<0.5	<0.217
	8/26/2004	NA	<0.005	<0.5	<0.5	<0.217
	11/15/2004	NA	NA	NA	NA	NA
	5/9/2005	NA	ND	<0.34	<0.387	<0.306
	9/20/2005	NA	<0.005	<0.572	<0.587	<1.25
	11/30/2005	NA	<0.005	<0.572	<0.587	<1.25
	3/24/2006	NA	NA	<0.2	<0.5	<0.2
MW-4	6/25/2004	NA	NA	**56.9**	<0.5	<0.217
	8/26/2004	NA	<0.005	**71.3**	<0.5	<0.217
	11/15/2004	NA	NA	**62.1**	<0.5	<0.217
	5/9/2005	NA	ND	**88.4**	<0.387	<0.306
	9/20/2005	NA	<0.005	**76.9**	<0.587	<1.25
	11/30/2005	NA	<0.005	**89.2**	<0.587	<1.25
	3/24/2006	NA	NA	**56**	<0.5	<0.2
64W97-9	8/26/2004	NA	<0.005	<0.5	<0.5	<0.217
	11/15/2004	NA	NA	<0.5	<0.5	<0.217
	5/9/2005	NA	ND	<0.34	<0.387	<0.306
	9/20/2005	NA	<0.005	<0.572	<0.587	<1.25
	11/30/2005	NA	<0.005	<0.572	<0.587	<1.25
	3/24/2006	NA	NA	<0.2	<0.5	<0.2
MM-SB-6	6/18/2007	2.44	1.71	2.71	<0.20	<0.20
	8/27/2007	2.3	0.88	0.83	NA	NA
	12/20/2007	5.64	0.32	4.59	NA	NA
	6/10/2008	NA	NA	<0.20	<0.30	<0.20
MM-SB-7	6/18/2007	NA	NA	**28**	0.68	**0.9**
	8/27/2007	NA	NA	**32.5**	0.82	<0.20
	12/21/2007	NA	NA	**36.4**	1.03	<0.20
	6/10/2008	NA	NA	**24.9**	0.66	<0.20
MM-SB-8	6/18/2007	NA	NA	<0.20	<0.20	<0.20
MM-SB-9	6/18/2007	NA	NA	<0.20	<0.20	<0.20
MM-SB-10	6/18/2007	1.87	1.09	<0.20	<0.20	<0.20
	8/27/2007	0.9	NA	NA	NA	NA
	12/21/2007	<0.60	NA	NA	NA	NA

Notes:
5.0 - Exceeds NR 140 ES
0.5 - Exceeds NR 140 PAL
-- = No NR 140 Standards
NA = Not Analyzed
ND = Not Detected
< = Less than laboratory detection limit
VOCs = Volatile Organic Compounds

TABLE 4

EVALUATION OF POTENTIAL SOIL REMEDIAL ALTERNATIVES
PROPOSED SENIOR APARTMENTS
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

Feasibility Criteria		Weight	No Action	Off-Site Landfilling	On-Site Reuse with Performance Barriers and Limited Off-Site Landfilling	Ex-Situ Thermal Treatment and Stabilization
Technical simplicity		5	3	3	3	2
Effectiveness in protecting human health and the environment		6	1	3	3	2
Affordability		6	3	1	2	1
Implementation time frame savings		7	3	3	2	1
Green Cleanup Evaluation	Minimizes Total Energy Use and Maximizes Use of Renewable Energy	1	3	1	2	1
	Minimizes Air Pollutants and Greenhouse Gas Emissions	1	3	1	3	2
	Minimizes Water Use and Impacts to Water Resources	1	3	1	2	1
	Reduces, Reuses and Recycles Material and Waste	1	0	1	3	1
	Optimizes Future Land Use and Enhances Ecosystems	1	0	0	2	1
	Optimizes Sustainable Management Practices During Stewardship	1	0	1	2	1
TOTAL UNWEIGHTED SCORE			19	15	24	13
TOTAL WEIGHTED SCORE			**69**	**65**	**73**	**42**

<u>Scoring</u>
1 = Low
2 = Medium
3 = High

TABLE 5

OPINION OF PROBABLE COSTS OF POTENTIAL REMEDIAL ALTERNATIVES
PROPOSED SENIOR APARTMENTS
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

	Estimated Costs			
	No Action	Off-Site Landfilling	On-Site Reuse with Performance Barriers and Limited Off-Site Landfilling	Ex-Situ Thermal Treatment and Solidification/Stabilzation
Community Involvement	$0	$10,000	$10,000	$10,000
Treatability Study	$0	$0	$0	$30,000
Preparation of Work Plan	$0	$10,000	$10,000	$20,000
Site Remedial Activities	$0	$1,400,000	$200,000	$20,000,000
Alternative (Deep) Foundation	$0	$0	$320,000	$0
Confirmatory Sampling	$0	$20,000	$10,000	$30,000
Preparation of Corrective Action Completion Report	$0	$20,000	$20,000	$20,000
Contigency (5%)	$0	$73,000	$28,500	$1,005,500
Total Estimated Cost	**$0**	**$1,533,000**	**$598,500**	**$21,115,500**

Table 6

Environmental Benefits of Green Remediation Best Management Practices

Best Management Practice	Applicability: Landfill	Applicability: Performance Barriers	Applicability: Soil Treatment	Green Remediation Core Element: Minimize total energy use	Minimize air pollutants and greenhouse gas emissions	Minimize water use and impact to water resources	Optimize future land use and enhance ecosystems	Reduce, reuse, recylce waste material	Optimize sustainable management practices during stewardship	Impact on other feasibility criteria: Technical practicabilty	Effectiveness in protecting human health and environment	Cost of implementation	Implementation schedule
Impose idle restrictions on construction equipment	⇧	⇧	⇧	+	+	o	o	o	+	o	+	o	-
Impose restrictions to minimize noise disturbance	⇧	⇧	⇧	o	+	o	o	o	+	o	+	o	-
Use low-sulfur diesel fuel	⇔	⇔	⇔	-	+	o	o	o	o	o	+	-	o
Use alternative fuels, E85, Biodiesel	⇔	⇔	⇔	-	+	o	o	+	+	o	o	-	o
Use enhanced emissions controls on construction equipment	⇧	⇧	⇧	-	+	o	o	o	o	o	+	-	o
Sequence work to minimize material handling	⇧	⇧	⇧	+	+	o	o	o	+	o	o	+	-
Cover stockpiles to control dust and sediment in runoff	⇧	⇧	⇧	o	+	+	+	o	o	o	+	o	o
Collect rainwater for use as dust control	⇔	⇔	⇔	o	o	+	o	+	o	o	o	-	o
Crush existing floor slab and asphalt pavement for use as construction material	⇩	⇧	⇩	-	-	o	o	+	+	o	o	-	-
Minimize contruction dewatering	⇩	⇧	⇩	+	o	+	+	o	o	o	o	+	-
Segregate wood waste from fill material, use as fuel source	⇩	⇩	⇩	-	o	o	o	+	o	o	o	-	-
Use energy efficient equipment in job trailer	⇧	⇧	⇧	+	+	o	o	o	o	o	o	o	o
Integrate anticipated future site use into cleanup strategy	⇩	⇧	⇩	+	+	o	+	o	+	o	o	-	+

