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Engineering a Sustainable Future

EPA Region 1 RAC 2 Contract No. EP-S1-06-03

April 5, 2013
Nobis Project No. 80022

Via Electronic Submittal

U.S. Environmental Protection Agency, Region 1
Attention: Mr. Daniel Keefe, Task Order Project Officer
5 Post Office Square, Suite 100
Boston, Massachusetts 02109-3919

Subject: Transmittal of Draft Final DNAPL Extraction System Evaluation Report
Nyanza Chemical Waste Dump Superfund Site – Operable Unit 2,
Ashland, Massachusetts
Remedial Action
Task Order No. 0022-RA-RA-0115

Dear Mr. Keefe:

Enclosed is the Draft Final DNAPL Extraction System Evaluation Report for the Nyanza Chemical Waste Dump Superfund Site, Operable Unit 2, located in Ashland, Massachusetts.

Should you have any questions or comments, please contact me at (603) 724-6238, or jmccullough@nobiseng.com.

Sincerely,

NOBIS ENGINEERING, INC.

Jeff A. McCullough, P.E.
Project Manager

Enclosure

c: Dave Buckley, MassDEP
File 80022/NH

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Engineering a Sustainable Future

Draft Final DNAPL Extraction System Evaluation

Nyanza Chemical Waste Dump – Operable Unit 2 Ashland, Massachusetts

Remedial Action
EPA Task Order No. 0022-RA-RA-0115

REMEDIAL ACTION CONTRACT No. EP-S1-06-03

FOR

US Environmental Protection Agency Region 1

BY

Nobis Engineering, Inc.

Nobis Project No. 80022

April 2013

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Nyanza Chemical Waste Dump – Operable Unit 2
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Jeff A. McCullough
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APPENDICES

1.0 INTRODUCTION

Nobis Engineering, Inc. (Nobis) prepared this DNAPL Extraction System Evaluation Report (Report) for the Nyanza Chemical Waste Dump Superfund Site, Operable Unit II (Nyanza OU2) located in Ashland, Massachusetts (Site). The Site location is depicted in Figure 1-1. This report evaluates three alternatives for removing dense non-aqueous phase liquid (DNAPL) from wells MW/B-11 and MW-113A.

This work was performed in accordance with the United States Environmental Protection Agency (EPA) Region I Remedial Action Contract 2, No. EP-S1-06-03, EPA Task Order No. 0022-RA-RA-0115, Amended Scope of Work (ASOW) dated March 23, 2012, Work Plan Amendment (WPA) No. 3 (Nobis Engineering, Inc, 2012).

1.1 Objective

The Task Order objective is to implement a Remedial Action (RA) for the Site that eliminates, reduces, or controls risks to human health and the environment. More specifically, the Task Order contemplates recovering Dense Non Aqueous Phase Liquid (DNAPL) through the use of multiple wellhead treatment systems. The most recent Task Order Amendment (WPA No. 3) extended the scope of groundwater monitoring, and expanded the area previously investigated in an effort to find additional locations where product recovery may be feasible. A secondary objective, made possible by the expansion of the groundwater monitoring program, is to evaluate the feasibility of Monitored Natural Attenuation (MNA) as an effective remedial alternative.

Tasks completed during the most recent (Fall 2012) field effort include:

- Completion of a supplemental step drilling investigation. This included the installation of new monitoring wells and the redevelopment of area-wide monitoring wells (the details of these activities have been reported under a separate report);
- Completion of a monitoring well location and elevation survey;
- Completion of a synoptic groundwater gaging round using all the monitoring wells on the Site;
- Analytical testing of groundwater collected from wells included in the work scope as Spring and Fall round monitoring wells; and

- Completion and submittal of the 2012 Groundwater Monitoring Report (separate report).

This DNAPL Extraction System Evaluation Report (Report) summarizes the above tasks are as the 2012 step drilling program throughout this report. Based on the 2012 step drilling program and historical Site sampling data, this Report presents the Conceptual Site Model; evaluates Corrective Action Alternatives and identifies several technologies for DNAPL extraction; and recommends an alternative for DNAPL extraction.

1.2 Site Location and Background

The former Nyanza facility is located on the north side of Megunko Road in the Town of Ashland, Middlesex County, Massachusetts (Figure 1-1). The current Site study area includes downgradient areas affected by shallow and deep groundwater contamination plumes located north and east of the former Nyanza facility and areas of contaminated sediment located in the Sudbury River. The Town of Ashland is located 25 miles west-southwest of Boston, and 20 miles east-southeast of Worcester, Massachusetts.

In 1994, DNAPL was discovered at the Worcester Air Conditioning (WAC) property, north of the Nyacol facility and across the railroad right of way. Potential DNAPL sources include:

- a former concrete "vault" adjacent to the main processing building of Nyanza, Inc., and used for solids separation prior to effluent discharge;
- two previously-used lined lagoons south of Megunko Road;
- two former settling ponds (1 and 2) south of Megunko Road between the lined lagoons and Trolley Brook;
- the former landfill on Megunko Hill;
- the former Chemical Brook; and
- Area E (the lower industrial area between Megunko Road and the railroad tracks).

Historically, EPA conducted groundwater monitoring at the Site two times per year between 1998 and 2004, and has recently reinstated the semi-annual monitoring events. Site monitoring wells and other features are presented in Figure 1-2. In addition to the recent groundwater monitoring events, other recent Site activity included two step-drilling investigations performed in 2009 and 2012, to evaluate DNAPL contamination at the WAC and Nyacol property, respectively.

A number of wells (historically up to 3), plus the newly-installed MW/B-11, have shown some evidence of DNAPL. However, based on recent well purging and evaluation of DNAPL recovery rates, only two of these wells are proposed for a DNAPL extraction system (MW113-A and MW/B-11). These two wells are located on opposite sides of the railroad tracks, are approximately 250 feet apart, and are both located downgradient from the former disposal vault. The intent of the DNAPL recovery is to encourage the DNAPL to flow toward these two primary wells for extraction and disposal.

