Final Proposed Plan
Acid Area 2
Plum Brook Ordnance Works, Sandusky, Ohio
DERP-FUDS Project Number DACW62-03-D-0004

Issued By U.S. Army Corps of Engineers
Huntington District

Prepared by Jacobs Engineering

March 2013

U.S. Army Corps of Engineers Announces Proposed Plan

This Proposed Plan identifies the Preferred Alternative for the cleanup of contaminated soil associated with the former Acid Area 2 (AA2) of the former Plum Brook Ordnance Works (PBOW), Sandusky, Ohio (Figure 1), and presents the rationale for this preference. The Preferred Alternative for AA2, as well as the other alternatives described herein, addresses the human health risks associated with potential soil exposure pathways.

U.S. Army environmental investigations and remediation at PBOW are administered under the Defense Environmental Restoration Program-Formerly Used Defense Sites (DERP-FUDS) as required for such sites by the Superfund Amendments and Reauthorization Act of 1986 (SARA). The U.S. Secretary of Defense delegated authority to the U.S. Army Corps of Engineers (USACE) to administer the DERP-FUDS program.

The Proposed Plan is a document issued by the USACE Huntington District, the lead agency for environmental response actions at the PBOW, to fulfill public participation requirements. The Preferred Alternative may be modified based on any new information or comments received during this designated public comment period. Therefore, the public is encouraged to review and

DATES TO REMEMBER

Comment Period
March 14 through April 15, 2013

Public Meeting
7 p.m. March 14, 2013, at Firelands Library
BGSU Foundation Hall
One University Drive
Huron, Ohio

Comments can be directed to:

U.S. Army Corps of Engineers,
Huntington District
Attn: CELRH-PM-PP-P (Mr. Rick Meadows)
502 8th Street
Huntington, WV 25701
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comment on all information presented in the Proposed Plan or Administrative Record file. The Proposed Plan was prepared in partnership with the Ohio Environmental Protection Agency (Ohio EPA). As the lead agency, the USACE is charged with planning and implementing environmental investigations and remedial actions at PBOW associated with past U.S. Department of Defense (DoD) activities. The USACE Nashville District provides design support services for environmental investigations at PBOW and provides technical review. The USACE Huntington District provides overall project management of FUDS activities at PBOW for the Louisville District as well as acts as the contracting and oversight office for remedial actions. The USACE Louisville District is the project and program management office for all FUDS property in the USACE Great Lakes and Ohio River Division. The Ohio EPA provides regulatory review, comment, and oversight.

This Proposed Plan is issued to accomplish the following:

- Provide basic background information about the site
- Describe all remedial options considered
- Identify the Preferred Alternative for soil associated with AA2 and explain reasons for the preference
- Solicit public review and comment on all alternatives
- Provide information on how the public can be involved in the remedy selection process.

The USACE, after coordinating with the Ohio EPA, will select a final remedy for AA2 soil after the public has had an opportunity to comment on this Proposed Plan and all comments received have been reviewed and considered. The comment period for the Proposed Plan is from March 15 through April 15, 2013, and the public meeting will be held at 7 p.m. on March 15 , 2013, at the Firelands Library, Firelands Campus of Bowling Green State University (BGSU), Huron, Ohio. The remedy selected for AA2 soil will be documented in a Decision Document.

The USACE is issuing this Proposed Plan for public comment as part of its public participation responsibilities consistent with Sections 117(a) and 113(k)(2)(B) of the Comprehensive Environmental Response Compensation, and Liability Act (CERCLA) of 1980, as amended by SARA, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) under CERCLA Part 300.430(f)(2)&(3).

This Proposed Plan summarizes information presented in greater detail in documents contained in the Administrative Record (AR) file for AA2. Background documents for AA2 are listed on

Page 4 and can be found in the AR file. These background documents are referenced within this Proposed Plan and are the basis of most of the information summarized herein. The USACE and the Ohio EPA encourage the public to review these documents and the entire AR file to gain a more comprehensive understanding of AA2 and the associated site activities. The AR file, which contains information upon which the selection of the response action will be based, is maintained at the Huntington District Office, 502 Eighth Street, Huntington, West Virginia, 25701. A request for visitors access must be made at least 24 hours in advance in order to access the AR files stored in the Huntington District Office. The request can be made to the Project Manager (see contact information at the bottom of page 1). The AR file can also be viewed online at the USACE Huntington District Web site:
http://www.lrh.usace.army.mil/Missions/CurrentProjects/DERPFUDSWVOWPBOWWVMA/PlumBrookOrdnanceWorks/Documents.aspx

The local Public Repository of the AR file is:

Firelands Library – BGSU
Foundation Hall
One University Drive
Huron, Ohio
Phone: 419-433-5560
Library hours vary throughout the year. Call for current hours. The AR file is maintained on compact disks; ask librarian at front desk for assistance.

Site Background

PBOW Description and History. PBOW is located approximately 4 miles south of Sandusky, Ohio, and 59 miles west of Cleveland (Figure 1). Although located primarily in Perkins and Oxford Townships, the eastern edge of the site extends into Huron and Milan Townships. PBOW is bounded on the north by Bogart Road, on the south by Mason Road, on the west by Patten Tract Road, and on the east by U.S. Highway 250. The area surrounding PBOW is mostly agricultural and residential (IT Corporation, 2001). The AA2 site is located in the northwestern portion of PBOW, adjacent to Patrol Road and approximately one mile west of Acid Area 3 (Figure 2).

PBOW was operated from 1941 to 1945 as a manufacturing plant for trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite. Production of explosives began in December 1941 and continued until 1945. It is estimated that more than one billion pounds of explosives were manufactured during the four-year operating period. The site is currently controlled and maintained by the National Aeronautics and Space Administration (NASA) and is operated as

Primary Background Documents for Acid Area 2

Science Applications International Corporation, 1991, ***Plum Brook Station Preliminary Assessment,*** June.

International Consultants Inc., 1995, ***Site Management Plan, Plum Brook Ordnance Works, Sandusky, Ohio,*** September.

IT Corporation, 1998, ***Site Investigations of the Acid Areas,*** **Former Plum Brook Ordnance Works, Sandusky, Ohio,** December.

Jacobs Engineering Group, Inc. (Jacobs), 2007, ***Final Site Characterization Report, Remedial Investigation Part 1 at Acid Area 2 and 3, Former Plum Brook Ordnance Works (PBOW), Sandusky, Ohio***, March.

Jacobs Engineering Group, Inc. (Jacobs), 2008a, ***Final Baseline Human Health Risk Assessment, Acid Area 2, Former Plum Brook Ordnance Works, Sandusky, Ohio***, February.

Jacobs Engineering Group, Inc. (Jacobs), 2008b, ***Final Screening Level Ecological Risk Assessment, Acid Area 2, Former Plum Brook Ordnance Works, Sandusky, Ohio***, February.

Jacobs Engineering Group, Inc. (Jacobs), 2012, ***Final Focused Feasibility Study, Acid Area 2, Former Plum Brook Ordnance Works, Sandusky, Ohio***, November.

the Plum Brook Station of the John Glenn Research Center. NASA acquired control of the former PBOW in 1963 and presently utilizes about 6,400 acres for conducting space research.

The acid areas were used to produce oleum, sulfuric acid, nitric acid, and mixed acids for the manufacture of TNT. AA2 contained eight process buildings, 24 above-ground storage tanks, and a rail line. Additional detail on the processes and facilities at the former AA2 site are provided in the Final Site Characterization Report (Jacobs, 2007a).

Since being excessed by the DOD, all above-ground facilities, including process buildings and storage tanks, have been removed from AA2 and the site has not been used by NASA since obtaining custody of the Plum Brook facility. Based on aerial photography, the facilities at AA2 were dismantled between 1958 and 1968. Much of the demolition debris was transported to one of several onsite burning grounds for incineration. Incineration activities have been documented to have ceased in 1962, so it is likely that demolition of the AA2 facilities was completed by 1962, preceding the acquisition of PBOW by NASA in 1963.

Soil, groundwater, surface water, and sediment have been investigated to determine whether activities associated with former DoD activities have adversely affected AA2 environmental media. Polychlorinated biphenyls (PCB) are the primary contaminants impacting the AA2 soil.

Potential Sources of PCB Contamination. Sampling results from the RI and subsequent delineation studies indicate large areas of PCB contamination in surface soil surrounding the former buildings and storage tanks. The source of PCB contamination may be PCB-containing paints and/or oils used for dust suppression and weed control along roadways, in parking areas, and around tank cradles and/or building foundations during the operation of the Acid Areas. All three applications (paint, dust suppression, and weed control) are documented uses for Aroclors 1254 and 1260. Evaluations of historical aerial photographs of the Acid Areas and the nature of the vegetation that has taken over these sites indicate NASA has not used the acid area facilities.

PCB-containing paints were commonly used in the U.S. and Canada from the 1930s to the 1970s (Gill, et al., 1997). PCB paints were applied to older U.S. Department of Defense (DoD) structures (ESTCP, 2011). PCBs were added to paints to enhance structural integrity, reduce flammability, increase antifungal properties, and impart heat resistance (Rodriguez, 2010). Data provided to EPA indicates that PCBs have been found in dried paint at concentrations that range from <1 to 97,000 parts per million (EPA, 1999). Aroclor 1254 was included in an old formulation for chlorinated rubber paints (Gordon and Gordon, 1955). A 1942 paint dictionary indicates that chlorinated rubber was used to enhance the chemical resistance of paints exposed to acids and alkalis (Stewart, 1942). Aroclor 1254 was believed to be a chemical component in the formulation for federal specification TT-P-912 for chlorinated rubber paint (Lowry, et al., 1998). In 2001, technicians at Army industrial sites discovered PCBs in paint that coated many structures and process equipment (USACE, 2011). PCB-containing paint at closed Army ammunition plants has delayed plans for the decontaminating equipment and buildings (Rodriguez, 2010; USACE, 2011). These problems have led the DoD to develop and test in situ technologies to remove and destroy PCBs found on DoD structures at locations such as the Badger Army Ammunition Plant (ESTCP, 2011). Badger Army Ammunition Plant was constructed in 1942 and sulfuric acid was produced at the facility.

PCBs were used in dust control formulations, and often found in used oils historically used for dust suppression, road oiling, and weed control. (PCB Fact Sheet, Department of Environmental Quality, State of Oregon)

"Prior to the regulation of PCBs under the Toxic Substances Control Act (TSCA) in 1976, PCBs were released (both accidentally and intentionally) into the atmosphere, water, and land through sewers, smokestacks, stormwater runoff, spills, and direct application to the environment (for example, to reduce dust emissions and to extend the life of some agricultural pesticide formulations) (Public Health Concerns About Environmental PCBs Flynn, 1997)."
In a press release by the EPA, dated April 19, 1979, the EPA states that it "will stop use of waste oil containing any level of PCBs for dust control. PCB-contaminated waste oil is now used extensively throughout the country to control dust on roadways, providing a direct source of environmental contamination. Other products to control dust on roadways are available and cost-effective."

Site Characteristics

AA2 covers approximately 25 acres. The ground surface is relatively flat, with minimal slope toward the east and southeast. The majority of the site is covered with small trees and brush, with occasional open grass areas with limited brush. The more densely wooded areas tend to be located in the eastern third and western third of the site, with the open areas concentrated in the central portion of the site. The areas outside of the site boundary are heavily wooded.