⇧ Easy to apply to remediation alternative

⇩ Difficult to apply to remediation alternative

⇔ Medium difficulty in applying to remediation alternative

\+ Advances core element of green remediation

\- Negative impact on core element of green remediation

o Little or no impact on core element of green remediation

\+ Positive impact on feasibility criterion

\- Negative impact on feasibility criterion

o Little or no impact on feasibility criterion

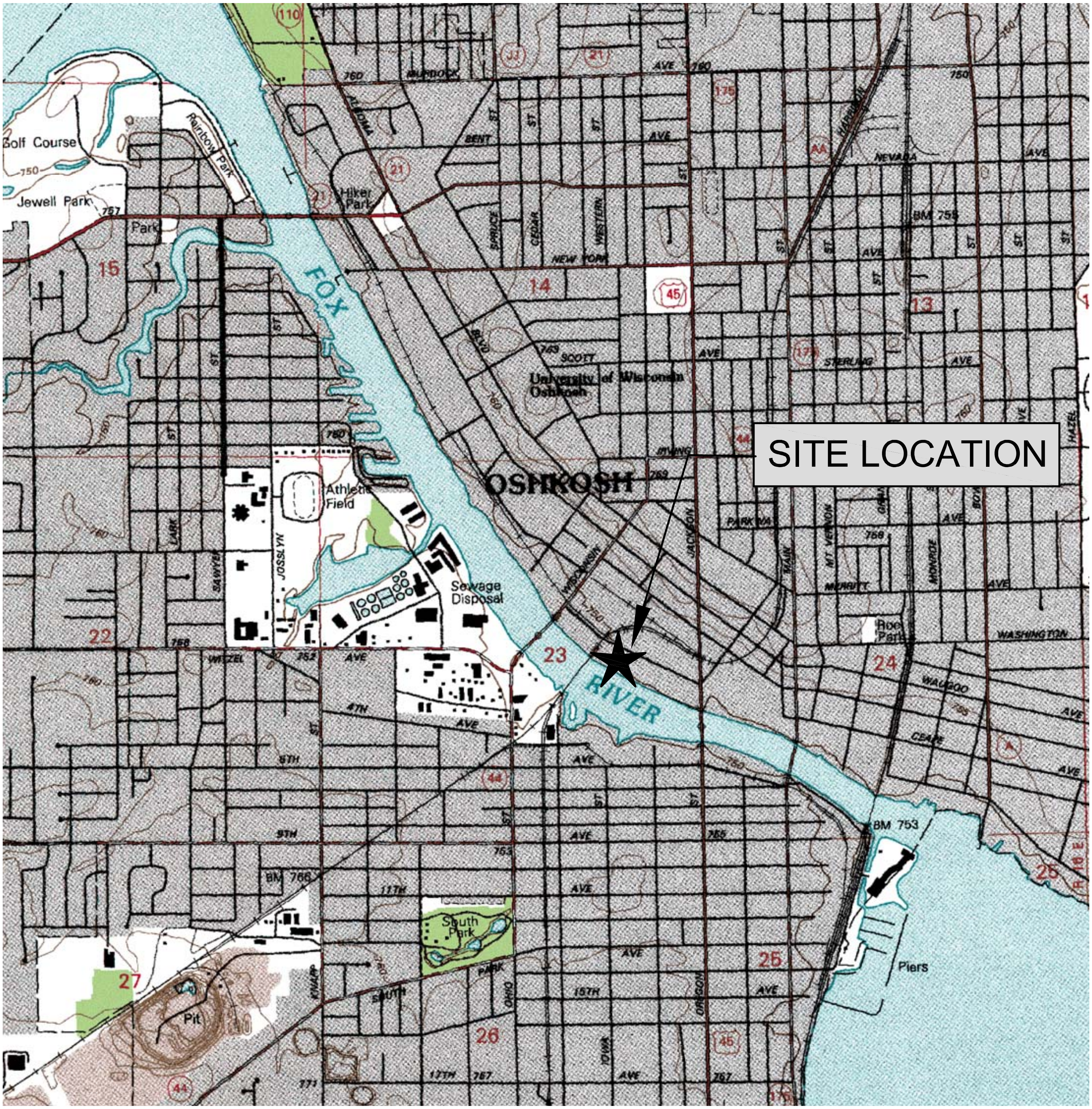
TABLE 7

SUMMARY OF SUSTAINABILITY METRICS
PROPOSED SENIOR APARTMENTS
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

Remedial Alternative	Atmospheric Carbon Dioxide Emissions (Tons)	Total Energy Consumption (Megajoules)	Lost Hours Due to Accidents
No Action	0	0	0
*Off-Site Landfilling	160	2,100,000	3.2
*On-Site Reuse with Performance Barriers and Limited Off-Site Landfilling	21	280,000	0.5
**Ex-Situ Thermal Treatment and Stabilization	853	1,688,000	2.6

Figure

Figure 1 Site Location Map



NOTE: PREPARED FROM 7.5 MINUTE U.S.G.S. QUADRANGLE MAP OF OSHKOSH, WI. DATED 1992.

AECOM

3909 Concord Avenue
Weston, WI 54476
715.355.4304
www.aecom.com

SITE LOCATION MAP
PROPOSED SENIOR APARTMENTS
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

Drawn :	ALB	06/12/2009
Checked:	ECS	06/12/2009
Approved:		
PROJECT NUMBER	13090002	
FIGURE NUMBER	1	

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Drawings

0 100
1" = 100'

LEGEND

	PROPOSED SENIOR APARTMENTS REDEVELOPMENT BOUNDARY
	FORMER PARCEL LINES
	FORMER RIGHT OF WAY LINE
	FORMER ROAD CENTERLINE
	EXISTING BUILDING
B-3	STS SOIL BORING LOCATION
MMSB-4	STS MONITORING WELL LOCATION
MW-3	STS ABANDONED MONITORING WELL
HA-4	STS HAND AUGER LOCATION
MW-4	SIGMA MONITORING WELL LOCATION
64W97-18	SIGMA ABANDONED MONITORING WELL

X:\Projects\13090002\DWG\13090002-FIGURES.dwg; 6/12/2009 2:06:20 PM; BREUNIG, ADAM; STS.stb

AECOM
3909 Concord Avenue
Weston, WI 54476
715.355.4304
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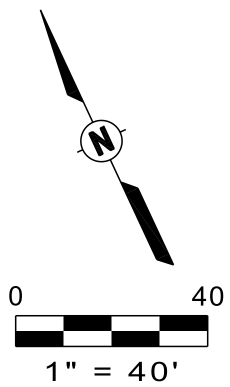
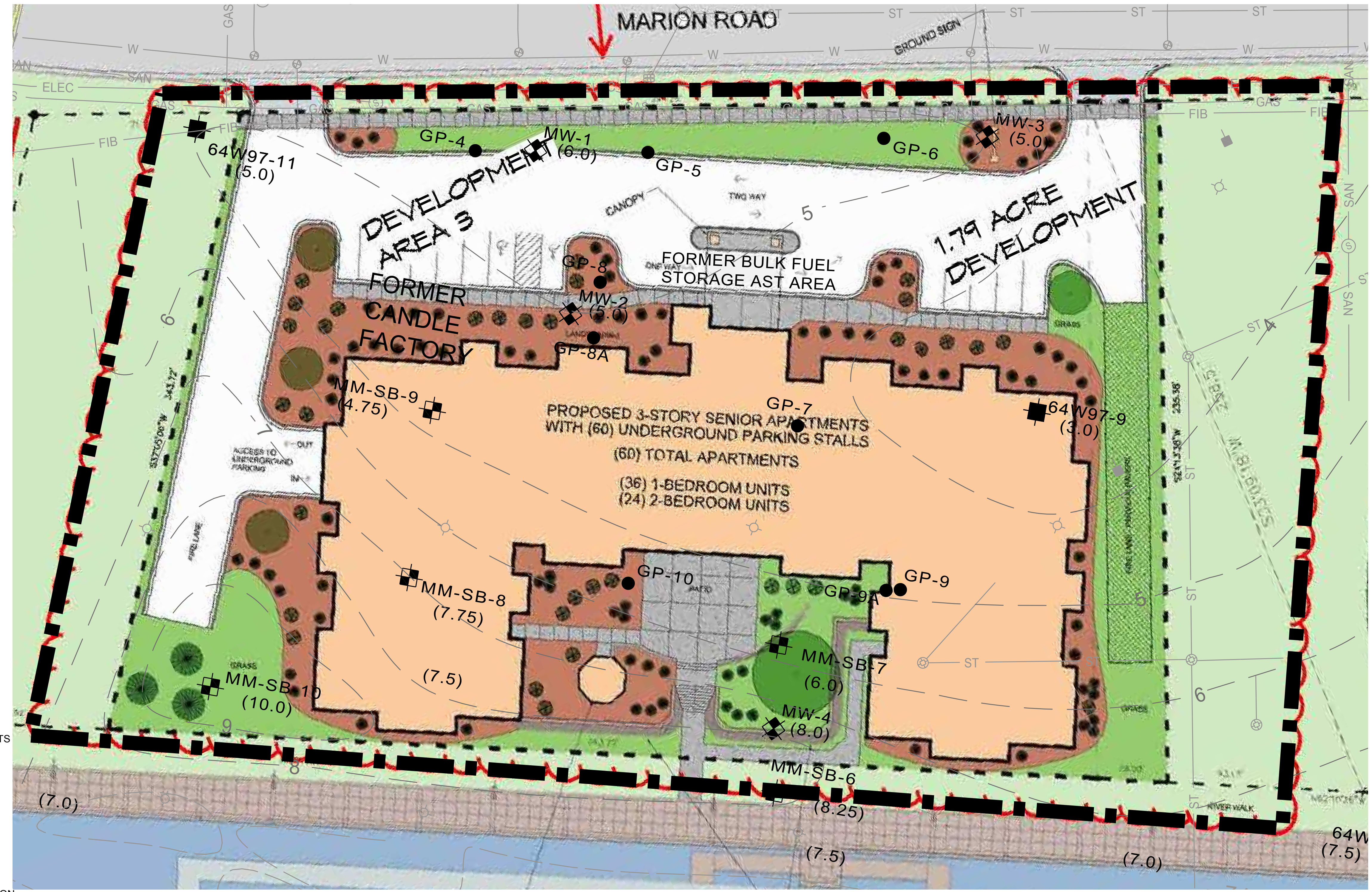
SITE DIAGRAM
PROPOSED SENIOR APARTMENTS
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