2.0 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) for the Site is provided in the following subsections with a focus on the DNAPL source areas.

2.1 Contaminants of Concern

A number of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and metals have been detected in the soil and groundwater at the Site. The three most common VOCs include chlorobenzene; 1,1-dichloroethene (DCE); and trichloroethene (TCE). The five principal SVOCs include 1,2,4-trichlorobenzene (TCB); dichlorobenzenes (DCB); aniline; naphthalene; and nitrobenzene. The 10 metals most frequently detected include antimony, beryllium, cadmium, iron, lead, manganese, mercury, nickel, sodium, and thallium. Historically, DNAPL has been identified in wells MW-113A and RW-1 located on the WAC property. DNAPL was more recently identified in MW/B-11 and SB-600 on the Nyacol property at the conclusion of the 2012 Step-Drilling Program (see Figure 2-1).

2.2 Geology and Hydrogeology

Site geology and hydrogeology are summarized below.

2.2.1 Soil Characteristics

Soil thickness varies approximately from 3.5 feet (MW-502B) to 115 feet (MW-404A). The soil at the Site consists mainly of silty fine sand and sandy silt (corresponding to glaciolacustrine sediment) and fine to coarse sands with gravels/cobbles found at some locations (corresponding to glaciofluvial sediment) (Ebasco Services, 1991). The content of fines is in the range of 1.5% to 33.5%, with no significant trend with depth below ground surface (bgs).

2.2.2 Bedrock Characteristics

Figure 2-2 shows bedrock surface elevation contours in the vicinity of the identified DNAPL. The bedrock is highest at the Megunko Hill area and decreases radially out from the Hill into a valley in the lowlands before beginning to rise again on the north shore of the Sudbury River and Mill Pond. A meandering bedrock trough is located in the center of the dissolved phase plume, roughly parallel to the Sudbury River. Although based on limited data, Figure 2-2 depicts a depression in the vicinity of MW-113A. This depression may provide a natural accumulation area for DNAPL.

2.2.3 Hydrogeology

In general, overburden and bedrock groundwater flow from Megunko Hill is both northerly from the north side of Megunko Hill (toward the Railroad tracks and Pleasant Street, and easterly toward the Eastern Wetlands from the east side of Megunko Hill and the cap area. Figures 2-3 and 2-4 provide recent overburden and bedrock groundwater level maps, respectively. Flow in the lowland areas east of Megunko Hill (i.e., Eastern Wetland) is in a northeasterly direction, toward the Sudbury River. In the lowland areas north of Megunko Hill, overburden and bedrock groundwater flow is also in a northerly direction towards the Sudbury River. Downward gradients were observed over most of the Site, with upward gradients observed primarily at locations adjacent to the Sudbury River.

2.3 DNAPL Description

DNAPL has been observed in borings MW-113A and RW-1 north of the railway tracks (on WAC property). In addition, DNAPL has been observed south of the tracks in MW/B-11 and SB-600 (on Nyacol property). Both of these locations are down gradient from the former concrete vault (see Figure 2-1). DNAPL thickness ranged up to 4.4 feet of product; however, the measured thickness within a well casing is very likely significantly different from DNAPL thickness in the adjacent bedrock formation.

2.3.1 Potential DNAPL Source Areas

Historic DNAPL sources (on site) include a concrete solids separation vault adjacent to the main processing building of Nyanza, Inc.; two lined lagoons south of Megunko Road; two settling ponds (Pond 1 and Pond 2) south of Megunko Road between the lined lagoons and Trolley Brook; the dump on Megunko Hill; Chemical Brook; and Area E in the lower industrial area between Megunko Road and the railroad tracks. Based on available file information, such as observations of DNAPL during a 1988 Removal Action, as well as the current configuration of the groundwater plume, it seems plain that a significant source of DNAPL was the concrete vault.

2.3.2 DNAPL Characterization

DNAPL from MW-113A was analyzed during fall 2001 characterization activities (Arthur D. Little, 2002) and in 2012. The table below provides the approximate percentages of the primary components.

Compound Name	Percent of Total - 2002	Percent of Total - 2012
1,2-Dichlorobenzene	30.9%	5.6%
Nitrobenzene	28.0%	88.3%
1,4-Dichlorobenzene	10.6%	1.3%
Chlorobenzene	10.3%	1.6%
Trichloroethene	3.5%	1.1%
1,3-Dichlorobenzene	2.8%	0.3%
1,2,4-Trichlorobenzene	2.4%	1.8%

The 2012 DNAPL samples were dark brown/black in color and had a very strong almond-like chemical odor. Two DNAPL samples were collected in August 2012 and analyzed for VOCs and SVOCs and the results are presented in Tables 2-1 and 2-2. These recent results are similar to the findings from the 2001 sampling.

In December 2012, samples of water and DNAPL were collected from MW-113A and MW/B-11, and analyzed for a select list of physical parameters related to fate and transport processes. The density of the DNAPL is greater than water and similar to the densities of the individual dichlorobenzene compounds. The viscosity at 100° F is higher than that of water at the same temperature, suggesting that the DNAPL may penetrate a porous media less readily than water. The DNAPL surface tension is about half that of water at 25°C. In general, the greater the surface tension, the less likely an emulsion will form; the more stable emulsions will be, if formed; and the better the phase separation after mixing. For the DNAPL at the Site, emulsion formation will be minimized because only DNAPL extraction is proposed and mixing with water will be minimal. The sample did not flash at the upper temperature limit of the flashpoint test; therefore, it would not be characterized as flammable. The complete results are provided in Appendix A.

DNAPL thickness was measured regularly in 2012 and results are shown below (inches found).

Date	8/13/2012*	11/6/2012	11/09/2012	11/20/2012	12/05/2012	12/18/2012
Well ID						
RW-1	0	0	0	--	--	--
SB-600	0	6	4	5	5	--
MW-113A	0.5	10	28	22	33	24
MW/B-11	0	19	12	12	4	4
MW/B-5	0	0	0	--	--	--

Notes:

1 – DNAPL was initially observed while installing MW/B-11 and while developing monitoring wells SB-600, MW/B-11, and MW-113A in summer 2012.