Site features include two drainage ditches running west to east: one on the northern perimeter of the site, and one on the southern perimeter of the site. A storm sewer system was constructed at the site, as evidenced by existing drainage grates, manhole covers, and open holes with brick lining. The remains of an old railroad grade with a few railroad ties and loose track were still evident at the site during investigations in 2010. Former building foundations are present on the north side of the site. There is evidence of concrete footers and/or concrete slabs present at the site based on refusal during drilling operations within the footprint of some of the former facilities. The extent of sub-grade building materials left in place is unknown. A paved service road completes a loop around the perimeter of the site.

Groundwater at AA2 includes both shallow overburden and the Delaware Limestone aquifers. Shallow groundwater generally flows toward the drainage ditches and east toward Pipe Creek. Groundwater elevation contours for the deeper Delaware Limestone aquifer indicate a linear groundwater high running north-south through the center of AA2. Bedrock groundwater flows east, west, and north away from the center of the site.

A Preliminary Assessment of the Plum Brook facility was performed in 1991, which included an assessment of AA2 (Science Applications International Corporation, 1991). A subsequent Site Investigation was conducted in 1998 to collect and analyze AA2 soils (IT Corporation, 1998). During the site investigation, 30 soil samples were collected from 15 borings (15 surface samples and 15 subsurface samples). Because the analytical results of several samples exceeded screening criteria for PCBs and PAHs, a remedial investigation (RI) was performed during 2004 and 2005 (Jacobs, 2007). The RI included an investigation of surface soil, subsurface soil, overburden groundwater, bedrock groundwater, surface water, and sediment.

Surface and subsurface soil samples were collected from soil borings advanced at 13 locations during the RI. A total of 33 soil samples were collected. Surface soil samples were collected from 0.5 to 1.5 ft below ground surface (bgs) at all locations. Subsurface samples were collected from three to five ft bgs at all locations and from eight to ten ft bgs at seven locations. All samples were analyzed for VOCs, SVOCs, nitroaromatics, TAL metals, and PCBs.

Results indicated that contamination above the USEPA Preliminary Remediation Goals (PRGs) was found in both the surface and subsurface soils. Contaminants exceeding the PRGs included PCBs, PAHs, lead and thallium. Contamination was most prevalent in the surface soil, with occasional PCB and PAH exceedances at the three to five ft interval. Elevated concentrations at the eight to ten ft interval were limited to thallium.

Additional surface soil sampling was performed from November 2008 through August 2010 in support of the feasibility study (FS) to delineate PCB contamination in surface soil. A total of 174 surface soil samples were collected and analyzed for PCBs only. The results from this delineation sampling were used to identify three separate areas of PCB contamination covering a total area of 127,705 sq ft (2.9 acres). Concentrations of PCBs in surface soil range as high as 49 mg/kg (combined aroclors). Concentrations in the subsurface soil only range as high 2.6 mg/kg (combined aroclors).

Two rounds of groundwater samples were collected from five existing monitoring wells to evaluate if the shallow and bedrock groundwater had been impacted with the same contaminants found in soil. Groundwater samples were analyzed for VOCs, SVOCs, PCBs, nitroaromatics, and TAL metals. The primary soil contaminants, PCBs and PAHs were not detected in groundwater.

Two rounds of surface water and sediment samples were collected from the adjacent drainage ditches. The initial round included three surface water and three sediment samples from the southern drainage ditch only, which were analyzed for VOCs, SVOCs, PCBs, nitroaromatics, and TAL metals. Elevated concentrations of PCBs and PAHs were detected in the sediment during round 1. The second round included twenty additional sampling locations, twelve from the southern drainage ditch and eight from the northern drainage ditch. The additional sampling confirmed the presence of PCBs and PAHs in the ditch immediately adjacent to the site, but showed that the PCBs had been transported downstream.

Scope and Role of AA2

One of DoD's specific goals from the Defense Planning Guidance for DERP-FUDS is to reduce risk to human health and the environment from contamination created as a result of past DOD activities, through implementation of effective, legally compliant, and cost-effective response actions. To that end, the environmental investigation of PBOW has been divided into 16 areas of concern, also referred to as DERP-FUDS projects, to address the potential concerns presented by each area associated with former DoD activities. A separate close-out document is required for each of the 16 DERP-FUDS projects. This current Proposed Plan specifically addresses AA2 only. The status for each of the other 15 DERP-FUDS sites is also shown so that it can be seen how the current action fits into the scope of action at PBOW, including all completed, ongoing, and planned activities.

The 16 DERP-FUDS projects and their status are briefly identified in the following paragraphs. Please note that 6 of these 16 projects have been closed or have signed Decision Documents, as indicated.

Reservoir No. 2 Burning Ground. The RI began in 2004, and the site characterization report was issued in January 2006. Human health and ecological risk assessments were completed in February 2010. Further delineation sampling was performed in October 2010, and a draft FS was submitted in July 2011. The final FS was submitted in September 2011. The Final Proposed Plan was submitted August 2012.

TNT and Red Water Pond Areas Groundwater. TNT and Red Water Pond Areas Groundwater. A baseline human health risk assessment (BHHRA) of groundwater associated with the three former TNT Areas and two former Red Water Pond Areas was finalized in September 2006, and an FS for groundwater associated with these areas was finalized in December 2008. An addendum to the groundwater FS was finalized in July 2011. The groundwater associated with these five areas is expected to be addressed in a single Decision Document to be completed in May 2013.

TNTA. A focused feasibility study (FFS) for soils and sediment was completed in 2003. A Decision Document for TNTA soils was signed on June 22, 2011, and a State of Ohio concurrence letter was received on July 20, 2011. A contract for remedial action for TNTA soils has been awarded, and remediation is ongoing.

TNTB. An FS for soils was completed in 2001. An Action Memorandum for a non-time-critical removal action (NTCRA) regarding soils was presented to the public on March 28, 2002. The Action Memorandum was finalized in June 2003, and the removal action was completed in December 2006. The final report of the interim soil removal action was issued in 2007. A Proposed Plan recommending no further action was presented during a July 16, 2009 public meeting. No comments were provided during the subsequent public comment period. A no-further-action Decision Document was signed on September 23, 2009, and State of Ohio concurrence letter was received on September 29, 2009. The project closeout report was signed on March 31, 2010.

TNTC. An FFS for soils and sediment was completed in 2003. A Proposed Plan was submitted in March 2009. A Decision Document was signed by DoD on December 7, 2009, and a concurrence letter, dated January 15, 2010, was received from the State of Ohio. Remedial action of TNTC soil and sediment is ongoing.

Red Water Pond Areas. An FFS for the Red Water Pond Areas soil was completed in December 2002. Remedial alternatives were developed and evaluated for Pentolite Road Red Water Pond (PRRWP) Area soil in the FFS because the human health risks associated with PRRWP Area soil were determined to be unacceptable under unrestricted land use. Because human health and ecological risks for West Area Red Water Pond (WARWP) Area soil were determined to be within acceptable levels for unrestricted land use, it was not necessary to develop remedial alternatives for the WARWP Area soil. An Action Memorandum was presented to the public in September 2002 for an NTCRA regarding PRRWP Area soil. An interim removal action at the PRRWP Area began in January 2003 under the NTCRA. During the NTCRA soil removal, the need for additional soil sampling was recognized based on the discovery of a dark layer of contaminated soil. A windrow composting action was selected to remediate this soil under the NTCRA. Composting began in 2007 and was completed in September 2008. Post-NTCRA delineation sampling was performed in spring and summer 2009. Because of residual human health risks, additional delineation sampling was completed in November 2010. A soil delineation report and risk evaluation have been prepared in support of an addendum to the FFS, which is scheduled for completion in 2013.

Acid Areas 1, 2, and 3. The site investigations of the three acid areas were completed in December 1998. An RI for Acid Areas 2 and 3 was completed in March 2007. The risk assessments for Acid Areas 2 and 3 were completed in February 2008. Additional delineation sampling was performed at Acid Areas 2 and 3 from November 2008 through August 2010. The Final FFS for AA2 and AA3 were submitted November 2012. The Draft Proposed Plan for AA2 and AA3 are scheduled for submittal on 23 January 2013. The Decision Documents for AA2 and AA3 are scheduled to be finalized on February 2014. The Acid Area 1 RI was completed in July 2009. The risk assessment for Acid Area 1 was completed July 2010. Additional delineation sampling was conducted in June and July 2011. The FFS for Acid Area 1 is scheduled for submittal in January 2013.

Additional Burning Grounds. A PA was performed in 1991. This project includes five burning ground areas. NASA has agreed to take full responsibility for three areas which include Taylor Road, Snake Road, and Fox Road Burning Grounds. The other two (G-8 and "Additional" Burning Grounds) require further records research review. Based on this records review, responsibility for these areas will be established.

Waste Water Treatment Plant Nos. 1 and 3. A limited site investigation was completed in July 2000. The RI report and risk assessments are scheduled for completion in 2012. These will include the associated wood-stave waste water sewer lines from TNTA and TNTB to Waste Water Treatment Plant No. 1. The former Waste Water Treatment Plant No. 3 neutral waste storage tank, which was used by NASA as the K-Site control building, was demolished by NASA in October 2012.

Waste Water Treatment Plant No. 2. A PA performed in 1991 found a potential for contamination of soil, surface water, sediment, and groundwater with acetone, pentaerythritol, and tetraerythritol tetranitrate. A site investigation was performed in 1997. An RI and FS were funded, which include the associated TNTC to Waste Water Treatment Plant No. 2 sewer lines and the steel sewer lines. Risk assessments are scheduled for completion in March 2013.

Power House No. 2 Ash Pit. A PA was performed in 1991. Final site characterization and risk assessment reports were submitted in September 2010. Additional soil sampling was conducted in July 2011 for the RI that scheduled to be submitted in April 2013.

Ash Pits Nos. 1 and 3. A limited site investigation performed in July 2000 resulted in the recommendation that further investigation be performed. A contract for an RI was awarded in June 2008, and fieldwork began in December 2008. A site characterization report and risk assessments were submitted in 2011 for Ash Pit No. 1 and are anticipated for completion in 2013 for Ash Pit No. 3.

TNT Loading Areas. A limited site investigation was completed in July 2000. The project was closed out in September 2006 with no further action; the State of Ohio concurred.

Pentolite Area Waste Lagoon. A limited site investigation was completed. The project was closed out in September 2006 with no further action; the State of Ohio concurred.

Lower Toluene Tanks. A limited site investigation was completed in July 2000. The project was closed out in September 2006 with no further action; the State of Ohio concurred.

Garage Maintenance Area. A limited site investigation was completed for the Locomotive Building Area in July 2000 and resulted in the recommendations to proceed with further investigation. The Locomotive Building Area is in the eastern portion of the Garage Maintenance Area. A final site characterization report was submitted for the Locomotive Building Area in September 2010, and the final risk assessment reports were submitted in December 2010. Fieldwork for the Sellite Area and Unloading Area RI began in June 2011 and was completed in May 2012. An RI report and risk assessments for these two portions of the Garage Maintenance Area will be submitted in May 2013.

Soil Actions on DERP-FUDS Projects. The soil actions undertaken at the PRRWP Area, TNTA, TNTB, and TNTC and the proposed actions at Reservior No. 2 Burning Ground are being implemented by the USACE under DERP-FUDS. To date, no other removal actions or response actions have been recommended.

Summary of Potential Site Risks

A BHHRA (Jacobs, 2008a) and screening level ecological risk assessment (SLERA) (Jacobs, 2008b) were performed for AA2 soil, surface water, sediment, and groundwater. The results of these evaluations are summarized below.