Drawn :	ALB	06/11/2009
Checked:	ECS	06/11/2009
Approved:		

PROJECT NUMBER 13090002

FIGURE NUMBER 1





LEGEND

	PROPOSED SENIOR APARTMENTS REDEVOLPMENT BOUNDARY
	FORMER PARCEL LINES
	FORMER RIGHT OF WAY LINE
	FORMER ROAD CENTERLINE
	EXISTING BUILDING
B-3	STS SOIL BORING LOCATION
MMSB-4	STS MONITORING WELL LOCATION
MW-3	STS ABANDONED MONITORING WELL
HA-4	STS HAND AUGER LOCATION
MW-4	SIGMA MONITORING WELL LOCATION
64W97-18	SIGMA ABANDONED MONITORING WELL
	EVEN FILL THICKNESS CONTOUR
	ODD FILL THICKNESS CONTOUR
(10.0)	FILL THICKNESS AT BORING LOCATION

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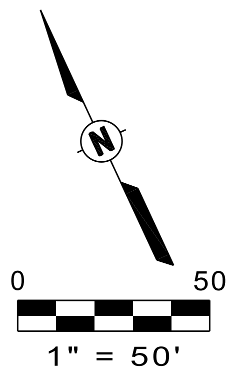
FILL ISOPACH
PROPOSED SENIOR APARTMENTS
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

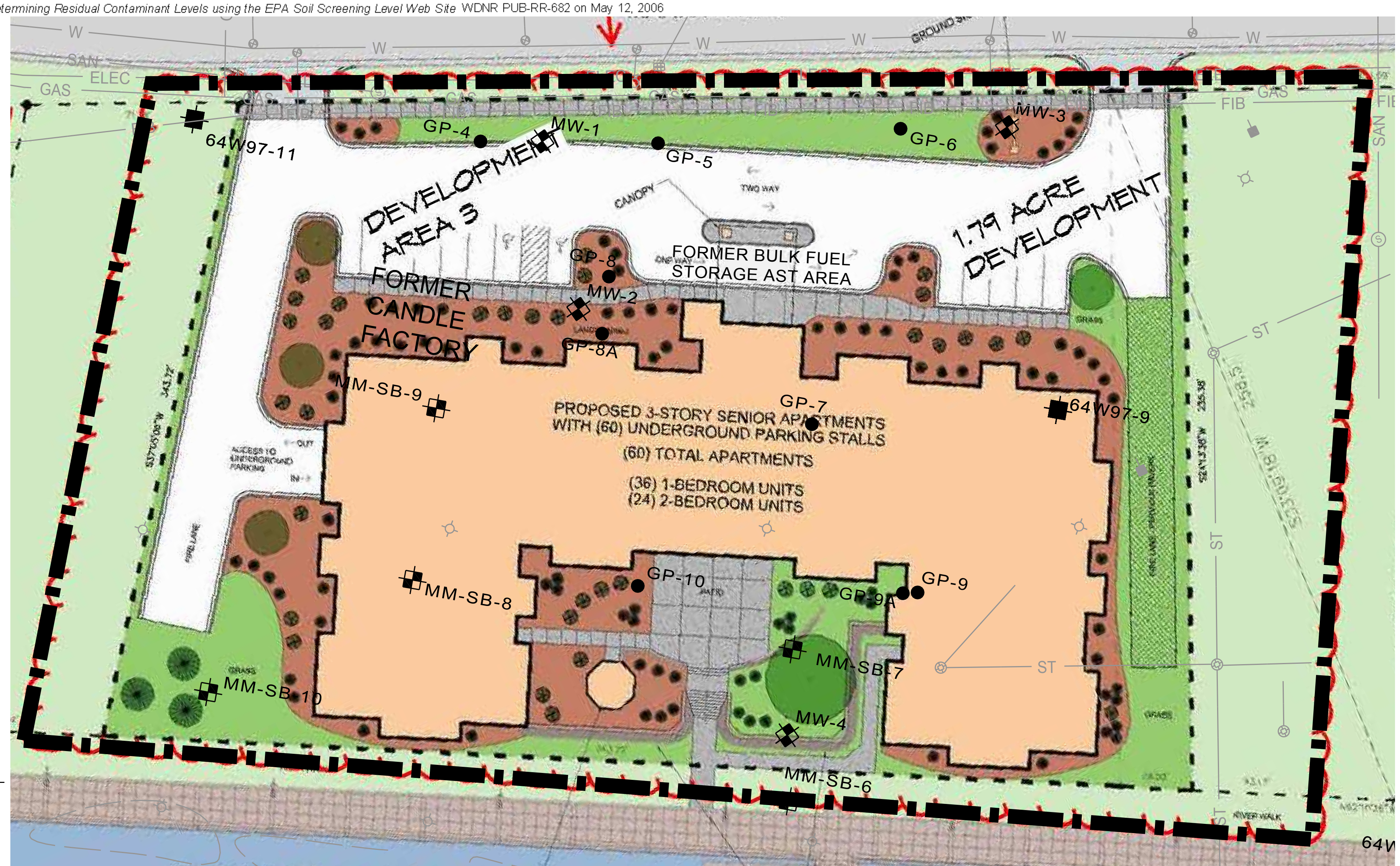
Drawn :	ALB	06/11/2009
Checked:	ECS	06/11/2009
Approved:		
PROJECT NUMBER	13090002	
FIGURE NUMBER	2	