2 – "—" means Not Gaged.

3 – DNAPL gaging on 8/13/12 was conducted using an interface probe. DNAPL gauging using a bailer proved to be more effective than the interface probe, and subsequent gauging rounds were completed by measuring inches of DNAPL smear or inches of recovered product on dedicated bailers lowered into each well during each gauging round.

2.4 Existing Infrastructure

Existing infrastructure will be used to the extent possible provided it does not infringe on the use of the property (such as day-to-day business operations) of the current tenants (i.e., Worcester Air Conditioning and Nyacol Nano Technologies). Existing infrastructure would include paved driveways for access to the extraction system locations and existing electrical service lines.

2.4.1 Access and Utilities

Aboveground wastewater piping restricts access at the Nyacol facility at the Site. During the 2012 step-drilling program, a facility plumber removed a section of the pipe temporarily to allow heavy equipment access to construct the extraction system. Access to the Nyacol facility will be taken into consideration when evaluating alternatives.

Existing buildings are not available for storing and repairing remedial system components; therefore, storage facilities will need to be constructed in locations that do not pose undue hardship to day-to-day business operations. Likewise, the system design assumes that tying into the existing electrical systems at the Nyacol facility and WAC is not an option and that any system will need to be self-powered. It is envisioned that a separate metered electrical service line will be connected to each extraction system for lighting and heating of the treatment system enclosure. The extraction system will itself be self-powered by a solar panel.

2.5 Current Wells with DNAPL

Of the four wells which had previously measureable amounts of DNAPL, only two (MW-113A and MW/B-11) are recommended for DNAPL recovery based recoverable thicknesses of DNAPL. These are both 2-inch diameter wells. MW-113A is on WAC property and is constructed of PVC. MW/B-11 is on Nyacol property and is constructed of stainless steel. MW-113A is screened from 46 feet to 51 feet bgs, slightly below the bedrock surface (43 feet bgs). The original borehole depth was 73 feet bgs and was backfilled to 55 feet bgs, thus leaving a 5-foot sump below the bottom of the screen. MW/B-11 is screened from 11.5 feet to 21.5 feet bgs with a 2-foot sump. The bedrock surface at MW/B-11 was encountered at approximately 9 feet bgs.

3.0 EVALUATION OF CORRECTIVE ACTION ALTERNATIVES

The remedial options considered involve DNAPL removal as outlined in the 2006 Explanation of Significant Differences (ESD) (U.S. EPA, 2006). Each remedial alternative is described in detail below, and then compared to the other alternatives (Section 3.2). As described in WPA No.3, the ESD and the Conceptual Design selected physical extraction of DNAPL from individual wellheads as the RA remedy. This evaluation report, detailed herein, finalizes the DNAPL extraction conceptual design through technology evaluation and selection.

3.1 Technology Evaluation

The three methods for removing DNAPL from the extraction wells are described here were evaluated in terms of their effectiveness (both short and long term), implementability, environmental impact, and cost. Table 3-1 compares all three technologies against the four evaluation criteria. These criteria were proposed in WPA No. 3 as a technology evaluation and the intent was not to complete a feasibility study for DNAPL extraction. The three methods evaluated for DNAPL extraction are submersible pumps, belt skimmer, and peristaltic pumping.

3.1.1 Submersible Pumps

The submersible pump uses compressed air (either bottled or compressed using a compressor) to operate a bladder pump. The bladder pump is designed with openings at the bottom so that the entry of water (instead of DNAPL) into the pump is minimized. The type of submersible pump evaluated was the Xitech system. This system was chosen because of its effectiveness and reliability.

The Xitech system includes: a controller which is set to the desired pumping time and number of cycles per day; the submersible pump and associated tubing; a product collection tank with a shutoff valve to prevent overflow; an air source; and a power source. The system may be connected to the existing Site electricity, or it may be operated using a solar panel and back-up battery. For this Site, the XiTech system is operated by a solar panel. System installation would be within a temporary enclosure that would require electrical grid power for heating and lighting.

The pump operates intermittently to remove product. The pump is set by recording the time required to pump the product off completely (when water appears), and then setting the pumping time to half that amount. Once the product recovery time is determined, the controller is set to that interval. Xitech suggests that the well may be emptied once per day for a slow-recovering DNAPL and 3-6 times per day for a fast-recovering DNAPL. Timers based on conductivity are not recommended because conductivity-based interface probes for determining DNAPL thickness performed poorly. The following discussion discusses the submersible pump in terms of the four evaluation criteria: effectiveness (both short and long term), implementability, environmental impact, and cost.

Effectiveness

The system is anticipated to be very effective at removing DNAPL. The submersible pump does not discriminate between DNAPL and water, so some system optimization may be required to minimize the amount of water removed along with the DNAPL. The relatively intensive intermittent pumping may improve DNAPL flow to the well. In the long term, the submersible pumps is very effective because requires little maintenance or equipment changeout.

Implementability

The system is readily implementable. Access to Nyacol property to move equipment and materials to the well area (MW/B-11) may be somewhat difficult because of existing structures. However; there is ample space at the well to construct the treatment system. At Nyacol, there are no overhead obstructions in the immediate vicinity to interfere with the solar panel. Equipment replacement parts can be transported to the target location with conventional equipment.

At WAC (MW-113A), by contrast, access to the treatment enclosure would not be an issue for construction vehicles, although there needs to be coordination with the active business to move existing storage equipment. Some obstructions to the solar panel (overhead trees) may need to be removed.

Building permits would be required for the enclosures and electrical power is needed for the enclosure (heating and lights). Disposal of DNAPL from the permanent storage tank could be implemented easily with transfer to a mobile waste tanker for off-site disposal.

Environmental Impact

Environmental impact of the system is minimal, especially if a solar-powered configuration is selected. The primary environmental impact would be travel to the Site to optimize the system and to pick up collected DNAPL by an approved disposal contractor.