Human Health Risks. The BHHRA evaluated potential risks under the following potential human receptor scenarios (exposure pathways evaluated in parentheses):

- Future long-term indoor worker (ingestion of surface soil; ingestion of groundwater; dermal contact with groundwater)
- Current/future long-term groundskeeper (ingestion of surface soil; dermal exposure to surface soil; inhalation of particulate originating from surface soil)
- Current/future shorter-term construction worker (ingestion of surface/subsurface soil; dermal exposure to surface/subsurface soil; inhalation of particulates originating from surface soil; ingestion of sediment; dermal contact with sediment/surface water)
- Hypothetical long-term future resident (ingestion of surface/subsurface soil; dermal exposure to surface/subsurface soil; inhalation of particulates originating from surface soil; ingestion of sediment; dermal contact with sediment/surface water; ingestion of

groundwater; dermal contact with groundwater; inhalation of volatile compounds from groundwater)

- Future/current hunter and child (consumers of contaminated venison; hunter ingestion of surface soil, dermal exposure to soil)
- Future/current hunter's child (consumption of venison).

Figure 3 depicts the exposure pathways evaluated for each receptor in the BHHRA.

The BHHRA identified no current human exposure to groundwater either on site or in adjacent areas off site. However, as agreed by the PBOW Project Delivery Team, it was assumed for purposes of the BHHRA that limestone bedrock groundwater underlying AA2 may be developed as a source of potable water at some time in the future. Based on the groundwater investigation (Jacobs, 2007), this limestone unit would not provide an adequate quantity of groundwater, and the quality of this water would fail drinking water standards due to the presence of naturally occurring compounds that are unrelated to former site activities. Also, the bedrock groundwater wells installed at AA2 (and other areas of PBOW) emit notable amounts of naturally occurring hydrogen sulfide gas, which may result in nuisance odors and, at elevated levels, potential health concerns. In addition, the presence of hydrogen sulfide gas, which has direct and indirect corrosive effects, results in the rapid deterioration of metal components of well materials, pumps, and plumbing. Therefore, groundwater from the limestone unit underlying AA2 is regarded as nonpotable, despite the assumption made in the BHHRA that it may be developed as a drinking water source. The assumption of potability for the limestone bedrock groundwater was made in the BHHRA because the Ohio EPA maintained that this assumption should initially be made under baseline conditions where no prior use restrictions are in place.

Shallow groundwater in the vicinity of Acid Area 2 is not regarded as a potential source of potable water because of the high clay content and limited, discontinuous permeable zones, resulting in low yields. It is possible that a construction worker may be exposed to shallow groundwater via direct contact; however, such exposure would likely be sporadic and of short duration. Therefore, the BHHRA did not quantitatively evaluate exposure to perched groundwater.

The incremental lifetime cancer risks (ILCR) that could result from a reasonable maximum exposure to potential carcinogenic (cancer-causing) chemicals detected in AA2 media (e.g., soil, groundwater, surface water, and sediment) were determined under each human receptor scenario. The ILCR is the "extra risk" that cancer will develop at some point in an exposed individual solely because of exposure to the pertinent chemicals. In this case, the ILCR is associated with chemicals in the site media that are resultant from DoD activities. This extra cancer risk does not include the baseline cancer risk statistically incurred by a member of the general population, whether or not he is exposed to the AA2 media. The ILCR from each chemical and exposure pathway (e.g., ingestion of groundwater as tap water, dermal exposure to soil, etc.) were summed to calculate the combined ILCRs to the individual receptors. The NCP states that acceptable exposure levels are generally concentrations that represent an excess upper bound lifetime cancer risk (or ILCR) to an individual between 1×10^{-6} (1 in 1,000,000) and 1×10^{-4} (1 in 10,000). The Ohio EPA considers total ILCR values greater than 1×10^{-5} (1 in 100,000) in an environmental medium to be unacceptable. This value is the logarithmic midpoint of the NCP acceptable range; the Army recognizes the full NCP range. Please note that the baseline risk for the general U.S. population of developing cancer is approximately 40 percent (4 in 10). As an illustration, if an individual is assumed to have exactly a 40 percent chance (400,000 in 1,000,000) of developing cancer without a specific exposure, an additional exposure at an ILCR of 1×10^{-5} (1 in 100,000, or 10 in 1,000,000) would theoretically result in an overall cancer risk of 400,010 in 1,000,000.

Noncancer human health effects are evaluated differently than are cancer risks because the nature of noncancer effects generally assumes a "threshold level" below which adverse health effects are regarded as unlikely to occur at all in the (hypothetically) exposed population. As stated in the NCP, acceptable exposure levels for systemic toxicants (i.e., noncancer effects) are represented by concentration levels to which a human population may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety. Consistent with U.S. Environmental Protection Agency (USEPA) risk assessment guidance, the estimated exposure levels of DoD-related chemicals were mathematically compared to threshold-level-based chronic reference doses to derive a hazard index (HI). These chronic reference doses are acceptable lifetime exposure rates that represent the term "acceptable exposure levels" used in the NCP. Further description of the chronic reference doses and their derivation is provided in the Toxicity Assessment (Chapter 4.0) of the BHHRA. An HI value greater than 1 indicates a possible concern for potential adverse health effects; HI values equal to or less than 1 indicate that adverse health effects are unlikely for any exposed individual.

The overall ILCR and HI values for each environmental medium and each receptor are summarized in Table 1, as are the total HI and ILCR values across all environmental media. The following conclusions are drawn from the BHHRA results and uncertainty evaluations.

- The surface soil HI values associated with the construction worker (HI=7.4) and resident (HI=13.3) exceed the acceptable threshold value of 1. Over 86 percent of the noncancer hazard for each receptor is associated with PCBs. The surface soil ILCR for the groundskeeper (4.5×10^{-5}), indoor worker (2.2×10^{-5}), and resident

(2.7×10^{-4}) exceed the Ohio EPA ILCR goal of 1×10^{-5}, and the ILCR for the resident exceeds the NCP acceptable risk range of 1×10^{-6} to 1×10^{-4}.

- With respect to surface soil exposure, neither the ILCR for the construction worker (7.2×10^{-6}) nor the ILCR for the hunter (6.4×10^{-6}) exceeded the PBOW cancer risk goal of 1×10^{-5}. Likewise, the HI of the groundskeeper (1.0), indoor worker (0.5), and hunter (0.1) exposed via surface soil pathways did not exceed the PBOW HI goal of 1. Thus, no unacceptable cancer risks or noncancer hazards are calculated for the hunter via surface soil pathways.

- The subsurface soil HI values associated with the two receptors evaluated for subsurface soil exposure, the construction worker (HI=2.2) and resident (HI=4.4), exceed the acceptable threshold value of 1. Over 69 percent of the noncancer hazard for each receptor is associated with Thallium, which is a naturally occurring metal found in the AA2 soils. The subsurface soil ILCR for the resident (1.2×10^{-4}) marginally exceeds the NCP acceptable risk range of 1×10^{-6} to 1×10^{-4}. Sixty five percent of the ILCR value is associated with PAHs, and the remainder is associated with the arsenic and PCBs.

- Assuming exposure to bedrock groundwater, the cancer risk and noncancer hazards to both receptors evaluated (indoor worker [ILCR=4.6E-5; HI=1.9] and resident [ILCR=2.0E-4; HI=13]) would exceed the NCP acceptable risk range of 1×10^{-6} to 1×10^{-4} or the HI threshold value of 1, respectively. Because of the poor groundwater quality and the naturally occurring petroleum hydrocarbons, the bedrock groundwater underlying AA2 is not suitable for potable use. Also, the bedrock is generally not capable of providing adequate yield. The noncancer hazard associated with groundwater is due primarily to thallium, iron, and arsenic. Over 96 percent of the cancer risk is associated with arsenic and the petroleum-related compound benzene. None of the organic soil COCs were detected in the groundwater.

- No noncarcinogenic chemicals of potential concern were identified in AA2 sediment. The ILCR values associated with sediment were less than the Ohio EPA goal of 1×10^{-5} in both receptors evaluated for sediment exposure, the construction worker (5×10^{-7}) and resident (7×10^{-6}).

- No noncarcinogenic chemicals of potential concern were identified in AA2 surface water. The ILCR values associated with surface water were also less than the NCP acceptable risk range of 1×10^{-6} to 1×10^{-4}.

In summary, predicted levels of exposure to site-related chemicals in surface soil and subsurface soil would result in unacceptable cancer risk levels and/or noncancer hazards for the groundskeeper (surface soil), indoor worker (surface soil), construction worker (surface/subsurface soil), and resident (surface/subsurface soil). Both cancer and noncancer risks to the hunter would not exceed acceptable levels in surface soil. Sediment and surface water would not pose any unacceptable human health risks or hazards.

Risks associated with the ingestion of AA2 groundwater resulted in unacceptable human health risks to both receptors evaluated, the indoor worker and the resident. However, as stated, the bedrock groundwater underlying AA2 is not regarded as potable because of naturally occurring petroleum hydrocarbons, elevated levels of hydrogen sulfide gas, and insufficient water yield.

Because unacceptable site-related risks/hazards were identified in surface and subsurface soil based on the results of the BHHRA, the BHHRA was used to identify COCs. COCs are defined as any site-related, DoD-related contaminant that contributes significantly to an exposure pathway with an unacceptable risk or hazard. For PBOW, a significant contribution to unacceptable risk is a chemical-specific cancer risk of greater than 1×10^{-6}; for noncancer hazards, a significant contribution to significant risk is a chemical-specific HI of greater than 0.1. In the BHHRA, the following analytes were reviewed to determine the COCs – Aroclor 1254 and Aroclor 1260:

- Aluminum
- Arsenic
- Iron
- Manganese
- Thallium
- Aroclor 1254
- Aroclor 1260
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)flouranthene
- Dibenz(a,h)anthracene
- Indeno(1,2,3-cd)pyrene

Metals in soil have been eliminated as COC for the following reasons: (1) The maximum detected concentrations (MDCs) for aluminum, arsenic, iron, and manganese were lower or comparable to their respective site-specific background levels (Jacobs 2008a). (2) The detected concentrations of thallium are likely to be associated with background conditions as the range of concentrations detected in samples falls within the range of detection limits used to establish background.

PAHs in soil have been eliminated as COCs for the following reasons: (1) PAHs were not historically used at the site other than in asphalt paving materials and lubricants and fuels for vehicles; (2) PAH concentrations detected at the site generally fall within global background levels for urban areas further supporting the conclusion that they are a result of anthropogenic sources in the area and are not a result of past site activities.

The primary driver of risk in subsurface soil is due to PAHs; however, the calculated risk values were based on the maximum detected concentration at the site. PAHs were only detected in 9 percent of the subsurface soil samples.

Ecological Risks. A SLERA was performed as part of the RI for AA2 (Jacobs, 2008b). The SLERA is composed of the following steps:

- Problem formulation
- Exposure characterization
- Ecological effects characterization
- Risk characterization.

The problem formulation provides an ecological description of the site and identifies the chemicals of potential ecological concern (COPEC) that are evaluated in the SLERA. The exposure characterization provides an estimate of the nature, extent, and magnitude of potential exposure. The ecological effects characterization identifies toxicity reference values for the COPECs in the various environmental media, and the risk characterization provides a qualitative and semiquantitative evaluation of ecological risks.