Parameters	Generic RCLs			NR 746 Soil Screening Levels	GP-4		GP-5		GP-6		GP-7		GP-8		GP-9		GP-10		MM-SB-6	MM-SB-9	MM-SB-10	
	Direct Contact Pathway		Groundwater Pathway		2-4' Fill 3/18/04	6-8' Silt/Clay 3/18/04	0-2' Fill 3/18/04	4-6' Silt 3/18/04	0-4' Fill 3/18/04	4-6' Silt/Clay 3/18/04	0-2' Fill 3/18/04	4-6' Fill/Silt/Clay 3/18/04	0-4' Fill 3/18/04	4-5' Silt 3/18/04	0-4' Fill 3/18/04	4-6' Fill/Clay 3/18/04	0-2' Fill 3/18/04	6-8' Clay 3/18/04	2.5-4.5' Fill 5/23/07	5-7' Clay 5/23/07	2.5-4.5' Fill 5/23/2007	10-12' Clay 5/23/2007
	Non-Industrial	Industrial																				
Metals (mg/kg)																						
Lead	50 [E]	500 [E]	--	--	**79.0** [A]	8.46	31.6	**440** [A]	41.9	**63.0** [A]	21.9	11.4	34.7	**195** [A]	**156** [A]	19.5	19.4	15.0	NA	NA	NA	NA
VOCs (μg/kg)																						
Benzene	1,100 [E]	52,000	5.5 [E]	8,500	ND	ND	**45.2** [C]	ND	ND	ND	ND	ND	ND	ND	ND	ND	**40.1** [C]	ND	<10	<10	<10	<10
Bromomethane	21,900	1,430,000	4.0	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<17	**87.1** [C]	<17	**27.1** [C]
Naphthalene	60,000 [E]	4,000,000 [E]	400 [E]	2,700	111	ND	216	ND	273	**2,350** [C]	133	ND	47.7	ND	215	53.5	**543** [C]	ND	234	<7.0	77.6	<7.0
PAHs (μg/kg) [F]																						
Acenaphthylene	18,000	360,000	700	--	561	ND	ND	ND	ND	**1,640** [C]	ND	ND	ND	**8,340** [C]	254	ND	ND	ND	<82.3	<9.0	<7.6	<8.9
Benzo(a)anthracene	88	3,900	17,000	--	**1,180** [A]	ND	**113** [A]	ND	**110** [A]	**698** [A]	ND	76.4	69.6	**218** [A]	**227** [A]	ND	**150** [A]	ND	<51.1	<5.6	40.1	<5.6
Benzo(a)pyrene	8.8	390	48,000	--	**706** [AB]	ND	**53.3** [A]	ND	**326** [A]	**406** [AB]	**48.3** [A]	7.74	**47.8** [A]	**75.2** [A]	**210** [A]	**13.8** [A]	**79.0** [A]	ND	**58** [A]	<3.2	**66.2** [A]	<3.1
Benzo(b)fluoranthene	88	3,900	360,000	--	**890** [A]	ND	58.7	ND	70	**201** [A]	ND	ND	ND	ND	**204** [A]	ND	**106** [A]	ND	**88.5** [A]	<2.9	**90.8** [A]	<2.8
Chrysene	8,800	390,000	37,000	--	977	ND	ND	ND	ND	6,720	ND	**8,910** [A]	ND	ND	168	ND	122	ND	176	<3.2	133	<3.1
Dibenzo(a,h,)anthracene	8.8	390	38,000	--	**683** [AB]	ND	ND	ND	ND	**326** [A]	ND	ND	ND	**17.6** [A]	**21.8** [A]	ND	**177** [A]	ND	<33.7	<3.7	<3.1	<3.7
Indeno(1,2,3-cd)pyrene	88	3,900	680,000	--	**631** [A]	ND	ND	ND	ND	ND	ND	ND	ND	**103** [A]	**229** [A]	ND	ND	ND	46.2	<3.0	56.8	<3.0
Naphthalene	20,000	110,000	400	--	ND	ND	142	ND	ND	**1,420** [C]	ND	ND	ND	ND	153	ND	**507** [C]	ND	68.7	<6.3	<5.3	<6.2
Phenanthrene	18,000	390,000	1,800	--	1,040	ND	275	ND	ND	**5,290** [C]	172	259	ND	**3,000** [C]	167	747	575	ND	<51.1	<5.6	167	<5.6
GRO (mg/kg)	--	--	100	--	<5.59	<6.23	7.95	21.9	<5.59	**330** [C]	22.6	<6.99	<5.96	**484** [C]	10.2	30.7	13.7	<7.04	NA	NA	NA	NA
DRO (mg/kg)	--	--	100	--	**106** [C]	<6.23	**406** [C]	87.5	**470** [C]	**3930** [C]	**723** [C]	NA	34.7	**195** [C]	**156** [C]	19.5	19.4	15.0	NA	NA	NA	NA

Notes:

DRO = Diesel Range Organics
GRO = Gasoline Range Organics
VOCs = Volatile Organic Compounds
PAHs = Polynuclear Aromatic Hydrocarbons
[1] Standards are for 1,2,4- and 1,3,5-Trimethylbenzene combined.
[A] Parameter exceeds NR 720 Generic RCL for Non-Industrial Direct Contact.
[B] Parameter exceeds NR 720 Generic RCL for Industrial Direct Contact.
[C] Parameter exceeds NR 720 Generic RCL for Groundwater Pathway.
[D] Parameter exceeds NR 746 Table 1 Soil Screening Levels
[E] Generic RCL is established under NR 720 or NR 746
[F] Generic RCLs provided in *Soil Cleanup Levels for PAHs Interim Guidance*, WDNR RR-5 1997
-- No Generic RCL established.
Generic RCLs not included in Wisconsin Administrative Code or Guidance are calculated from the US EPA Soil Screening Level Web Page and the default values contained in *Determining Residual Contaminant Levels using the EPA Soil Screening Level Web Site* WDNR PUB-RR-682 on May 12, 2006



LEGEND

- PROPOSED SENIOR APARTMENTS REDEVELOPMENT BOUNDARY
- FORMER PARCEL LINES
- FORMER RIGHT OF WAY LINE
- B-3 STS SOIL BORING LOCATION
- MMSB-4 STS MONITORING WELL LOCATION
- MW-3 STS ABANDONED MONITORING WELL
- HA-4 STS HAND AUGER LOCATION
- MW-4 SIGMA MONITORING WELL LOCATION
- 64W97-18 SIGMA ABANDONED MONITORING WELL
- PROPOSED SOIL EXCAVATION AREA

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SOIL ANALYTICAL RESULTS
PROPOSED SENIOR APARTMENTS
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

Drawn: ALB 06/11/2009
Checked: ECS 06/11/2009
Approved:
PROJECT NUMBER 13090002
FIGURE NUMBER 3

		Metals (µg/L)		VOCs (µg/L)		
		Arsenic	Lead	Benzene	1,2-Dichloroethane	Vinyl Chloride
NR 140	**ES**	**10**	**15**	**5.0**	**5.0**	**0.2**
Standards	*PAL*	1.0	1.5	0.5	0.5	0.02
MW-1	6/25/2004	NA	NA	<0.5	<0.5	<0.217
	8/26/2004	NA	<0.005	<0.5	<0.5	<0.217
	11/15/2004	NA	NA	<0.5	<0.5	<0.217
	5/9/2005	NA	ND	<0.34	<0.387	<0.306
	9/20/2005	NA	<0.005	<0.572	<0.587	<1.25
	11/30/2005	NA	<0.005	<0.572	<0.587	<1.25
	3/24/2006	NA	NA	<0.2	<0.5	<0.2
MW-2	6/25/2004	NA	NA	<0.5	<0.5	<0.217
	8/26/2004	NA	<0.005	<0.5	<0.5	<0.217
	11/15/2004	NA	NA	<0.5	<0.5	<0.217
	5/9/2005	NA	ND	<0.34	<0.387	<0.306
	9/20/2005	NA	<0.005	<0.572	<0.587	<1.25
	11/30/2005	NA	<0.005	<0.572	<0.587	<1.25
	3/24/2006	NA	NA	<0.2	<0.5	<0.2
MW-3	6/25/2004	NA	NA	<0.5	<0.5	<0.217
	8/26/2004	NA	<0.005	<0.5	<0.5	<0.217
	11/15/2004	NA	NA	NA	NA	NA
	5/9/2005	NA	ND	<0.34	<0.387	<0.306
	9/20/2005	NA	<0.005	<0.572	<0.587	<1.25
	11/30/2005	NA	<0.005	<0.572	<0.587	<1.25
	3/24/2006	NA	NA	<0.2	<0.5	<0.2
MW-4	6/25/2004	NA	NA	**56.9**	<0.5	<0.217
	8/26/2004	NA	<0.005	**71.3**	<0.5	<0.217
	11/15/2004	NA	NA	**62.1**	<0.5	<0.217
	5/9/2005	NA	ND	**88.4**	<0.387	<0.306
	9/20/2005	NA	<0.005	**76.9**	<0.587	<1.25
	11/30/2005	NA	<0.005	**89.2**	<0.587	<1.25
	3/24/2006	NA	NA	**56**	<0.5	<0.2
64W97-9	8/26/2004	NA	<0.005	<0.5	<0.5	<0.217
	11/15/2004	NA	NA	<0.5	<0.5	<0.217
	5/9/2005	NA	ND	<0.34	<0.387	<0.306
	9/20/2005	NA	<0.005	<0.572	<0.587	<1.25
	11/30/2005	NA	<0.005	<0.572	<0.587	<1.25
	3/24/2006	NA	NA	<0.2	<0.5	<0.2
MM-SB-6	6/18/2007	2.44	1.71	2.71	<0.20	<0.20
	8/27/2007	2.3	0.88	0.83	NA	NA
	12/20/2007	5.64	0.32	4.59	NA	NA
	6/10/2008	NA	NA	<0.20	<0.30	<0.20
MM-SB-7	6/18/2007	NA	NA	**28**	0.68	**0.9**
	8/27/2007	NA	NA	**32.5**	0.82	<0.20
	12/21/2007	NA	NA	**36.4**	1.03	<0.20
	6/10/2008	NA	NA	**24.9**	0.66	<0.20
MM-SB-8	6/18/2007	NA	NA	<0.20	<0.20	<0.20
MM-SB-9	6/18/2007	NA	NA	<0.20	<0.20	<0.20
MM-SB-10	6/18/2007	1.87	1.09	<0.20	<0.20	<0.20
	8/27/2007	0.9	NA	NA	NA	NA
	12/21/2007	<0.60	NA	NA	NA	NA