Cost

The capital cost for the system would be comparable to other similar technologies. Routine system operations and maintenance O&M costs are anticipated to include: nitrogen (pump air supply); vapor-phase carbon replacements; DNAPL disposal; electrical and phone service; and weekly inspections. The disposal cost for the system takes into account the removal of some amount of water (which should be minimal with the proper pump extraction rate and frequency setting).

Conclusion

The submersible pump is a low-maintenance option which becomes more cost-effective over time.

3.1.2 Belt Skimmer

A belt skimmer consists of a rotating belt made of hydrophobic material which extends to the bottom of the extraction well. As the belt rotates, the (D)NAPL adhering to the belt is brought to the collection shed. The (D)NAPL is then wiped off the belt and directed to a collection container and the cleaned portion of the belt is returned down the well to pick up more material. The belt skimmer can be programmed to operate continuously or at set intervals. The type of belt skimmer evaluated was the PetroXtractor system. This system was chosen because its effectiveness and reliability.

System installation includes the belt skimmer assembly, controller, power source (expected to be solar plus back-up battery), and product collection tank with automatic shut-off switch.

The following discussion discusses the belt skimmer system in terms of the four evaluation criteria: effectiveness (both short and long term), implementability, environmental impact, and cost.

Effectiveness

The belt skimmer is somewhat effective in removing only DNAPL. However, it has more moving parts and is potentially less reliable than a submersible pump.

All parts potentially in contact with the DNAPL must be chemically resistant and robust enough to operate for long periods unattended. ICF Consulting (ICF, 2006) performed lab testing of belt materials to determine if they were compatible with and capable of attracting DNAPL. The stainless steel and polymer belts both collected DNAPL, but the DNAPL did not bind tightly and was readily washed off with water. This suggests that the motion of pulling the belt through the water column may dislodge a significant portion of the DNAPL. A fuzzy polymer belt captured more of the DNAPL, but it separated from its backing strip after less than 2 weeks of being submerged in the DNAPL. More mechanical equipment would make this option less effective in the long term due repairs and changeouts.

Implementability

The system is readily implementable. The belt skimmer system would have similar access issues as the submersible pump system. A treatment-system enclosure would be needed at each well location.

Building permits would be required for the enclosures and electrical power is needed. Disposal of DNAPL from the permanent storage tank could be implemented easily with transfer to mobile waste tankers for off-site disposal.

Environmental Impact

As with the submersible pump, the environmental impact of the belt skimmer system is minimal, especially if it is solar powered. The primary environmental impact would be travel to the Site to optimize and troubleshoot the system and to pick up collected DNAPL by an approved disposal contractor.

Cost

The capital cost for the belt skimmer system is somewhat higher than other technologies evaluated. Treatment system enclosure and other components would be similar to the submersible pump system. Monthly O&M costs would be slightly higher for the belt skimmer system because the mechanical parts would likely require more maintenance. Because the belts are designed to attract only DNAPL, the volume of liquid to be handled for off-Site disposal is minimized.

Conclusion

The belt skimmer is a relatively low-maintenance option which minimizes water recovery relative to NAPL recovery; however, the belt material and additional mechanical parts make this technology less attractive.

3.1.3 Peristaltic Pumping

The third and simplest option is to travel to the Site on a regular basis and remove the DNAPL with a peristaltic pump. The peristaltic pump uses rollers to induce a vacuum and remove liquid. The only item in contact with the DNAPL is the tubing itself, which can be left in the well when not in use and replaced as needed. No treatment enclosure is required for this option.

Return visits can be scheduled based on the rate of DNAPL recovery. Based on the 2012 DNAPL gauging and removal information, the DNAPL thickness fluctuated but appeared to return within two weeks. Therefore, return visits to physically pump off the NAPL will probably be needed three times every month. The following discusses the peristaltic pump in terms of the four evaluation criteria: effectiveness (both short and long term), implementability, environmental impact, and cost.

Effectiveness

DNAPL removal with a peristaltic pump is effective. The field technician can visually determine when the DNAPL has been fully removed and water begins to enter the system. However, if DNAPL production is higher than anticipated, biweekly visits will not be as effective in the long term as an automated system which can remove DNAPL.

Implementability

Peristaltic pumping uses equipment and supplies that are readily available, and there are no barriers to implementation. DNAPL collection periods can be adjusted easily based on field observations. However, this option requires transfer of DNAPL to 55-gallon drums and temporary storage of those drums on the Site. Without permanent facilities, this is less implementable, especially in the winter months. Also, drums of DNAPL would need to be secured at both locations.

No permits would be required for this technology, because no new structure is needed. Disposal of drums would be more cumbersome compared to bulk transfer to a waste tanker, because extra effort is needed to transfer drums onto a truck.

Environmental Impact

The environmental impact of the peristaltic pumping will vary based on the number of trips required to return to the Site. The peristaltic pumping does not involve the construction of semi-permanent structures or heavy equipment, so construction impacts of heavy equipment are minimal. More disposable supplies (primarily personal protective equipment [PPE]) would be used.

Cost

The peristaltic pump has minimal capital costs (for the drums and tubing), but it could require additional O&M monthly costs for handling the DNAPL. Monthly costs are very dependent on the amount of DNAPL recovered with each visit. The disposal costs are slightly higher because of the need to dispose of PPE and drums of DNAPL.

Conclusion

Peristaltic pumping is the simplest option and requires minimal start-up cost and effort; however, the use of a technician to physically remove the DNAPL increases the O&M costs.

3.2 Technology Comparison

The three technologies are technically feasible, will remove existing DNAPL within a reasonable timeframe, and are not prohibitively expensive. The alternatives are compared to each other in the following subsections. Table 3-1 compares all three technologies against the four evaluation criteria.