AA2 is composed of upland old fields, early shrub thicket, successional woodlands, and lowland woods. There are two minor surface water features consisting of drainage ditches on the northern and southern side of the site. Both drainage ditches are shallow and intermittent in nature. Given the nature of the northern surface water drainage, which is poorly defined, shallow and intermittent flow, it is likely to support low trophic level aquatic organisms only. The southern surface water drainage feature is larger and more well defined, but it is also shallow and intermittent. This drainage will support aquatic organisms and possibly waterfowl during migration in the early Spring when water is present. It is not likely that either drainage feature supports significant populations of forage fish due to their shallow depths and intermittent nature.

Mammalian, avian, and herptilian wildlife species have been identified at PBOW, some of which would be expected and/or have been observed at AA2. Although several threatened and endangered animal and plant species have been reported within a 2-mile radius of PBOW, none have been observed at AA2 during the site ecological survey (Jacobs, 2008b).

The SLERA focuses on the potential exposure to species or ecological components that are the most likely to be affected, given the toxicological and mobility characteristics of the COPECs, and on those COPECs that would most likely produce the greatest effects in the on-site ecosystem.

Site biota are organized into major functional groups. The following seven receptor species were selected to evaluate the potential terrestrial effects for AA2 soil COPECs.

- Deer mouse (*Peromyscus maniculatus*) (small omnivorous mammal)
- Short-tailed shrew (*Blarina brevicauda*) (small insectivorous mammal)
- Eastern cottontail rabbit (*Sylvilagus floridanus*) (medium-sized herbivorous mammal)
- Marsh wren (*Cistothorus palustris*) (small insectivorous bird)
- White-tailed deer (*Odocoileus virginianus*) (large herbivorous mammal)
- Raccoon (*Procyon lotor*) (medium-sized omnivorous mammal)
- Red-tailed hawk (*Buteo jamaicensis*) (large carnivorous bird).

The following two receptor species were selected to evaluate the potential aquatic effects for AA2 surface water and sediment COPECs.

- Raccoon (*Procyon lotor*) (medium-sized omnivorous mammal)
- Mallard (*Anas platyrhynchos*; medium-sized aquatic omnivore)

Potential impacts to terrestrial plants were considered qualitatively in the risk characterization. Ecological terrestrial receptors were evaluated for exposure to soil from the surface to a depth of 5 feet bgs. The terrestrial food web diagram for the above receptors is provided as Figure 4. The aquatic food web diagram for the above receptors is provided as Figure 5.

Measurement endpoints for the SLERA are based on toxicity values from the available literature and not on statistical or arithmetic summaries of actual field or laboratory observations or measurements. The assessment endpoints for AA2 are stated as "the protection of long-term survival and reproductive capabilities for terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, benthic invertebrates, omnivorous aquatic mammals, and omnivorous aquatic birds."

Ecological routes of exposure for biota may be direct (e.g., ingestion of soil; plants absorbing contaminants from soil) or indirect via the consumption of contaminated organisms. Media-to-tissue transfer factors and food-chain multiplier values were used to model indirect exposure via ingestion of contaminated biota.

The ecological effects characterization includes the selection of benchmark values and the development of reference toxicity values. These values focus on the growth, survival, and reproduction of species and/or populations and provide a reference point for the comparison of toxicological effects upon exposure to a contaminant.

The risk characterization integrates information on exposure, exposure-effects relationships, and defined or presumed target populations. The result is a determination of the likelihood, severity, and characteristics of adverse effects of COPECs present at a site, based on qualitative and quantitative approaches. The weight-of-evidence risk characterization results, in conjunction with the uncertainties described in the SLERA, are summarized by the following statements.

- Impacts to terrestrial plants appear to be insubstantial.
- Several ecological hazard quotient (EHQ) values associated with soil were elevated for terrestrial receptors for PCBs (mouse EHQ=400,000), (shrew EHQ=300,000), (wren EHQ=200,000), (raccoon EHQ=100,000), (cottontail EHQ=200,000) (Table 2).
- Ecological hazard quotient (EHQ) values associated with surface water and sediment were elevated for aquatic receptors for PCBs (mallard EHQ=700) and lead (mallard EHQ=100) (Table 2).

The SLERA concluded that a remedial action based specifically on ecological concerns is not warranted, as no threatened or endangered species are present, and that a remedial action based on human health effects will also address ecological concerns. The major chemicals driving ecological hazards, PCBs Aroclor-1254 and aroclor-1260, were also identified as COCs to be remediated based on the BHHRA.

Remedial Action Objective

The following remedial action objective (RAO) was developed in the FS for AA2 soil:

- Remedial actions will be taken to prevent adverse residential exposure via any exposure route (ingestion, inhalation, or dermal contact) to soil containing the COCs at concentrations that exceed AA2 remedial goals (RGs) of 1 mg/kg for Aroclor 1254 and 2 mg/kg for total PCBs, combine aroclors.

The AA2 RGs were derived in the FS for the COCs assuming unrestricted future land use. This assumption is appropriate because the area surrounding the former PBOW facility is rural and residential and if/when the property is excessed, the land will likely become residential. Please note that because no unacceptable site-related risks are associated with AA2 groundwater or surface water, no RAO for groundwater or surface water is developed.

In general, an RG may be based on an applicable or relevant and appropriate requirement (ARAR) or human health or ecological risks/hazards. Because no ARARs are pertinent to any of the COCs at the concentrations present, the RG for each AA2 COC is primarily risk based. The risk-based level of 1 mg/kg for Aroclor 1254 and 2 mg/kg for total PCBs, combined aroclors is selected as the RG for PCBs because it is protective.

The risk-based RGs were designed based on site-specific concentrations such that the cumulative cancer risk (i.e., ILCR) associated with residential exposure to the soil would not result in a cumulative cancer risk that exceeds the target cancer goal of 1×10^{-5} or the target cumulative noncancer hazard of 1. The Ohio EPA has maintained an ILCR of 1 x 10^{-5} as a target cancer risk goal for all PBOW sites, which is consistent with Ohio EPA policy. Though USACE is bound by the CERCLA/NCP range of 1 x 10^{-6} to 1 x 10^{-4}, the Ohio EPA target goal of 1 x 10^{-5} is the logarithmic midpoint of the CERCLA/NCP risk range, and as such, can be used to initially set remediation goals subject to possible modification in accordance with appropriate risk considerations. The noncancer RGs were derived so that the sum of the noncancer effects of those chemicals that affect the same target organ does not exceed the target HI goal of 1.

The RGs will be used statistically during excavation and confirmation sampling as part of a risk-based approach to aid in determining whether additional soil removal is required. This will involve the averaging of samples from each excavation and comparing the analytical results to the respective RGs. The exceedance of an RG level in an individual discrete sample will be acceptable for an area of an excavation as long as the overall excavation site does not exceed the RG. Also, for Remedial Alternatives 3 and 4 (described below), which may include on-site placement of treated materials, an exceedance of an RG level in an individual discrete sample would be acceptable for a given batch of treated soil as long as the overall batch did not exceed the RGs.

RAOs based specifically on ecological risk were not recommended for soil because of considerable uncertainties associated with toxicity, no observation of vegetative stress at AA2, and absence of any threatened and endangered species. Also, the major risk-driving chemicals for terrestrial ecological risks in soil are predominant with respect to human health risks. Therefore, through remediation which attains human health-based RG concentrations, potential ecological hazard estimates will be greatly reduced.

Summary of the Remedial Alternatives

The following five remedial alternatives were developed and evaluated in the FS for contaminated soil at AA2:

- ***Alternative 1:*** No action
- ***Alternative 2:*** Excavation and Off-Site Treatment/Disposal
- ***Alternative 3:*** In-situ Remediation, MuniRem®
- ***Alternative 4:*** Ex-situ Remediation, Enhanced Bioremediation
- ***Alternative 5:*** Incineration

Each of the four action-based alternatives (Alternatives 2 through 5) would require the excavation and/or treatment of PCB contaminated soil from three contamination areas, as shown on Figure 6. Based on delineation efforts an estimated 14,189 cubic yards (CY) of contaminated soil will need to be remediated. This volume estimate is based on the surface contamination extending to 36 inches below ground surface.

The vertical extent of contamination is unclear since the delineation effort focused on surface soil only. Based on the RI sampling results, there is limited contamination at the 3 to 5 ft interval; therefore, extensive delineation of the subsurface was not warranted. It is expected that most of the contamination is at the surface, as PCBs are hydrophobic and have a low aqueous solubility. PCBs bind to organic matter in soils and often do not migrate to depths greater than a few inches from the surface. The PCBs that have been detected at depth at AA2 are more likely due to regrading of the site after demolition and removal of the AA2 process facilities. It is possible that PCBs will not be detected below 18 inches over much of the contamination area. Verification sampling results at the time of remediation may result in a reduction of the estimated soil volume. It is also possible that the lateral extent of contamination may be expanded based on verification sampling results. The actual volume of contaminated soil may be significantly less than the current estimated volume.

The following sections present a summary of each of the remedial alternatives that were addressed in the Final FFS for AA2 (Jacobs, 2012).

Alternative 1 – No Action

Under this alternative, no remedial action or monitoring would be conducted for contaminated soil at the site. This alternative fails to meet the RAO for soil at the site.

The following estimated costs and durations are associated with Alternative 1:

Capital Cost: $0 K
Total Operation and Maintenance Costs: $0 K
Present Worth Cost: $0 K
Time to Implement: 0 Months
Time to Achieve RAO: (would not be met in the foreseeable future).

Alternative 2 – Excavation and Off-Site Disposal

This alternative would involve excavation of the contaminated soil, waste characterization, and transportation to a local non-hazardous waste landfill. The contaminated area would be marked in the field based on the delineation sampling. Initial excavation to a depth of 18 inches would be conducted using a bulldozer and excavator. Soil removal would progress both laterally and vertically as needed based on verification sampling.

Verification samples would be collected from the excavation floor using the USACE guidance for incremental sampling approach. A total of 30 to 100 incremental samples will be collected from each sample unit, to be determined based on the statistical approach outlined in the USACE Interim Guidance 09-02 (July, 2009). The sample unit will be defined as a 20 ft by 20 ft area, consistent with the sample area currently being used at other remediation sites at Plum Brook for excavation verification. Excavation wall samples will also be collected using the incremental sampling approach. Each unit area will be defined by 20 linear feet of exaction wall, consistent with current site practices as negotiated with the Ohio EPA. Samples will be analyzed on-site using a portable GC unit. Duplicate samples will be sent to an off-site laboratory at a rate of 10% for quality assurance.

The cost estimate for Alternative 2 discussed later in this document is based on an excavation to 36 inches; however, excavation would be conducted in 18-inch lifts to potentially reduce soil volumes.

Soil would be characterized to ensure that the waste meets the requirements for a local sanitary landfill, and transported in accordance with state, federal, and local requirements.

Soil backfill material would be selected from either on-Base or off-Base sources. Soil backfill would be used to regrade the excavated site. Once the backfill material is placed and graded, the site would be reseeded.

As a component of this alternative, ambient air monitoring would be performed at the perimeter of the excavation area. The purpose of air monitoring is to protect the health of site workers, and to assess off-site migration of contaminants

The following estimated costs and durations are associated with Alternative 2:

Capital Cost: $2.0M
Annual Operation and Maintenance Costs: $0
Present Worth Costs: $2.0M
Time to Implement: 6 Months
Time to Achieve RAO: 6 Months.