Notes:
5.0 - Exceeds NR 140 ES
0.5 - Exceeds NR 140 PAL
-- = No NR 140 Standards
NA = Not Analyzed
ND = Not Detected
< = Less than laboratory detection limit
VOCs = Volatile Organic Compounds

LEGEND
PROPOSED SENIOR APARTMENTS REDEVELOPMENT BOUNDARY
FORMER PARCEL LINES
FORMER RIGHT OF WAY LINE
FORMER ROAD CENTERLINE
EXISTING BUILDING
B-3 STS SOIL BORING LOCATION
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MW-4 SIGMA MONITORING WELL LOCATION
64W97-18 SIGMA ABANDONED MONITORING WELL

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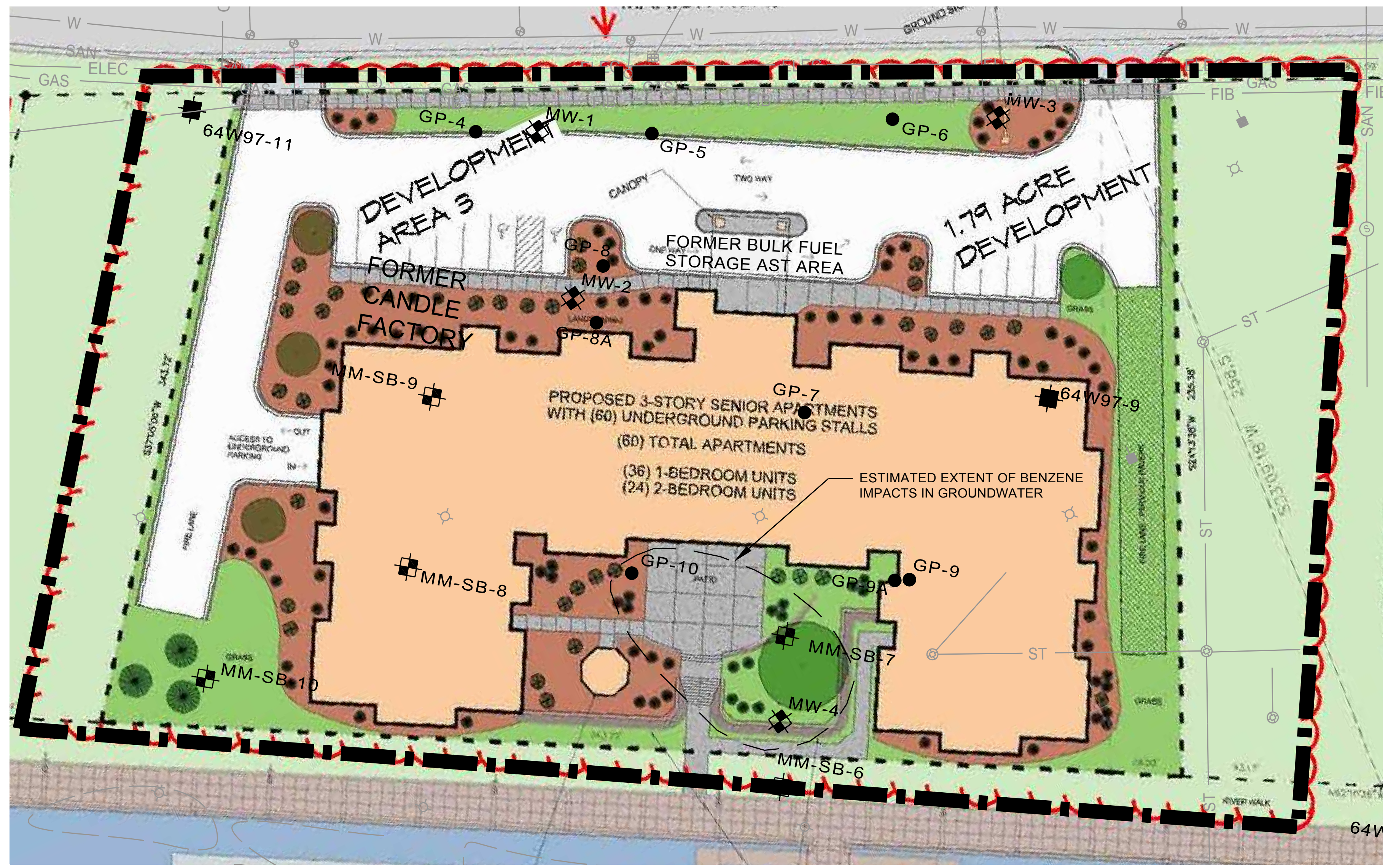
1" = 50'



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GROUNDWATER ANALYTICAL RESULTS
PROPOSED SENIOR APARTMENTS
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

Drawn: ALB 06/11/2009
Checked: ECS 06/11/2009
Approved:
PROJECT NUMBER 13090002
FIGURE NUMBER 4

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Appendix A

EPA Citizen's Guides

United States
Environmental Protection
Agency

Office of Solid Waste and
Emergency Response
(5102G)

EPA 542-F-01-022
December 2001
www.epa.gov/superfund/sites
www.cluin.org

A Citizen's Guide to Capping

The Citizen's Guide Series

EPA uses many methods to clean up pollution at Superfund and other sites. If you live, work, or go to school near a Superfund site, you may want to learn more about these methods. Perhaps they are being used or are proposed for use at your site. How do they work? Are they safe? This Citizen's Guide is one in a series to help answer your questions.

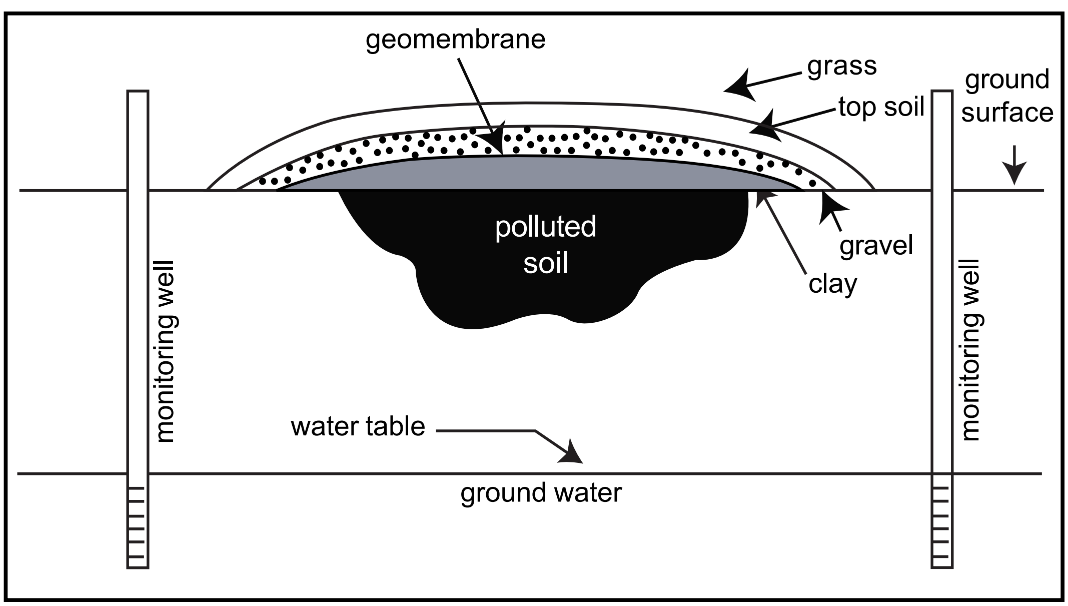
What is capping?