3.2.1 Technical Feasibility

All three options would remove DNAPL from the monitoring wells at acceptable rates, and all three can vary the rate of liquid removal based on the rate of DNAPL recovery. The peristaltic pump is the most technically feasible because it is the simplest. But because it is not an automated process, a technician must be at the Site more often to evaluate conditions and optimize the treatment. The submersible pump would have similar technical feasibility, because it is an extremely reliable pumping method with few moving parts. The belt skimmer is considered the least technically feasible because the three belts tested either did not attract the Site DNAPL very strongly, or degraded in the continuous presence of the DNAPL. The belt skimmer may also be a less reliable option.

3.2.2 Schedule

The three options would remove the DNAPL at roughly similar rates; therefore, the long-term schedule for all three is the same. However, the peristaltic pumping method has no lead time for startup and optimization, so it could begin sooner. The other two options are considered to be the same.

3.2.3 Environmental Impact

The peristaltic pumping has less impact initially, because it requires minimal equipment and no construction. However, if DNAPL recovery continues for a long time, the increased number of trips required to pump the material and the quantity of disposable PPE used may result in a relatively high environmental impact compared to the automated systems.

The environmental impacts of the three options are considered roughly even or unquantifiable, but belt skimmer is generally considered to have the most environmental impact considering the possible need to replace equipment. The submersible pump system would use solar power for operation and thus minimize the need for electricity from the grid.

3.3.4 Cost

Peristaltic pumping is initially the cheapest option because it has minimal capital costs. However, costs increase dramatically after several years. The other two options have similar costs, but the submersible pump is considered to be slightly less expensive because of lower maintenance costs.

3.3.5 Technology Comparison Matrix

The three options are summarized in the technology comparison matrix below. The best technology for a particular consideration is indicated with a filled circle, the next technology is indicated with an open circle, and the least desirable is indicated with a dashed line.

	Submersible Pump	Belt Skimmer	Peristaltic Pump
Technical Feasibility	●	-	○
Implementation Schedule	○	○	●
Environmental Impact	●	-	○
Cost	●	○	-

Based on the evaluation criteria comparison and the comparison matrix, the submersible pump technology is the preferred alternative based on its effectiveness, technical feasibility, and cost.

4.0 SELECTED ALTERNATIVE

This DNAPL Extraction System Evaluation Report was prepared to evaluate different mechanisms by which DNAPL could be extracted from the bedrock from two well locations, MW/B-11 and MW-113A on the Nyacol and WAC properties, respectively. Based on the remedial alternatives evaluated (detailed in Section 3.0), the preferred remedial alternative is submersible pump technology. The submersible pump system evaluated and selected is the XiTech extraction system. XiTech Instruments extraction system is one vendor available for this technology. XiTech was selected based past performance, reliable, system effectiveness and cost. This XiTech design for the DNAPL extraction system is a custom performance-based specification to achieve the remedy (DNAPL extraction). This design will form the basis for a technical specification that will be a competitively bid procurement and the selected remedial contractor will construct the treatment system.

The selected design includes a recovery pump installed in each well that is operated by a solar-powered electronic controller. The extracted DNAPL is recovered into a double-walled storage tank for periodic off-site disposal. The storage tank is vented through a vapor-phase carbon system prior to discharge to the atmosphere. The pump is operated by a compressed air nitrogen tank. The recovery system and components are set inside an enclosure that is lighted and heated and powered by electrical service from the grid. (The storage tank is also inside the enclosure.) Remote monitoring of the system is provided by a cellular Sensaphone®. A layout of the system is presented on the attached design drawings (Figures 4-1 and 4-2). The components of the selected system are described below.

<u>Well Locations</u>

Based on the previous stepped-drilling program performed at the Site, two monitoring wells, MW/B-11 and MW-113A, have shown measureable thicknesses of DNAPL that warrant periodic recoverable activities. Both wells are screened in the bedrock at known fractures. Boring logs for both wells are attached in Appendix B (monitoring well construction logs). As shown, sumps were installed in the wells with the future intent of product extraction. Given the density and low viscosity of the DNAPL, the 2-inch well diameter is sufficient for product extraction as discussed below.

XiTech Smart Pump

The DNAPL recovery pump is a 2-inch diameter pump designed to recover low viscosity product. The pump fits into a 2-inch diameter monitoring well and is resistant to all solvents. The pump is equipped with a 9-inch long inlet screen and has the capacity to operate at a well depth of up to 200 feet and can extract up to a rate of 12 gallon per hour (GPH). Based on the observed product thicknesses in both wells, a 9-inch long screen is sufficient for MW-113A and a 4-inch long screen is recommended for MW/B-11. The pump assembly includes 3 lines (for product, air supply, and exhaust). The technical specification for the pump is included in Appendix C.

Electronic Controller

The electronic controller is the XiTech 2550ES explosion proof (Class 1, Division 1) controller. It will operate the pump and provide continuous monitoring of the extraction system. The controller is programmable so efficient intermittent pumping of product can be achieved. A high-level shutoff switch is built into the storage tank. The controller can be powered by AC or DC. For this system, DC power will be supplied by solar mounted arrays on the roof of the enclosure. The technical specification is included in Appendix C.

Solar Panel

The solar panel is provided by XiTech. The solar panel is mounted onto the extraction system enclosure and will face south at a 45-degree angle for maximum effect. The panel is wired to the electronic controller and powers a DC battery that operates the controller.

Nitrogen Tank

The air supply that operates the pump is a nitrogen tank. The tank will be located inside the extraction system enclosure and connected to the controller. The required air pressure is function of the depth to the pump inside the well. The formula is:

$$\text{Air Pressure} = 70 + \frac{\text{Total Vertical Lift}}{2.85}$$

The total vertical lift is approximately 60 feet; therefore the needed air is calculated to be 91 pounds per square inch (PSI). The tank is equipped with a regulator to adjust the air pressure to 91 PSI. The air tank capacity will be 200 gallons. The design requires replacing the tank every three months.

Product Storage Tank

The DNAPL product will be temporarily stored in a double-walled polyethylene containment tank located inside the extraction system enclosure. The tank complies with secondary containment requirements and has a capacity of 220 gallons. A high-level shutoff sensor will be installed in the tank so when the product level touches the sensor, the pump will shut off and an alarm notification will be sent. The tank is equipped with a lid that facilitates periodic off-site disposal of the product. The size of the storage tank is based on an estimated removal rate between 1 and 2 gallons per day. Therefore, tank storage capacity will be reached in approximately 4 to 6 months.