Alternative 3 – In-situ Remediation, MuniRem®

Alternative 3 involves in-situ remediation using MuniRem® powder. MuniRem® would be spread over the surface area to be remediated and then mixed into the soil with a tiller/rotovator. Several passes with the tiller would likely be required to ensure thorough mixing of the agent. The tilled area would be sprayed with water as needed to encourage agent mixing and maximum reaction with the contaminant. The soil would be remediated within the footprint of the contaminated area; however, the process would require excavation from one area within the contamination footprint and redisposition within an adjacent area for treatment. Soil would be remediated in 9-inch lifts to be effective. This method would also incorporate the procedures outlined in Alternative 2 for vertical and horizontal delineation of the contaminated area and depth.

Prior to full-scale remediation of the AA2 soil, a test plot would be remediated to evaluate optimum soil to MuniRem® proportions, optimum moisture content, frequency and amount of mixing required, and length of time needed to meet remediation goals. Frequent samples would be collected and analyzed on-site during this phase to evaluate progress and effectiveness of the various parameters.

The contaminated area would be subdivided into 10 equal sized areas from left to right or right to left and designated as areas 1-10. The soil from areas 1 and 10 would be excavated and stockpiled on a liner and covered adjacent to areas 5 and 6. Soil from area 2 would be moved into the Area 1 excavation in 9-inch lifts and evenly spread over the Area 1 excavation. This soil would be remediated with MuniRem® as described above. While this area is being tilled and remediated, soil from area 9 would be moved into area 10 for similar remediation. Tiller and excavator would rotate sides and slowly add lifts and work from area to area until areas 5 and 6 have been excavated. At that point the stockpiled soil from areas 1 and 10 would be placed in areas 5 and 6 for remediation.

Samples of the tilled soil would be collected and field screened to evaluate the effectiveness of the remediation. Field screening will incorporate the incremental sampling methodology to ensure more accurate results. Based on field screening results, additional rounds of remediation may be required to achieve the remediation objectives. The soil would be left in place and graded for final seeding of the area.

The following estimated costs and durations are associated with Alternative 3:

Capital Cost: $2.3M – $4.3M
Annual Operation and Maintenance Costs: $0
Present Worth Costs: $2.3M – 4.3M
Time to Implement: 8-20 Months
Time to Achieve RAO: 8-20 Months.

Alternative 4 – Ex-situ Remediation, Enhanced Bioremediation

This alternative would involve excavation and on-site remediation of soil using enhanced bioremediation. This alternative would involve working the soil in windrows to affect both aerobic and anaerobic conditions as needed to degrade the PCBs. This approach would consist of adding nutrients and moisture to the soil as well as periodic aeration. Contaminated soils would be placed in an area capable of handling 9200 CY of soil. This would involve using the existing compost area at Pentolite Road and development of a new pad at the AA3 site. The new area would be 296 ft wide by 260 ft long, capable of accommodating 13 windrows each 12 ft wide by 200 ft long, and 6 ft high. Ten similar windrows would be accommodated at the existing pad. The windrows would be mixed three times each week to aerate and stimulate microbial activity. Anaerobic conditions would be created by adding molasses. Moisture content would be maintained at approximately 18 percent.

Contaminated soil would be excavated and transported to the on-site remediation areas. This method would also incorporate the procedures outlined in Alternative 2 for vertical and horizontal delineation of the contaminated area and depth. The remediated soil would be tested to verify PCB remediation goals had been achieved and then placed back in the excavation, graded, and seeded. Testing would incorporate the incremental sampling methodology to ensure accurate results.

The following estimated costs and durations are associated with Alternative 4:

Capital Cost: $2.0M - $2.9M
Annual Operation and Maintenance Costs: $0
Present Worth Costs: $2.0M-$2.9M
Time to Implement: 15-26 Months
Time to Achieve RAO: 15-26 Months.

Alternative 5 – Incineration

This alternative would involve excavation of the contaminated soil, waste characterization, and transportation to a TSCA permitted incinerator. The contaminated area would be marked in the field based on the delineation sampling and vertical and lateral delineation verification will be conducted as outlined in Alternative 2. The cost estimate for Alternative 5 discussed later in this document is based on an excavation to 36 inches; however, excavation would be conducted in 18-inch lifts to potentially reduce soil volumes.

The excavated soil would be loaded into roll-off boxes at the site and transported to a rail yard in Willard, Ohio for rail shipment to the Triad Rail Spur in Houston, Texas. The roll-off boxes would be off-loaded and transported by truck to the TSCA incinerator managed by Veolia Environmental Services, in Port Arthur, Texas.

Veolia Services can handle approximately 15 roll-off boxes per week. A maximum of six roll-off boxes can be stacked on a single flat bed rail car; therefore, this alternative would utilize a shipment rate of two railcars per week, or 12 roll-off boxes per week.

Soil backfill material for the excavation at the site would be selected from either on-Base or off-Base sources. Soil backfill would be used to regrade the excavated site. Once the backfill material is placed and graded, the site would be reseeded.

As a component of this alternative, ambient air monitoring would be performed at the perimeter of the excavation area. The purpose of air monitoring is to protect the health of site workers, and to assess off-site migration of contaminants.

The following estimated costs and durations are associated with Alternative 5:

Capital Cost: $19.7M
Annual Operation and Maintenance Costs: $0
Present Worth Costs: $19.7M
Time to Implement: 24 Months
Time to Achieve RAO: 24 Months.

Evaluation of the Alternatives

Each of the remedial alternatives for AA2 soil was evaluated with respect to the following nine criteria, as required by the NCP at 40 Code of Federal Regulations 300.430 (e)(9)(iii). Criteria 1 and 2 are the threshold criteria, which must be met; criteria 3 through 7 are the primary balancing criteria; and criteria 8 and 9 are the modifying criteria.

Threshold Criteria

1. Overall Protectiveness of Human Health and the Environment
2. Compliance with ARARs

Primary Balancing Criteria

3. Long-Term Effectiveness and Permanence
4. Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment
5. Short-Term Effectiveness
6. Implementability
7. Cost

Modifying Criteria

8. State Support/Agency Acceptance
9. Community Acceptance.

The threshold criteria are requirements that a remedial alternative must meet to be eligible for selection. The five primary balancing criteria are used to determine the trade-offs between alternatives. The modifying criteria are public and state acceptance. Although the public and the State of Ohio have had opportunity for input throughout the AA2 RI/FS process and have previously accepted these technologies for other PBOW sites, these criteria are not finalized until conclusion of the public comment period on the AA2 Proposed Plan.

Threshold Criteria. Each of the four action-based alternatives (i.e., Alternatives 2 through 5) meet the threshold criteria for protection of human health and the environment and compliance with ARARs. Alternative 1, no action, does not meet the threshold criterion for protection of human health and the environment. Thus, Alternative 1 is not regarded as viable for AA2 and is not further discussed in this evaluation of alternatives.

Primary Balancing Criteria. Alternatives 2 through 4 are equally effective in the long term because the contaminated soil would be treated and/or taken off site. Alternatives 3 through 5 would meet the preference for treatment technologies that result in a reduction in toxicity, mobility, or volume. Alternative 2 relies only on off-site disposal and long-term management of contaminated material at a local non-hazardous landfill.

The four action-based alternatives could be performed in 24 months or less upon commencement of field remediation activities. Alternative 2 is estimated to take the shortest duration (6 months). Alternative 3 could be performed within 8 months if the process can be performed successfully as proposed, but could take up to 20 months if certain process variables need to be increased to meet the RAOs. Alternative 4 could be performed within 15 months if the process can be performed successfully, as demonstrated in previous studies, but could take up to 26 months if certain process variables need to be increased to meet the RAOs. Alternative 5 would require 24 months to complete site remediation.

Alternatives 2 through 5 can all be carried out safely without appreciable risk to remediation workers, NASA employees, or nearby residents. Alternatives 2 and 5 require the transportation of contaminated material outside of the PBOW boundary; however procedures can be implemented to eliminate potential exposure to the public. Alternatives 3 and 4 maintain handling and transportation of contaminated material within the PBOW boundary.

Alternatives 2 and 5 represent proven technological approaches and each is regarded as implementable. Alternatives 3 and 4 are emerging technologies that have been demonstrated to reduce PCBs in soil in small scale studies, but there are uncertainties associated with each technology. There are concerns with Alternative 3 relative to the ability to adequately mix the product with all of the soil and effectively introduce the product to the interior portions of soil clumps. Additional soil working or smaller lifts may be required. Prior to full-scale implementation of this technology at AA2, an in-situ treatability study should be performed on a small test plot at the site prior to finalizing the proposed plan.

There are concerns with Alternative 4, that the soil remediated during prior studies did not have PCB concentrations as high as the soil at AA2. In order for this technology to be successful at AA2, a reduction of up to 96 percent would be required. It is also unclear what the optimum ratios of amendments to soil would be for the AA2 soil, or what the optimum aerobic/anaerobic cycle time would be for AA2 soil. Prior to full-scale implementation of this technology, an on-site pilot study should be performed to evaluate effectiveness and to optimize the process variables prior to finalizing the proposed plan.

Costs for the four action-based alternatives are as follows, from least to most expensive:

- Alternative 2 – $2.0M
- Alternative 4 – $2.0M - $2.9M (pilot study - $258,000)
- Alternative 3 – $2.3M – $4.3M (pilot study - $91,000)
- Alternative 5 – $19.7M

Because of the uncertainties associated with Alternatives 3 and 4, cost contingencies were added to account for potential increases in the process variables, which are reflected in the range of costs presented above. The cost for conducting a pilot study to evaluate the effectiveness of Alternatives 3 and 4 are also included above.

Modifying Criteria. The two modifying criteria, state acceptance and public acceptance, are not fully evaluated until the Responsiveness Summary of the Decision Document is complete. The evaluation in the Responsiveness Summary is based on state comment on the Proposed Plan, state comment during the public meeting and comment period, and public comment during the public meeting and public comment period.

It is noted that each of the technologies represented by the four action-based alternatives have been presented to the State of Ohio and public in the past. Neither the State of Ohio nor the public has expressed concern over any of these technologies. Off-site transportation, disposal at the local landfill, and composting, and on-site treatment have been employed at different PBOW sites after approval by the public and state. No objections were expressed by the public or the State of Ohio to any of the technologies presented, either during the meeting or during the public comment period for the various remediation projects previously conducted at PBOW. However, it is emphasized that evaluation of the modifying criteria for the preferred alternative for AA2 will be completed in the Responsiveness Summary of the AA2 Decision Document, based on public and state input provided specifically during the AA2 public meeting and public comment period.

Summary of the Preferred Alternative

Alternative 2: Excavation and Off-Site Disposal, is selected as the preferred remedial alternative for AA2 soil.

Alternative 2 is recommended over Alternative 1 because Alternative 1 does not meet the threshold criterion of protecting human health and the environment.

Alternative 2 is recommended over Alternatives 3 and 4 because it is a proven alternative that has no uncertainties regarding implementation. Although Alternative 2 does not meet the preference for reduction in toxicity or contaminant volume, it does allow for reduction in mobility, as the materials will be managed in a controlled environment.

Alternative 2 ($2.0M) is recommended over Alternative 3 ($2.3M-$4.3M plus $91,000 pilot study), Alternative 4 ($2.0M - $2.9M plus $258,000 pilot study), and Alternative 5 ($19.7M) because it would cost less to implement.