Capping involves placing a cover over contaminated material such as the waste buried at a landfill. Such covers are called "caps." Caps do not clean up the contaminated material. They just keep it in place so it will not come into contact with people or the environment.

How does it work?

Sometimes digging up and removing contaminated material can be difficult or expensive. Instead, a cap will be placed over it to keep it in place. A cap works in three main ways:

1) It stops rainwater from seeping through the hazardous material and carrying the pollution into the groundwater, lakes or rivers.
2) It stops wind from blowing away the hazardous material.
3) It keeps people and animals from coming into contact with the contaminated material and tracking it off the site.



Constructing a cap can be as simple as placing a single layer of asphalt on top of the contaminated material. More often, however, caps are made of several layers. The top layer at the ground surface is usually soil with grass or other plants. Plants take up rainwater with their roots and help prevent it from soaking down into the next layer. They also keep the topsoil from eroding. The second layer down drains any water that comes through the first layer. It is usually constructed of gravel and pipes. A third layer may be added to control gasses that come from the hazardous material. The bottom layer lies directly on the contaminated material. It is usually made of clay. The clay is covered by a sheet of strong synthetic material called a *geomembrane*. Together the clay and the geomembrane help stop further flow of water downward.

Is capping safe?

When properly built and maintained, a cap is a safe method for keeping contaminated material in place. A cap will continue to work safely as long as it is not broken or eroded. Regular inspections are made to make sure that the weather, plant roots or some human activity have not damaged the cap. Also, groundwater monitoring wells are placed around the edges of the cap so that any leakage from the site can be found and fixed.

How long will it take?

Building a cap can take a few days up to several months.

The length of time depends on several factors that vary from site to site:

- size of the area
- thickness and design of the cap
- availability of clean topsoil and clay

Caps can be effective for many years as long as they are properly maintained.

Why use capping?

Caps have been used at hundreds of sites because they are an effective method for keeping wastes contained. Caps are usually only part of a cleanup remedy. Often they are used with pump and treat systems (See *A Citizen's Guide to Pump and Treat* [EPA 542-01-025]). The pumping and treating cleans up polluted groundwater, while the cap prevents contaminated materials from reaching the groundwater.

For more information

write the Technology Innovation Office at:

U.S. EPA (5102G)
1200 Pennsylvania Ave., NW
Washington, DC 20460

or call them at
(703) 603-9910.

Further information also can be obtained at **www.cluin.org** or **www.epa.gov/superfund/sites**.

United States
Environmental Protection
Agency

Office of Solid Waste and
Emergency Response
(5102G)

EPA 542-F-01-023
December 2001
www.epa.gov/superfund/sites
www.cluin.org

EPA

A Citizen's Guide to Soil Excavation

The Citizen's Guide Series

EPA uses many methods to clean up pollution at Superfund and other sites. If you live, work, or go to school near a Superfund site, you may want to learn more about cleanup methods. Perhaps they are being used or are proposed for use at your site. How do they work? Are they safe? This Citizen's Guide is one in a series to help answer your questions.

What is excavation?

Excavation is digging up polluted soil so it can be cleaned or disposed of properly in a landfill. The soil is excavated using construction equipment, like backhoes or bulldozers.

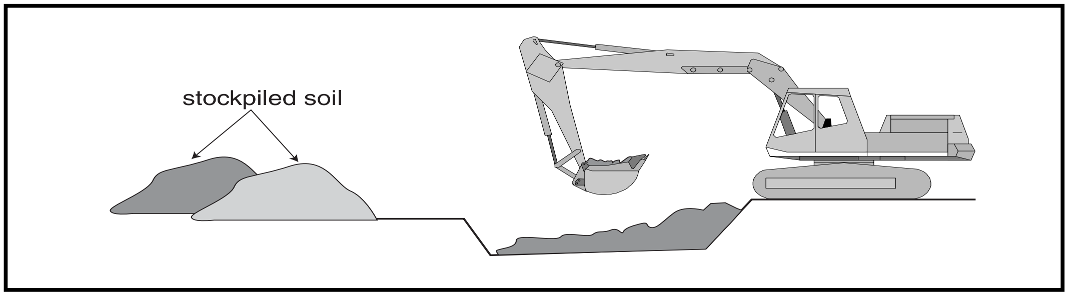
How does it work?

Before soil can be excavated, EPA must figure out how much of it there is. EPA also determines the types of harmful chemicals in the soil. This requires research on past activities at the site as well as testing of the soil.

Once the polluted areas are found, digging can begin. Backhoes, bulldozers and front-end loaders remove the soil and put it on tarps or in containers. The soil is covered to prevent wind and rain from blowing or washing it away. The covers also keep workers and other people near the site from coming into contact with polluted soil. The digging is complete when test results show that the remaining soil does not pose a risk to people or the environment.

The polluted soil may be cleaned up onsite or taken elsewhere for this purpose (See *A Citizen's Guide to Thermal Desorption* [EPA 542-F-01-003], and *A Citizen's Guide to Soil Washing* [EPA 542-F-01-008]). The soil may also may be disposed of in a regulated landfill. If the soil is cleaned, it may be returned to the holes it came from. This is called *backfilling*. The area may also be backfilled with clean soil from another location.

After an excavation is backfilled, it may be landscaped to prevent erosion or it may be paved or prepared for some other use.



Is excavation safe?

Excavation can safely remove most types of polluted soil from a site. However, certain types of harmful chemicals require special safety precautions. For example, some chemicals may *evaporate*, or change into gases. To prevent the release of gases to the air, site workers may coat the ground with foam or draw the vapor into gas wells. Other chemicals, like acids and explosives, also require special handling and protective clothing to reduce the danger to site workers.

How long will it take?

Excavating polluted soil may take as little as one day or as long as several months. Cleaning the soil may take much longer. The total time it takes to excavate and clean up soil depends on several factors:

- types and amounts of harmful chemicals present
- size and depth of the polluted area
- type of soil
- amount of moisture in the polluted soil (wet soil slows the process)

Why use excavation?

EPA has had lots of experience using excavation to clean up sites. Excavation is used most often where other underground cleanup technologies will not work or will be too expensive. Excavation of soil for disposal or treatment above ground is often the fastest way to deal with chemicals that pose an immediate risk. Polluted soils deeper than 10 feet generally cannot be excavated. This method is most cost-effective for small amounts of soil.

For more information

write the Technology Innovation Office at:

U.S. EPA (5102G)
1200 Pennsylvania Ave., NW
Washington, DC 20460

or call them at
(703) 603-9910.

Further information also can be obtained at **www.cluin.org** or **www.epa.gov/superfund/sites**.

United States Environmental Protection Agency
Office of Solid Waste and Emergency Response (5102G)
EPA 542-F-01-018
February 2002
www.epa.gov/superfund/sites
www.cluin.org

EPA

A Citizen's Guide to Incineration

The Citizen's Guide Series

EPA uses many methods to clean up pollution at Superfund and other sites. If you live, work, or go to school near a Superfund site, you may want to learn more about these methods. Perhaps they are being used or are proposed for use at your site. How do they work? Are they safe? This Citizen's Guide is one in a series to help answer your questions.