Vapor Phase Carbon Vessel

The atmosphere within the DNAPL storage tank will be vented to the atmosphere. Because VOCs could be emitted from the tank, vapor-phase carbon will be used to treat the vapors prior to discharge to the atmosphere. The 55-gallon carbon vessel will be connected directly to the storage tank, without a blower unit, relying on the positive pressure in the tank to support air flow to the carbon vessel. Given the low air flow rate, the pressure drop across the carbon vessel is minimal (<0.5 inches of water). See the carbon vessel technical specification in Appendix C. A safety relief valve will be installed to protect the storage tank from excess internal pressure should the carbon vessel become blocked or plugged. For added safety, a flame arrestor and backflow preventer will be installed, as shown on the drawings. For this application, a VENTSORB® 55-gallon vessel from Calgon Carbon was selected. The vessel will need to be replaced after 3 to 5 months of use.

Wireless Sensaphone Monitoring System

A remote monitoring system will be provided by a Sensaphone® Cell682 alarm system. The system uses cellular technology to signal a Sensaphone server when an alarm condition occurs. The alarm conditions established for this system include: power off; high level in the storage tank; and low solar battery power. Alarm notifications will be set up for email and phone messages. A web site is included with the service so that all conditions can be checked at any time. A cellular service plan will be needed for this monitoring system.

Treatment System Enclosure

The design intent is for the main extraction system components to be housed inside an enclosure for security and protection against weather. This will be a heated wood-framed structure equipped with interior lighting but no windows. The structure would be approximately 8 feet by 10 feet in size and have a height of 8 feet. A pre-engineered enclosure will be considered. This building will be supported on a 6-inch-thick slab on grade. Double-wide doors will provide sufficient width to remove the storage tank or carbon vessel, as needed. The extraction well will be sleeved through the slab and capped, so that all tubing will be located inside the enclosure. The storage tank and carbon vessel will be located near the doors to facilitate DNAPL pump-out and carbon vessel changeouts.

Electrical Supply

A dedicated electrical supply will be provided separately for both systems. While the electronic controller is powered by the solar panel, electrical supply is needed for the treatment enclosure lighting and heating. An electric meter and circuit breaker panel will be installed on the exterior of the enclosure. It is anticipated that electric service will be supplied from existing nearby service lines. Installation of new power poles may be required for the single-phase electric service.

Given the risk for an explosive atmosphere that could be generated inside the enclosure should sufficient DNAPL product be exposed inside the enclosure, all wiring and electrical components will be explosion proof.

The attached drawings illustrate the components and the system layout (Figures 4-1 and 4-2). Vendor specifications sheets are included in Appendix C.

System Performance Operation, Maintenance and Monitoring

O&M and monitoring of the remedial system will be performed to accomplish the following objectives:

- Provide for safe operation of the DNAPL extraction system;
- Maintain specified operating conditions of the equipment and the sump;
- Collect and evaluate physical and chemical data to modify and balance the operation of the remedial system, and to determine its effectiveness; and
- Maintain compliance with regulatory requirements, such as off-site transportation and disposal of DNAPL.

System monitoring is presented for both performance evaluation and protection of human health and the environment.

Personnel performing the system's routine O&M activities will do the following:

- Operate the XiTech pumps and check for blockage or clogging;
- Monitor recovery rates and frequencies periodically to optimize the recovery rates;
- Record and track total volume of DNAPL product (gallons) extracted by the system;
- Inspect DNAPL product in the storage tank and schedule off-site disposal as needed;
- Monitor vapor-phase carbon vessel performance and schedule changeouts as needed;
- Monitor nitrogen tank level and refill the tank as needed; and
- Inspect the solar panel for any damage and insure it is operating correctly.

An O&M Plan, describing in detail the performance monitoring and maintenance activities, will be developed prior to completion of the remedial system.

Permits

The following permits are anticipated for the installation of the DNAPL extraction system:

- Building permit (Town of Ashland)
- Electrical permit (Local Utility)

5.0 REFERENCES

Ebasco Services, Inc., 1991. Draft Final Remedial Investigation Report, Nyanza II - Groundwater Study, Ashland, Massachusetts, Volumes I and II. April.

ICF Consulting, Inc. 2006. Draft Conceptual Design for DNAPL Extraction System, Nyanza Chemical Waste Dump Superfund Site, Operable Unit II, Ashland, Massachusetts. September 12.

Arthur D. Little, Inc., 2002. Memorandum: Nyanza Fall 2001 DNAPL Characterization Activities. January 28.

Nobis Engineering, Inc., 2012. Amended Scope of Work (ASOW) dated March 23, 2012, Work Plan Amendment (WPA) No. 3. April.

U.S. EPA, 2006. Explanation of Significant Differences: Nyanza Chemical Waste Dump Site, Groundwater Study, Operable Unit II, Ashland, Massachusetts. September.

TABLES

Table 2-1
August 2012 DNAPL Analytical Results - VOCs
Nyanza Chemical Waste Dump Superfund Site
Ashland, Massachusetts
Page 1 of 2