Alternative 2 is the most cost-effective alternative based on an evaluation of the five primary balancing criteria used in the FS process. The USACE expects Alternative 2 to satisfy the following statutory requirements of CERCLA Section 121(b): (1) be protective of human health and the environment; (2) comply with ARARs; (3) be cost effective; (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (5) satisfy the preference for treatment as a principal element or explain why the preference for treatment will not be met. Although Alternative 2 does not meet the criteria in items 4 and 5 above, it has been chosen based on cost, timeliness, and demonstrated effectiveness. The uncertainties associated with Alternatives 3 and 4 and the potential for significant cost escalation do not warrant further consideration.

The Preferred Alternative is subject to change after the public comment period as the result of input by the State of Ohio or the public. This change would be reflected in the AA2 Decision Document, and the comment(s) providing the basis for such change would be recorded in the Responsiveness Summary of the Decision Document.

Community Participation

A level of community relations activities that is consistent with CERCLA, SARA, and the NCP is required for DERP-FUDS projects. The objective of the community relations program at PBOW is to provide a mechanism for the communication and exchange of information among Army agencies, government agencies, and residents of local communities and those adjacent to Plum Brook downgradient from PBOW. In January 1997, a Restoration Advisory Board composed of local citizens with varying backgrounds, along with members from the USACE, NASA, and the Ohio EPA, was established to promote a two-way dialog to keep local citizens informed about site progress and to allow them the opportunity to provide input to DERP-FUDS project decisions. The USACE and Restoration Advisory Board follow the community relations plan, which was developed in 1999 and is updated each year.

In compliance with CERCLA (Section 113), the USACE has developed the AR file to provide documentation as to how and why decisions specific to the remediation of the site are made. The AR file contains these final documents as well as all others for the PBOW site. Currently, these final documents are located in the AR file at the USACE Huntington District Office (Huntington, West Virginia) and at the Public Repository located at the BGSU Firelands Library (Huron, Ohio). A request for visitors access must be made at least 24 hours in advance in order to access the AR files stored in the Huntington District Office. The request can be made to the Project Manager (see contact information at the bottom of page 1). All documents are available for public viewing at the Firelands Library, at the USACE Huntington District Office, and at the following Web site:
http://www.lrh.usace.army.mil/Missions/CurrentProjects/DERPFUDSWVOWPBOWWVMA/PlumBrookOrdnanceWorks/Documents.aspx

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ACRONYMS AND ABBREVIATIONS

ACRONYMS AND ABBREVIATIONS

Common acronyms and abbreviations used in this Proposed Plan are defined below:

AR	Administrative Record
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BGSU	Bowling Green State University
BHHRA	baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (also referred to as "Superfund")
COC	chemical of concern
COPEC	chemical of potential ecological concern
DERP-FUDS	Defense Environmental Restoration Program-Formerly Used Defense Sites
DNT	dinitrotoluene
DoD	U.S. Department of Defense
EHQ	ecological hazard quotient
FFS	focused feasibility study
FS	feasibility study
HI	hazard index
ILCR	incremental lifetime cancer risk
Jacobs	Jacobs Engineering Group, Inc.
mg/kg	milligram per kilogram
NASA	National Aeronautics and Space Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NTCRA	non-time-critical removal action
Ohio EPA	Ohio Environmental Protection Agency
PA	preliminary assessment
PAH	polycyclic aromatic hydrocarbon
PBOW	Plum Brook Ordnance Works
PCB	polychlorinated biphenyl
PRRWP	Pentolite Road Red Water Pond
R2BG	Reservoir No. 2 Burning Ground
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RG	remedial goal
RI	remedial investigation
SARA	Superfund Amendments and Reauthorization Act of 1986
SLERA	screening level ecological risk assessment
TNT	trinitrotoluene
TNTA	TNT Area A
TNTB	TNT Area B
TNTC	TNT Area C
TSCA	Toxic Substances Control Act
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
WARWP	West Area Red Water Pond

TABLES

Table 1
Summary of Total Hazard Index and Total Cancer Risk from Chemicals of Potential Concern[a]
Acid Area 2, Plum Brook Ordnance Works, Sandusky, Ohio

	Groundskeeper		**Indoor Worker**		**Adult Hunter**		**Construction Worker**		**On-Site Resident[b]**	
Contaminant Source	Total Hi[c]	Total ILCR[d]	Total HI	Total ILCR	Total HI	Total ILCR	Total HI	Total ILCR	Total HI	Total ILCR
Surface Soil	1.0	*4.53E-05*	0.5	*2.24E-05*	0.1	6.38E-06	***7.4***	7.21E-06	***13.3***	***2.70E-04***
Subsurface soil	NA[e]	NA	NA	NA	NA	NA	***2.2***	3.16E-06	***4.4***	***1.20E-04***
Total Soil[f]	NA	NA	NA	NA	NA	NA	***7.4***	*7.21E-06*	***13.3***	***2.70E-04***
Surface Water	NA	NA	NA	NA	NA	NA	0.004	7.64E-09	0.002	1.56E-07
Sediment	NA	NA	NA	NA	NA	NA	0.7	4.79E-07	0.3	*1.20E-05*
Groundwater	NA	NA	***1.9***	*4.63E-05*	NA	NA	NA	NA	***13.1***	***2.02E-04***
Total across all media	1.0	*4.53E-05*	***2.4***	*6.87E-05*	0.1	6.38E-06	***8.1***	7.70E-06	***26.7***	***4.84E-04***

a The values shown are based on information contained in the text, tables, and appendices of the BHHRA (Jacobs, 2008).
b The BHHRA includes both a childhood and adult resident exposure scenarios. For noncancer effects, the HI value (see footnote c) for childhood exposure is shown for Total HI because it is higher (more health protective) than the adult value from the BHHRA. The Total ILCR (see footnote d) is the summed ILCR values for both child and adult scenarios which, unlike noncancer HI values, are regarded as additive throughout the lifetime of an individual.
c The hazard index (HI) is a measure of noncancer hazard for an exposed individual.
d The incremental lifetime cancer risk (ILCR) is the estimated extra cancer risk which an individual encounters based on exposure to a site.
e NA = Not applicable.
f For soil exposure, either surface soil or subsurface soil exposure was assumed in this sum, whichever would lead to a higher Total HI and Total ILCR. Summed totals are rounded to one significant figure.

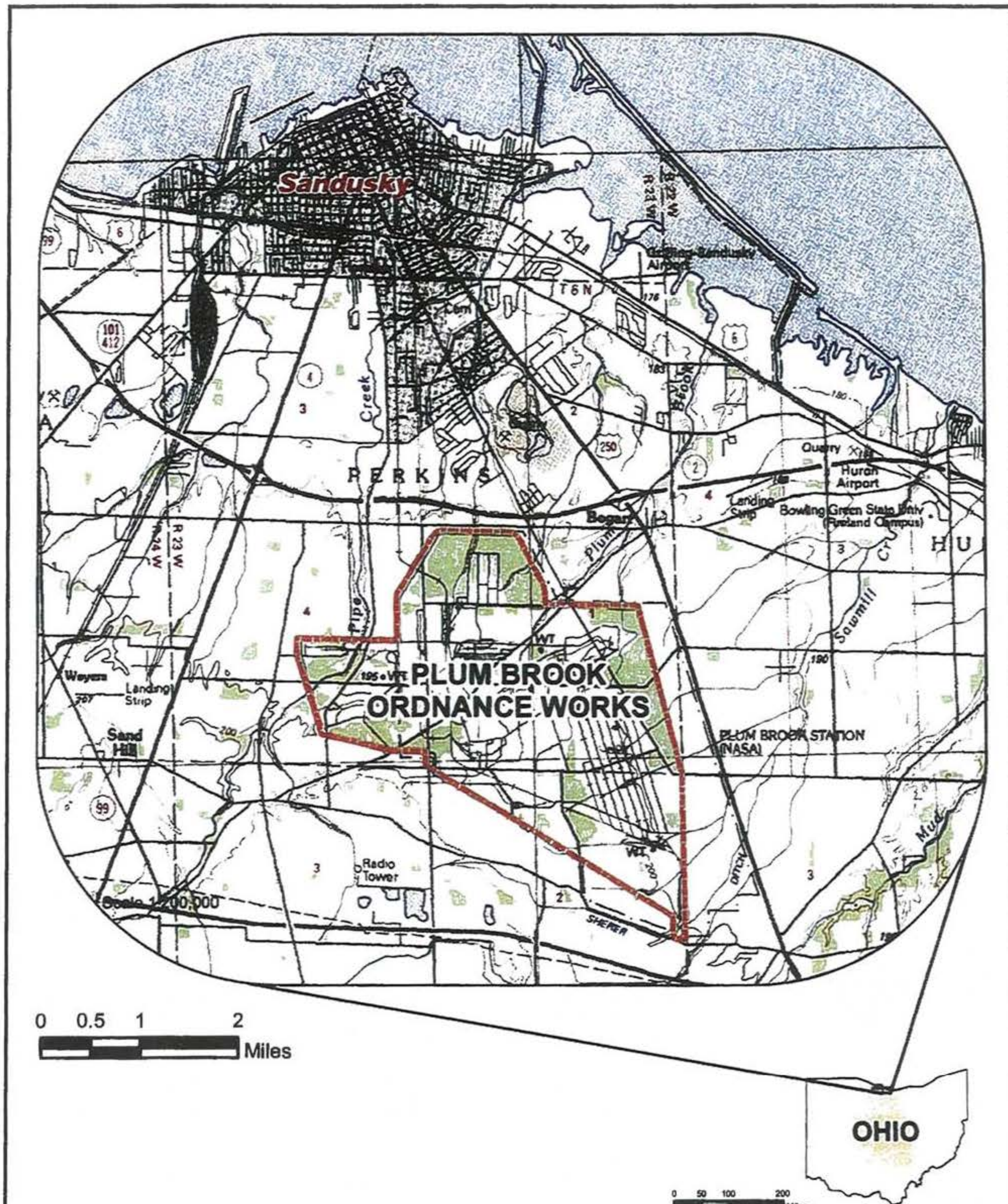
Notes:
1. HI values equal to or less than 1 are unlikely to result in adverse noncancer human health effects for any member of the exposed population and are regarded as acceptable.
2. ILCR values equal to or less than 1E-5 (1 in 100,000) are generally regarded by the Ohio Environmental Protection Agency (OEPA) as acceptable.
3. The NCP identifies ILCR values less than 1E-6 (1 in 1,000,000) as negligible, and ILCR values of 1E-6 (1 in 1,000,000) through 1E-4 (1 in 10,000) are within the NCP acceptable range. It is noted that the average lifetime cancer risk of the general U.S. population is approximately 40,000 in 100,000.
4. *Italics* (non-bolded) apply only to cancer risks and indicate that the value exceeds the the 1E-5 value that is regarded as acceptable by the OEPA.
5. ***Bold intalics*** indicates that the noncancer hazard is unacceptable, or that the cancer risk value exceeds the NCP acceptable range (1E-6 to 1E-4).
6. An adult and child venison consumer were also evaluated for AA2. Cancer risks were less than 1E-6 and potential noncancer hazards less than 0.001 for both receptors

Table 2
Summary of Screening-Level Ecological Risk Assessment
Acid Area 2, Former Plum Brook Ordnance Works
Sandusky, Ohio

Risk Driving Chemical[a]	Minimum Ecological Hazard Quotient (receptor)[b]	Maximum Ecological Hazard Quotient (receptor)[c]
2,4-Dinitrotoluene	1 (deer, hawk)	200 (mouse)
Lead	0.1 (hawk)	500 (racoon)
Thallium	0.04 (deer)	900 (racoon)
PCB-1254	0.08 (deer)	100,000 (racoon)
PCB-1260	1000 (deer)	400,000 (mouse)
Benzo(a)anthracene	0.008 (deer, hawk)	40 (racoon)
Benzo(a)pyrene	0.008 (deer)	30 (racoon)
Chrysene	0.008 (deer)	40 (racoon)

a Chemicals shown are those which are site related and have an ecological hazard quotient greater than 10 in at least one receptor.
b Receptor associated with the minimum ecological hazard quotient is shown in parentheses.
c Receptor associated with the maximum ecological hazard quotient is shown in parentheses.