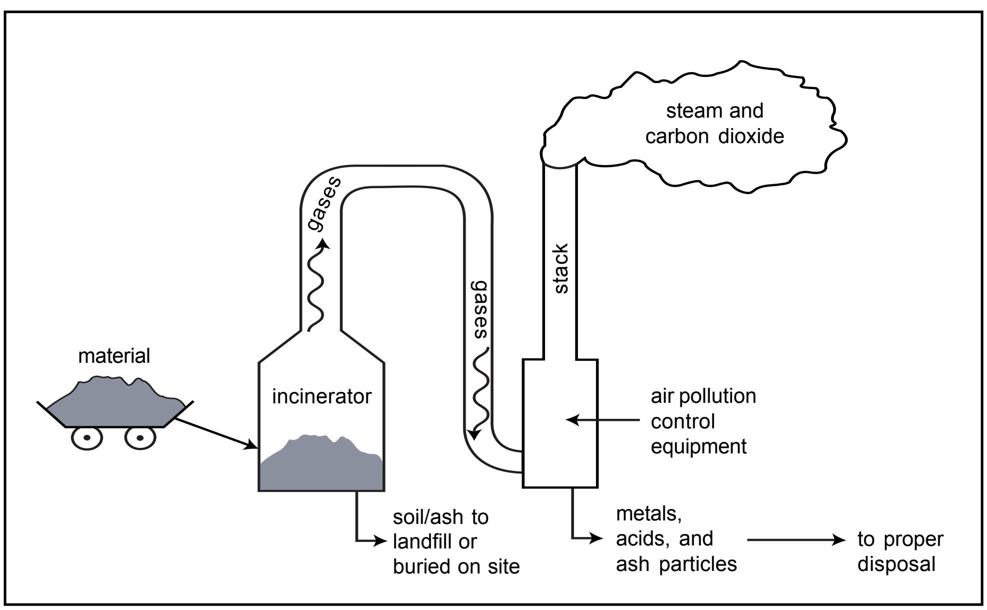
What is incineration?

Incineration is the process of burning hazardous materials to destroy harmful chemicals. Incineration also reduces the amount of material that must be disposed of in a landfill. Although it destroys a range of chemicals, such as PCBs, solvents, and pesticides, incineration does not destroy metals.

How does it work?

An *incinerator* is a type of furnace. It burns material, such as polluted soil, at a controlled temperature, which is high enough to destroy the harmful chemicals. An incinerator can be brought to the site for cleanup or the material can be trucked from the site to an incinerator.

The material is placed in the incinerator where it is heated. To increase the amount of harmful chemicals destroyed, workers control the amount of heat and air in the incinerator. As the chemicals heat up, they change into gases, which pass through a flame to be heated



further. The gases become so hot they break down into smaller components that combine with oxygen to form less harmful gases and steam.

The gases produced in the incinerator pass through air pollution control equipment to remove any remaining metals, acids, and particles of ash. These wastes are harmful and must be properly disposed of in a licensed landfill. The other cleaner gases, like steam and carbon dioxide, are released outside through a stack.

The soil or ash remaining in the incinerator after the burning may be disposed of in a landfill or buried on site. The amount of material that requires disposal is much less than the initial amount of waste that was burned.

Is incineration safe?

An incinerator that is properly designed and operated can safely destroy harmful chemicals. It can also run without producing odors or smoke. EPA tests the incinerator before and during operation to make sure that gases are not released in harmful amounts.

How long will it take?

The time it takes for incineration to clean up a site depends on several factors:

- size and depth of the polluted area
- types and amounts of chemicals present
- whether or not the waste must be trucked to the incinerator

Larger incinerators can clean up several hundred tons of waste each day.

Why use incineration?

Incineration can destroy some types of chemicals that other methods can't. It is also quicker than many other methods. This is important when a site must be cleaned up quickly to prevent harm to people or the environment. On-site incineration can reduce the amount of material that must be moved to a landfill. Incinerators have been used to clean up 136 Superfund sites across the country.

For more information write the Technology Innovation Office at:

U.S. EPA (5102G)
1200 Pennsylvania Ave., NW
Washington, DC 20460

or call them at (703) 603-9910.

Further information also can be obtained at **www.cluin.org** or **www.epa.gov/superfund/sites**.

United States Environmental Protection Agency
Office of Solid Waste and Emergency Response (5102G)
EPA 542-F-01-024
December 2001
www.epa.gov/superfund/sites
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EPA

A Citizen's Guide to Solidification/Stabilization

The Citizen's Guide Series

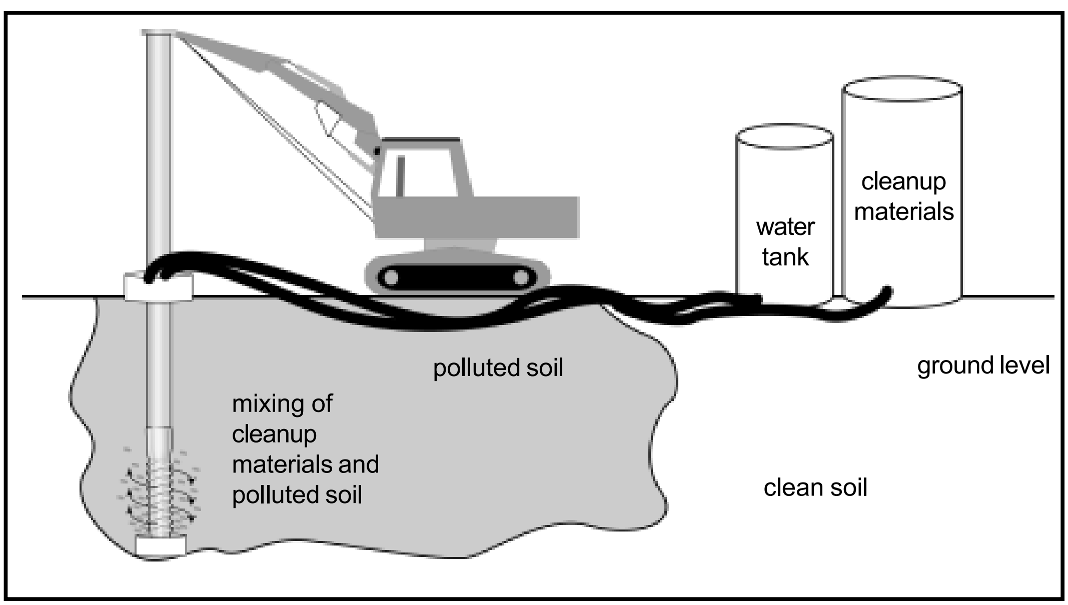
EPA uses many methods to clean up pollution at Superfund sites. If you live, work, or go to school near a Superfund site, you may want to learn more about these methods. Perhaps they are being used or are proposed for use at your site. How do they work? Are they safe? This Citizen's Guide is one in a series to help answer your questions.

What is solidification/stabilization?

Solidification/stabilization refers to a group of cleanup methods that prevent or slow the release of harmful chemicals from polluted soil or sludge. These methods usually do not destroy the chemicals—they just keep them from moving into the surrounding environment. Solidification refers to a process that binds the polluted soil or sludge and cements it into a solid block. Stabilization refers to changing the chemicals so they become less harmful or less mobile. These two methods are often used together to prevent exposure to harmful chemicals.

How do they work?

Solidification involves mixing polluted soil with a substance, like cement, that causes the soil to harden. The mixture dries to form a solid block that can be left in place or removed to another location. The solidification process prevents chemicals from spreading into the surrounding environment. Rain or other water cannot pickup or dissolve the chemicals as it



moves through the ground. Solidification does not get rid of the harmful chemicals, it simply traps them in place.

Stabilization changes harmful chemicals into substances that are less harmful or less mobile. For example, soil polluted with metals can be mixed with lime. The lime reacts with metals to form metal hydroxides. The metal hydroxides do not move through and out of the soil as easily.

Solidification/stabilization methods may or may not require the soil to be removed. Sometimes it is better to dig up the soil and place it in large mixers above ground to be sure that all of the polluted soil mixes with the cleanup materials, such as cement and lime. The mixture may then be returned to the ground at the site or placed in a landfill. At other sites, instead of digging up the soil, it is mixed in place with the cleanup materials. Then it is covered with clean soil or pavement. After solidification/stabilization is completed, EPA tests the surrounding soil to make sure no pollution was missed.

Is solidification/stabilization safe?

In order to make sure of the safety of the remedy, EPA tests the final mixture to confirm proper sealing of the harmful chemicals and for strength and durability of the solidified or stabilized materials. Sometimes EPA will place use restrictions on areas that have received solidification or stabilization. These land use restrictions can prevent future damage to the treated area.

How long will it take?

Solidification/stabilization may take weeks or months to complete, depending on several factors that vary from site to site:

- types and amounts of chemicals present
- size and depth of the polluted area
- types of soil and geologic conditions
- whether the mixing occurs in place or in mixing tanks

Why use solidification/stabilization?