	Sample Name	A4756	A4757
	Sample Location	B-11	MW-113A
	Lab Sample ID	S-5101.01	S-5101.02
	Station ID	B-11-081412A	MW-113A-081412A
	Dilution Factor	1/50	5/25
	Sample Date	14 Aug 12	14 Aug 12
	Date Analyzed	24 Aug 12/27 Aug 12	27 Aug 12
Chemical	**RL**		
1,1,1-Trichloroethane	250	25000 U	130000 U
1,1,2,2-Tetrachloroethane	250	25000 U	130000 U
1,1,2-Trichloro-1,2,2-trifluoroethane	250	25000 U	130000 U
1,1,2-Trichloroethane	250	25000 U	130000 U
1,1-Dichloroethane	250	25000 U	130000 U
1,1-Dichloroethene	250	25000 U	130000 U
1,2,3-Trichlorobenzene	250	32000 J	130000 U
1,2,4-Trichlorobenzene	250	***210000*** J	***450000***
1,2-Dibromo-3-chloropropane	250	25000 U	130000 U
1,2-Dibromoethane	250	25000 U	130000 U
1,2-Dichlorobenzene	250	***25000000*** J	***14000000***
1,2-Dichloroethane	250	25000 U	130000 U
1,2-Dichloropropane	250	25000 U	130000 U
1,3-Dichlorobenzene	250	***1400000*** J	***740000***
1,4-Dichlorobenzene	250	***6800000*** J	***3300000***
1,4-Dioxane	5000	500000 U	2500000 U
2-Butanone	500	50000 U	250000 U
2-Hexanone	500	50000 U	250000 U
4-Methyl-2-pentanone	500	50000 U	250000 U
Acetone	500	50000 U	250000 U
Benzene	250	25000 U	130000 U
Bromochloromethane	250	25000 U	130000 U
Bromodichloromethane	250	25000 U	130000 U
Bromoform	250	25000 U	130000 U
Bromomethane	250	25000 UJ	130000 U
Carbon disulfide	250	25000 U	130000 U
Carbon tetrachloride	250	25000 U	130000 U
Chlorobenzene	250	***9400000*** J	***3900000***
Chloroethane	250	25000 U	130000 U
Chloroform	250	25000 U	130000 U
Chloromethane	250	25000 U	130000 U
cis-1,2-Dichloroethene	250	25000 U	130000 U
cis-1,3-Dichloropropene	250	25000 U	130000 U
Cyclohexane	250	25000 U	130000 U
Dibromochloromethane	250	25000 U	130000 U
Dichlorodifluoromethane	250	25000 U	130000 U
Ethylbenzene	250	25000 U	130000 U
Isopropylbenzene	250	25000 U	130000 U
m,p-Xylene	250	***26000*** J	130000 U
Methyl acetate	250	25000 U	130000 U
Methyl tert-butyl ether	250	25000 U	130000 U
Methylcyclohexane	250	25000 U	130000 U
Methylene chloride	250	25000 U	130000 U

Table 2-1
August 2012 DNAPL Analytical Results - VOCs
Nyanza Chemical Waste Dump Superfund Site
Ashland, Massachusetts

	Sample Name	A4756	A4757
	Sample Location	B-11	MW-113A
	Lab Sample ID	S-5101.01	S-5101.02
	Station ID	B-11-081412A	MW-113A-081412A
	Dilution Factor	1/50	5/25
	Sample Date	14 Aug 12	14 Aug 12
	Date Analyzed	24 Aug 12/27 Aug 12	27 Aug 12
Chemical	**RL**		
o-Xylene	250	***12000*** J	130000 U
Styrene	250	25000 U	130000 U
Tetrachloroethene	250	***22000*** J	130000 U
Toluene	250	***46000*** J	130000 U
trans-1,2-Dichloroethene	250	25000 U	130000 U
trans-1,3-Dichloropropene	250	25000 U	130000 U
Trichloroethene	250	***2200000***	***2700000***
Trichlorofluoromethane	250	25000 U	130000 U
Vinyl chloride	250	25000 U	130000 U
		DCBs, Chlorobenzene, TCE results from 1:50 dilution	1,4-DCB from 1:25 dilution

Notes:
1. VOC = volatile organic compound
2. All concentrations listed in micrograms per liter (µg/L).
3. MCP = Massachusetts Contingency Plan (February 2008)
4. **Bold** text indicates concentrations that exceed the MCP Method 1 GW-1 standard
5. ***Italic*** text indicates concentrations that exceed the MCP Method 1 GW-2 standard
6. "U"= below detection limit
7. "J"= Estimated Value
8. "R" = data rejected due to quality issues

Table 2-2
August 2012 DNAPL Analytical Results - SVOCs
Nyanza Chemical Waste Dump Superfund Site
Ashland, Massachusetts

	Sample Name	A4756	A4757
	Sample Location	B-11	MW-113A
	Lab Sample ID	S-5101.01	S-5101.02
	Station ID	B-11-081412A	MW-113A-081412A
	Dilution Factor	1/1000	1/2000
	Sample Date	14 Aug 12	14 Aug 12
	Date Analyzed	30 Aug 12	30 Aug 12
Chemical	**RL**		
1,1'-Biphenyl	5000	14000	9600 J
1,2,4,5-Tetrachlorobenzene	5000	10000 J	8800 J
2,2'-Oxybis(1-chloropropane)	5000	10000 U	10000 U
2,3,4,6-Tetrachlorophenol	5000	10000 U	R
2,4,5-Trichlorophenol	5000	10000 U	R
2,4,6-Trichlorophenol	5000	10000 U	R
2,4-Dichlorophenol	5000	R	R
2,4-Dimethylphenol	5000	R	R
2,4-Dinitrophenol	10000	20000 U	R
2,4-Dinitrotoluene	5000	10000 U	R
2,6-Dinitrotoluene	5000	10000 U	R
2-Chloronaphthalene	5000	10000 U	R
2-Chlorophenol	5000	10000 U	10000 U
2-Methylnaphthalene	5000	R	R
2-Methylphenol	5000	10000 U	10000 U
2-Nitroaniline	10000	20000 U	R
2-Nitrophenol	5000	R	R
3,3'-Dichlorobenzidine	5000	10000 U	10000 U
3-Nitroaniline	10000	20000 U	7800 J
4,6-Dinitro-2-methylphenol	10000	20000 U	20000 U
4-Bromophenyl-phenylether	5000	10000 UJ	10000 UJ
4-Chloro-3-methylphenol	5000	R	R
4-Chloroaniline	5000	**4200** J	R
4-Chlorophenyl-phenylether	5000	10000 U	R
4-Methylphenol	5000	10000 U	10000 U
4-Nitroaniline	10000	20000 U	R
4-Nitrophenol	10000	20000 U	R
Acenaphthene	5000	10000 U	R
Acenaphthylene	5000	10000 U	R
Acetophenone	5000	10000 U	10000 U
Anthracene	5000	10000 U	10000 U
Atrazine	5000	10000 U	10000 U
Benzaldehyde	5000	10000 U	10000 U
Benzo(a)anthracene	5000	10000 U	10000 U
Benzo(a)pyrene	5000	10000 U	10000 U
Benzo(b)fluoranthene	5000	10000 U	10000 U
Benzo(g,h,i)perylene	5000	10000 U	10000 U
Benzo(k)fluoranthene	5000	10000 U	10000 U
Bis(2-chloroethoxy)methane	5000	R	R
Bis(2-chloroethyl)ether	5000	10000 U	10000 U
Bis(2-ethylhexyl)phthalate	5000	**39000**	**15000**
Butylbenzylphthalate	5000	10000 U	10000 U
Caprolactam	5000	R	R
Carbazole	5000	10000 U	10000 U
Chrysene	5000	10000 U	10000 U
Dibenzo(a,h)anthracene	5000	10000 U	10000 U