FIGURES



Legend

Plum Brook Ordnance Works Boundary

N

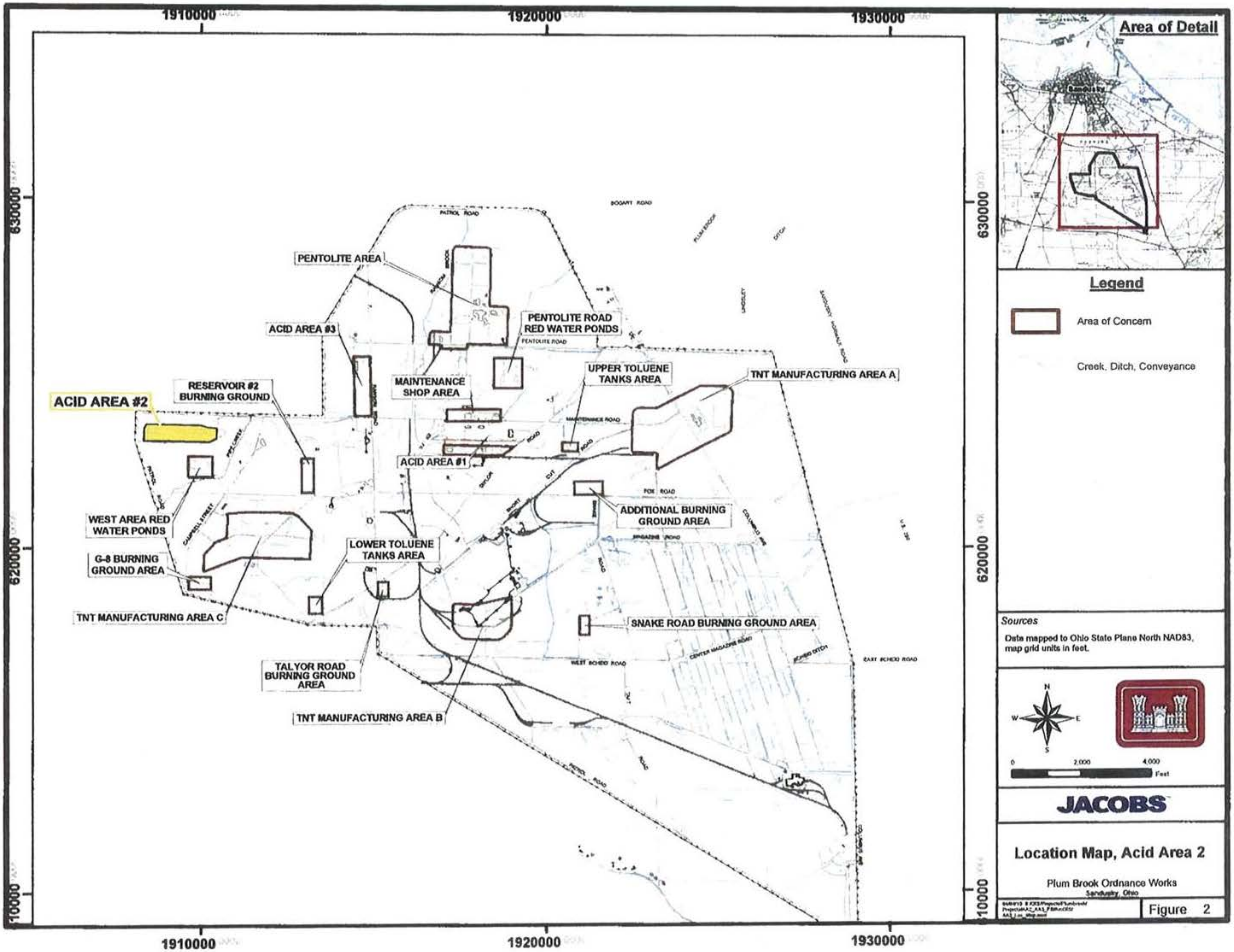
JACOBS

Location Map,
Plum Brook Ordnance Works
Sandusky, Ohio

Plumbrook Ordnance Works
Sandusky, Ohio

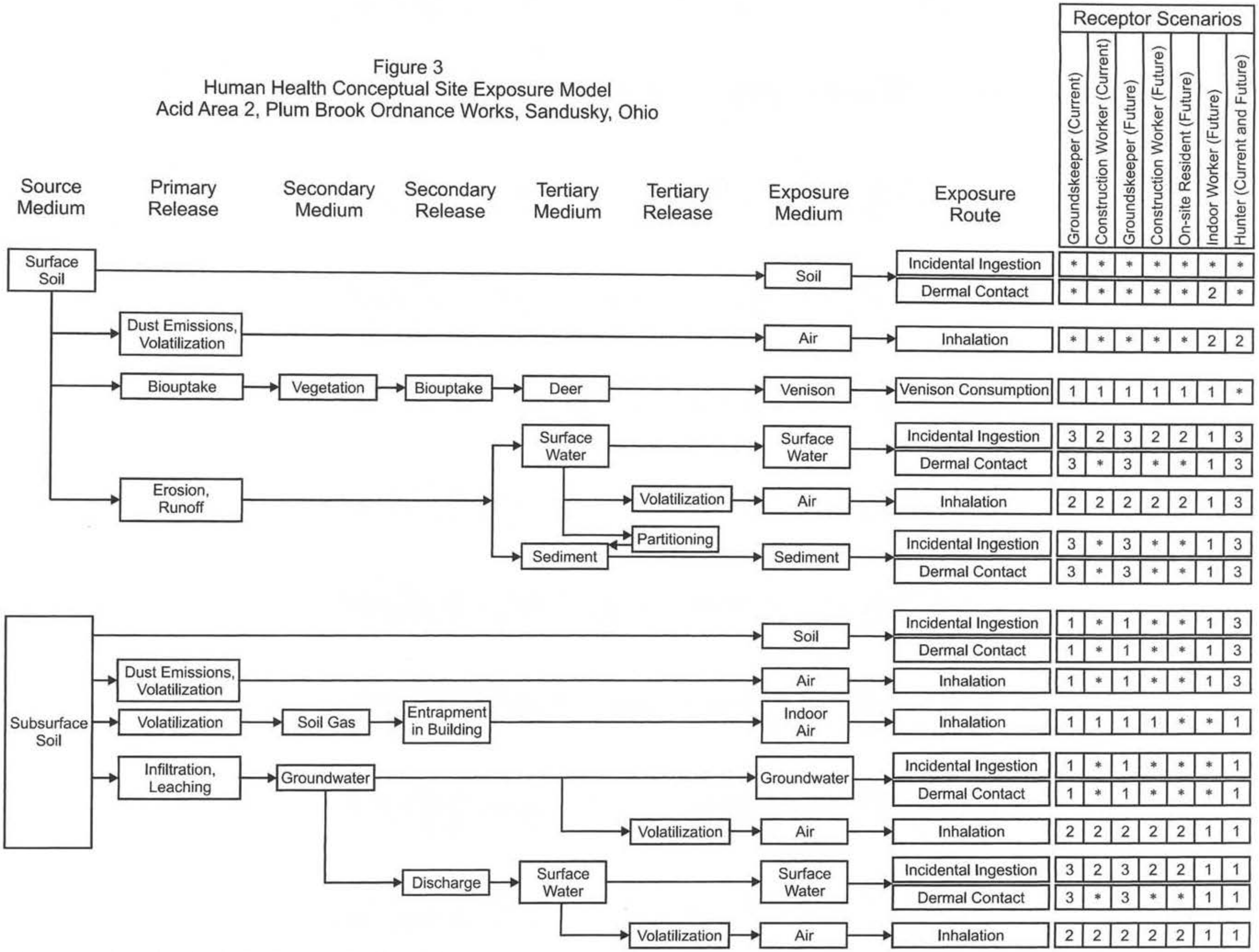
04/04/10 S:/GIS/Projects/Plumbrook/
Projects/AA2_AA3_FS/ArcGIS/
PBOW_Site_Location.mxd

Figure 1



1910000
1920000
1930000
630000
620000
610000
Area of Detail
Sandusky
Legend
Area of Concern
Creek, Ditch, Conveyance
ACID AREA #2
PENTOLITE AREA
ACID AREA #3
PENTOLITE ROAD RED WATER PONDS
RESERVOIR #2 BURNING GROUND
MAINTENANCE SHOP AREA
UPPER TOLUENE TANKS AREA
TNT MANUFACTURING AREA A
ACID AREA #1
ADDITIONAL BURNING GROUND AREA
WEST AREA RED WATER PONDS
G-8 BURNING GROUND AREA
LOWER TOLUENE TANKS AREA
TNT MANUFACTURING AREA C
SNAKE ROAD BURNING GROUND AREA
TALYOR ROAD BURNING GROUND AREA
TNT MANUFACTURING AREA B
PATROL ROAD
BOGART ROAD
PENTOLITE ROAD
MAINTENANCE ROAD
FOX ROAD
MAGAZINE ROAD
WEST SCHEID ROAD
EAST SCHEID ROAD
CENTER MAGAZINE ROAD
CAMPBELL STREET
Sources
Data mapped to Ohio State Plane North NAD83, map grid units in feet.
N
S
E
W
0
2,000
4,000
Feet
JACOBS
Location Map, Acid Area 2
Plum Brook Ordnance Works
Sandusky, Ohio
Figure 2

Figure 3
Human Health Conceptual Site Exposure Model
Acid Area 2, Plum Brook Ordnance Works, Sandusky, Ohio



* = Complete exposure route quantified in the risk assessment.
1 = There is no plausible pathway for exposure in this medium.
2 = Although theoretically complete, this pathway in not quantified as explained in text.
3 = Contact with this medium, although plausible, is not part of this receptor's normal or expected activities; therefore, contact would be sporadic and is not quantified.