Solidification/stabilization provides a relatively quick and low cost way to protect from the threat posed by harmful chemicals, especially metals. Solidification/stabilization has been chosen as part of the remedy at 183 Superfund sites across the country.

For more information
write the Technology Innovation Office at:

U.S. EPA (5102G)
1200 Pennsylvania Ave., NW
Washington, DC 20460

or call them at
(703) 603-9910.

Further information also can be obtained at **www.cluin.org** or **www.epa.gov/superfund/sites**.

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Appendix B

Sustainability Evaluation Calculations

SUSTAINABLE REMEDIATION TOOL CALCULATION

THERMAL TREATMENT REMEDIAL OPTION (EXCAVATION PORTION ONLY)
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

SUSTAINABLE REMEDIATION TOOL

1. Enter Project Information.

Site Name FORMER MERCURY MARINE
Location OSHKOSH, WISCONSIN
Site/Project Phase for Calculation Capital and O&M

Tier 1 **Tier 2**

Fuel Costs

Gasoline	$2.50	*$/gallon*
Diesel	$2.50	*$/gallon*
Electricity	$0.10	*$/kWh*
Natural gas	$11.00	*$/mcf*

Instructions:

=Enter your data here. Click button to the right of the cell for help.
=Use this default value or override with your own.
=Calculated value. You cannot change this.
For help, click on the square gray buttons located throughout the SRT.

***New users**: Fill in the boxes as indicated above. Choose Soil or Groundwater. Click buttons on Recommended Flow to proceed through the screens.*
***Advanced users**: Follow Recommended Flow, or click on tabs to navigate.*

Fit Window

2. Choose Environmental Media

Soil...

Recommended flow:

Main → **Soil Input** → **Excavation** / **SVE** → **Output**

...or Groundwater.

Recommended flow:

Main → **GW Input** → **Pump & Treat** / **Enhanced Bioremediation** → **Output**

SUSTAINABLE REMEDIATION TOOL CALCULATION

THERMAL TREATMENT REMEDIAL OPTION (EXCAVATION PORTION ONLY)
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

SOIL/SOURCE INPUT

FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

Area of Affected Soil	105600	ft^2
Depth to Top of Affected Soil	0	ft
Depth to Bottom of Affected Soil	6	ft
Depth to Groundwater	3	ft
Soil Type	Sandy gravel	
Contaminant Class		
Max Concentration		mg/kg
Typical Concentration		mg/kg
Contaminant mass	0.	lbs

Calculate natural resource service? Yes No

Instructions:

=Enter your data here. Click button to the right of the cell for help.

=Use this default value or override with your own.

=Calculated value. You cannot change this.

Paste Tier 2 Example

Clear Soil Inputs

Recommended flow:

You are here

Main → Input →

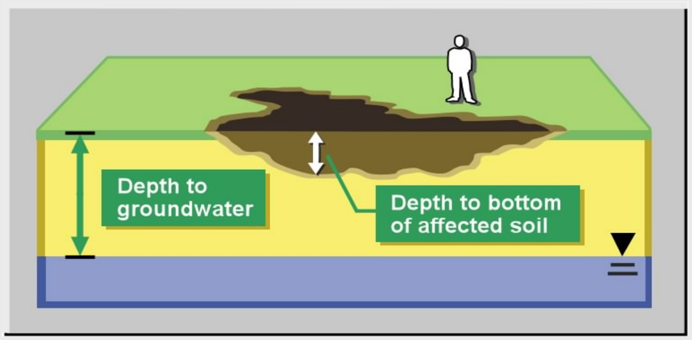
Next: Choose Technologies

☑ Excavation

☑ Soil Vapor Extraction

Next>>

→ Results



SUSTAINABLE REMEDIATION TOOL CALCULATION

THERMAL TREATMENT REMEDIAL OPTION (EXCAVATION PORTION ONLY)
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

EXCAVATION - TIER 1

FORMER MERCURY MARINE
OSHKOSH, WISCONSIN
CAPITAL and O&M

Instructions:
- (blank box) =Enter your data here. Click button to the right of the cell for help.
- (light grey box) =Use this default value or override with your own.
- (dark grey box) =Calculated value. You cannot change this.

Restore Defaults

Recommended flow: Main → Input → Technology Design (You are here) [Excavation, Soil Vapor Extraction] Next>> → Results

Design for Managing Soil

Airline miles flown by project team (total miles for all travelers)	0	*miles over proj lifetime*
Average Distance Traveled by Site Workers per one-way trip	10	*miles one-way*
Trips by Site Workers during construction	100	*# over project lifetime*
Trips by Site Workers after construction	10	*# over project lifetime*
Distance to Disposal (one-way)	1	*miles*
Type of Disposal	Non-hazardous	
Volume of affected soil	633,600.	*cu ft*
Volume of affected soil	23,467.	*cu yd*
Total hours to excavate	610.	*person-hours*
Number of loads for disposal	2,200.	*#*
Total miles driven for disposal	4,400.	*miles*
Total hours for fill dirt placement	240.	*hours*
Number of loads of fill dirt	2,500.	*#*
Total miles driven for fill	50,000.	*miles*

Materials and Consumable Amounts used for Metrics

Diesel	9,400.	*gal*
Gasoline	150.	*gal*

Technology Cost

Capital	2,300,000.	*$*
O&M	n/a	*$*

Project-specific Metrics (Add & Subtract/Offsets)

Yes No

Additional Technology Cost		*$*
Total Energy Consumed		*Megajoules*
CO_2 Emissions to Atmosphere		*tons CO_2*
Safety / Accident Risk		*lost hours*

SUSTAINABLE REMEDIATION TOOL CALCULATION

THERMAL TREATMENT REMEDIAL OPTION (EXCAVATION PORTION ONLY)
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

SOIL/SOURCE RESULTS

Instructions:

- (white box) =Enter your data here.
- (light grey box) =Use this default value or override with your own.
- (dark grey box) =Calculated value. You cannot change this.

Recommended flow:

Main → Input → Technology Design → Results (You are here*)

* Normalize metrics to see more, go back to Inputs to adjust & compare, go back to Main (Tier 1/2 or GW), or Exit.

Non-normalized

Calculations in natural units

	Excavation	SVE	
Carbon Dioxide Emissions to Atmosphere	120.	-	*tons CO_2*
CO_2 per pound of contaminant	#N/A	-	*lbs CO_2 per lb contam*
Total Energy Consumed	1,600,000.	-	*Megajoules*
	440,000.	-	*kWh*
Technology Cost	2,300,000.	-	*dollars*
Cost per pound of contaminant	#N/A	-	*dollars per lb contam*
Safety/Accident Risk	2.5	-	*lost hours*
	5.2E-02	-	*injury risk*
Change in Resource Service for Land - Economic	-	-	
Change in Resource Service for Land - Ecologic	-	-	

Normalize? Yes No

SRT

LDW SUSTAINABILITY TOOL CALCULATION

THERMAL TREATMENT REMEDIAL OPTION
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

8 THERMAL TREATMENT			
Description	**Equipment**	**Units**	**Alt 1**
volume	desorber	cubic yard	23,466
construction area	-	acres	2
soil density	-	pounds/cubic yard	2,601
soil temperature increase	-	°C	300
specific heat of soil	-	megajules/pund °C	0.0004
plant throughput	desorber	long tons/day	336
number of construction equipment operators	-	worker	3
OTHER CATEGORIES	-	worker	0

LDW SUSTAINABILITY TOOL CALCULATION

THERMAL TREATMENT REMEDIAL OPTION
FORMER MERCURY MARINE
OSHKOSH, WISCONSIN

8 THERMAL TREATMENT			Thermal	
GAS EMISSION	CO_2 emissions	lb	E_{CO2}	1,467,059
	CO emissions	lb	E_{CO}	275
	NOx emissions	lb	E_{NOx}	1,763
	SOx emissions	lb	E_{SOx}	8,648
WORK ACCIDENTS	expected number of accidents during miscellaneus activities	-	N_I	0.014
	expected number of deadly accidents during miscellaneus activities	-	N_F	0.000
ENERGY	energy consumption	MJ	E	8.80E+04