Figure 4

Simplified Terrestrial Food Web Conceptual Site Model (CSM)
Plum Brook Ordinance Works, Sandusky, Ohio

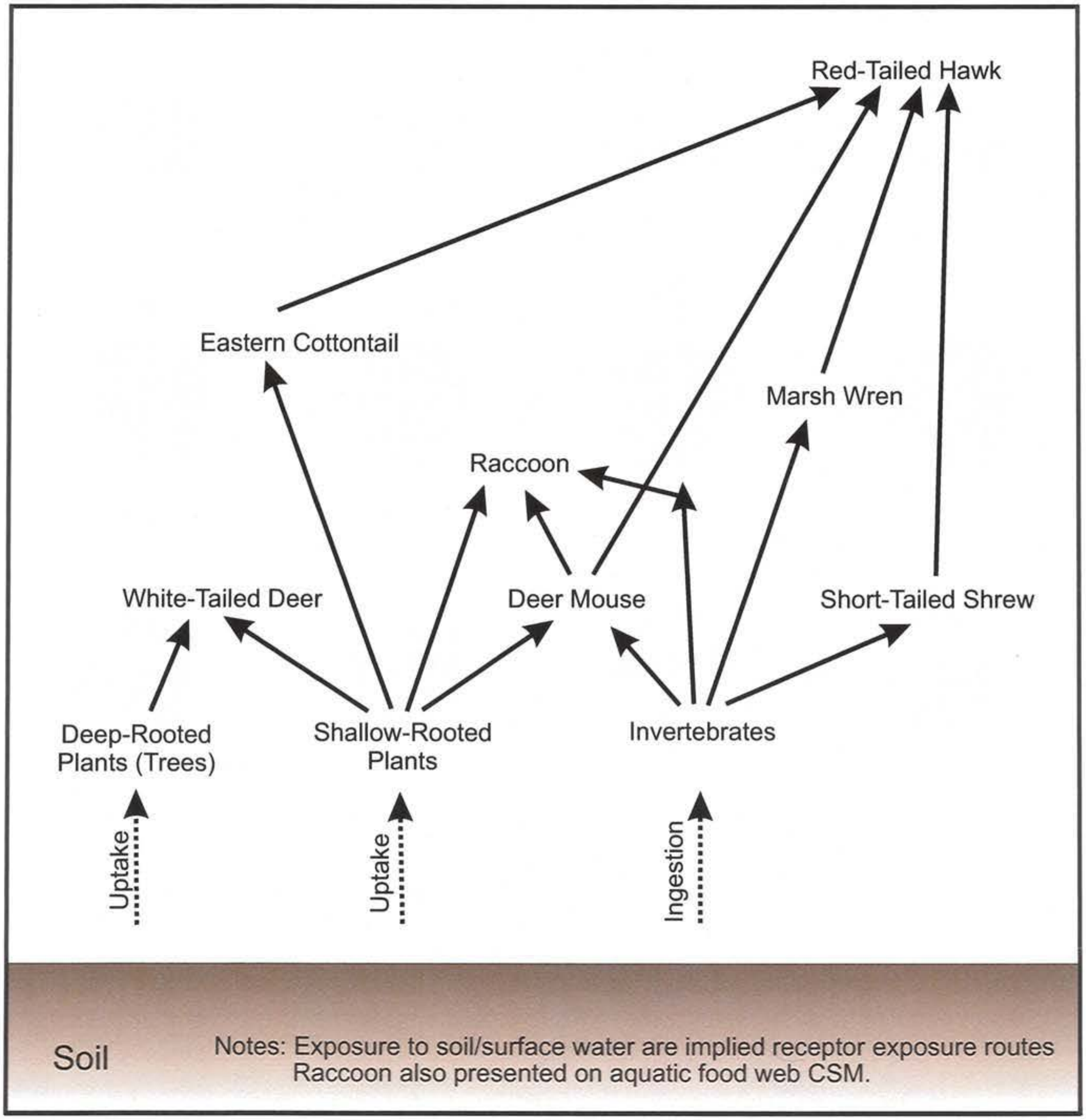
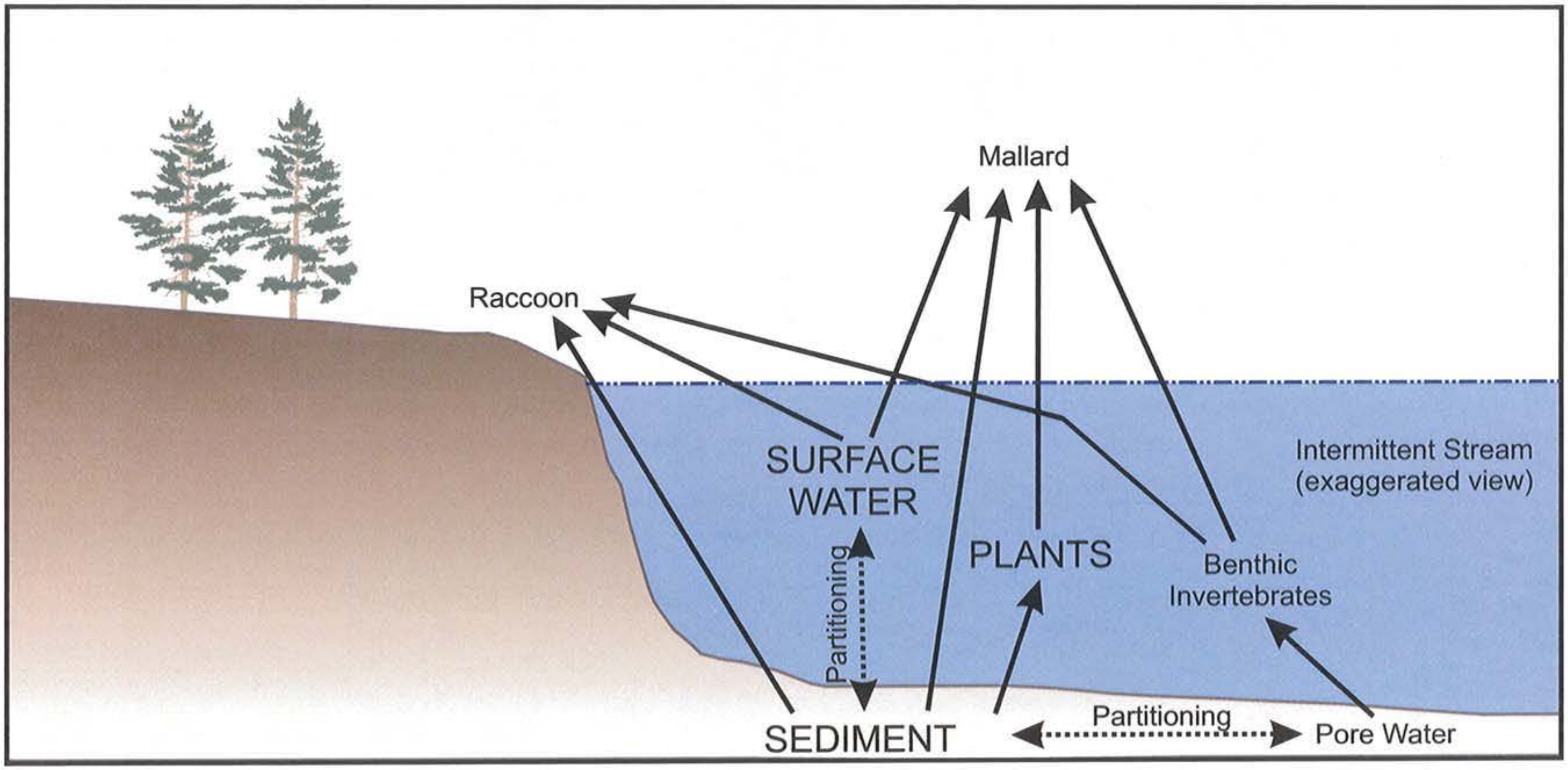
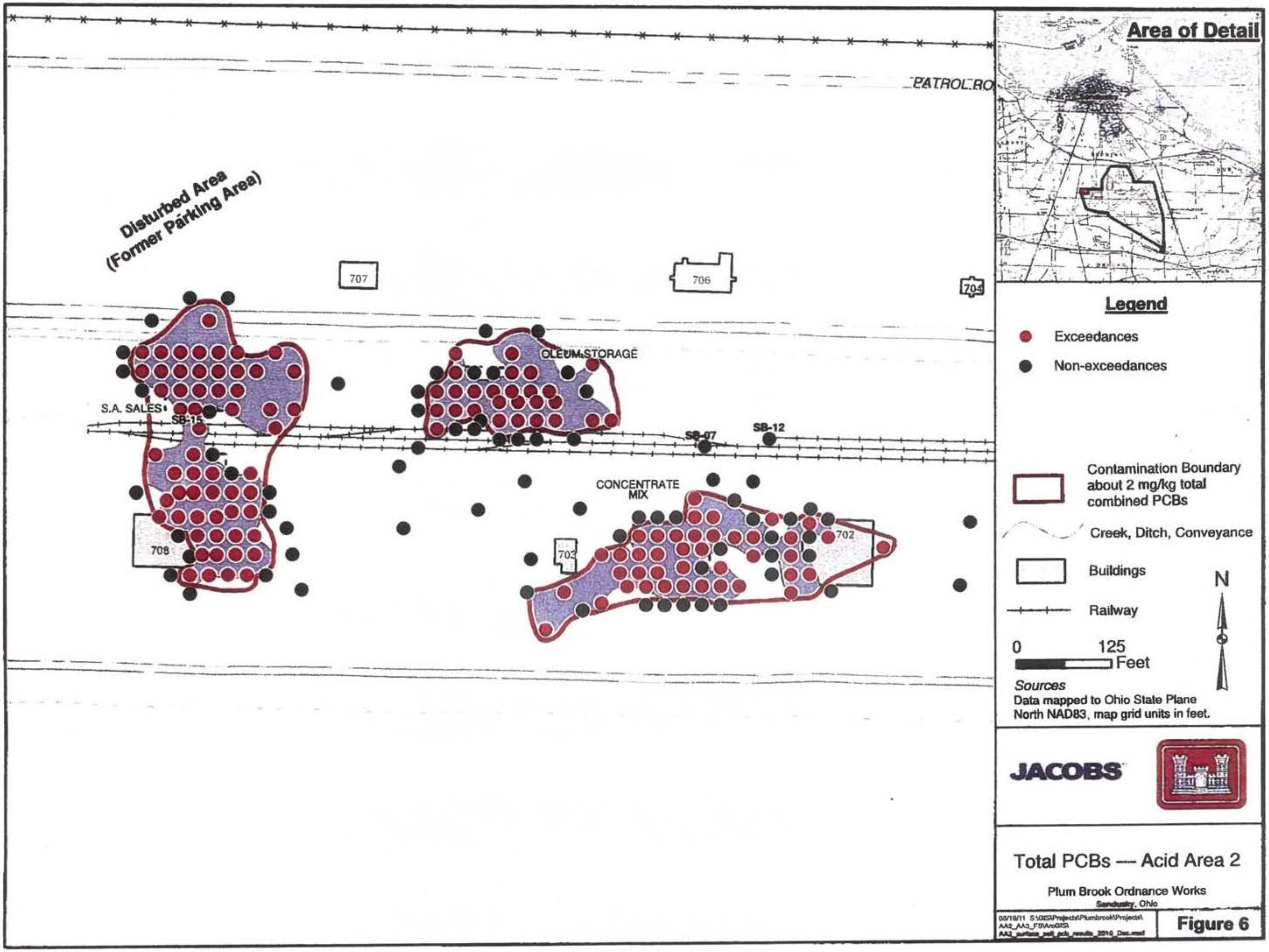


Figure 5

Simplified Aquatic Food Web Conceptual Site Model (CSM)
Plum Brook Ordinance Works, Sandusky, Ohio



Notes: Raccoon also presented on terrestrial food web CSM.


Area of Detail
PATROL RO
Disturbed Area
(Former Parking Area)
707
706
704
OLEUM STORAGE
S.A. SALES
SB-15
SB-07
SB-12
CONCENTRATE MIX
702
703
708
Legend
Exceedances
Non-exceedances
Contamination Boundary about 2 mg/kg total combined PCBs
Creek, Ditch, Conveyance
Buildings
Railway
0
125
Feet
N
Sources
Data mapped to Ohio State Plane North NAD83, map grid units in feet.
JACOBS
Total PCBs — Acid Area 2
Plum Brook Ordnance Works
Sandusky, Ohio
Figure 6