Table 2-2
August 2012 DNAPL Analytical Results - SVOCs
Nyanza Chemical Waste Dump Superfund Site
Ashland, Massachusetts

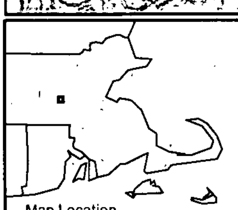
	Sample Name	A4756	A4757
	Sample Location	B-11	MW-113A
	Lab Sample ID	S-5101.01	S-5101.02
	Station ID	B-11-081412A	MW-113A-081412A
	Dilution Factor	1/1000	1/2000
	Sample Date	14 Aug 12	14 Aug 12
	Date Analyzed	30 Aug 12	30 Aug 12
Chemical	**RL**		
Dibenzofuran	5000	10000 U	R
Diethylphthalate	5000	10000 U	R
Dimethylphthalate	5000	10000 U	R
Di-n-butylphthalate	5000	10000 U	10000 U
Di-n-octylphthalate	5000	10000 U	10000 U
Fluoranthene	5000	**12000**	**7700** J
Fluorene	5000	10000 U	R
Hexachlorobenzene	5000	10000 U	10000 U
Hexachlorobutadiene	5000	R	R
Hexachlorocyclopentadiene	5000	10000 U	R
Hexachloroethane	5000	10000 U	10000 U
Indeno(1,2,3-cd)pyrene	5000	10000 U	10000 U
Isophorone	5000	R	R
Naphthalene	5000	***69000*** J	***48000*** J
Nitrobenzene	5000	110000000 J	220000000 J
N-Nitroso-di-n-propylamine	5000	10000 U	10000 U
N-Nitrosodiphenylamine	5000	10000 U	10000 U
Pentachlorophenol	10000	**22000** J	**9700** J
Phenanthrene	5000	**16000**	**10000**
Phenol	5000	10000 U	10000 U
Pyrene	5000	**11000**	**6300** J
		Nitrobenzene from 1:1000 dilution	Nitrobenzene from 1:2000 dilution

Notes:
1. SVOC = semi volatile organic compound
2. All concentrations listed in micrograms per liter (µg/L).
3. MCP = Massachusetts Contingency Plan (February 2008)
4. **Bold** text indicates concentrations that exceed the MCP Method 1 GW-1 standard
5. ***Italic*** text indicates concentrations that exceed the MCP Method 1 GW-2 standard
6. "U"= below detection limit
7. "J"= Estimated Value
8. "R" = data rejected due to quality issues

Table 3-1
Comparison of DNAPL Technology Alternatives
Nyanza Chemical Waste Dump Superfund Site
Ashland, Massachusetts

Technology	Xitech Submersible Pumps	PetroXtractor Belt Skimmer	Peristaltic Pumping of DNAPL
Short-Term Effectiveness	Effective, will quickly draw as much DNAPL as the well will yeild	Potentially effective, will quickly draw as much DNAPL as the well will yield down to a 5inch layer on the bottom. Question as to efficacy in product removal without re-introducing DNAPL into the water column from loss off of the belt during extraction	Effective, will quickly draw as much DNAPL as the well will yeild
Long-Term Effectiveness	Effective, complete mechanical removal should limit the amount of DNAPL in the bedrock	Mostly Effective, complete mechanical removal should limit the amount of DNAPL in the bedrock and will only leave a small amount remaining in the well sump. Question as to efficacy in product removal without re-introducing DNAPL into the water column from loss off of the belt during extraction	Effective, complete physical removal should limit the amount of DNAPL in the bedrock
Implementability	Moderate difficulty to Implement, semi-complex set up with substantial amount of time to optimize, but once working there is limited long-term time requirements	Minimal to Moderate implementability, semi complex system but should not be hard to optimize or get running, once working there is limited long-term requirements	Very easy to implement, only need to install dedicated tubing into well
Reduction in Toxicity	Will remove DNAPL readily reducing the free-phase toxicity but will not influence the groundwater toxicty levels in the short-term, should have some effect in the long-term	Will remove DNAPL readily reducing the free-phase toxicity but will not influence the groundwater toxicty levels in the short-term, should have some effect in the long-term	Will remove DNAPL readily reducing the free-phase toxicity but will not influence the groundwater toxicty levels in the short-term, should have some effect in the long-term
DNAPL Volume and Mobility	Will reduce DNAPL as quickly as it can flow into the well, as fast as possible without flow augmentation	Will reduce DNAPL as quickly as it can flow into the well, as fast as possible without flow augmentation provided there is no issue with the belt reintroducing DNAPL into the water column	Will reduce DNAPL fairly quickly, there will be minimal limitations depending on field staff availability, scheduling, and frequency of required site visits
Costs	Medium	High	Low

FIGURES



USGS Topographic Map
Ashland, Massachusetts
Revised 1982

0 500 1,000 2,000
Feet
1 inch = 2,000 feet

N

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FIGURE 1-1

SITE LOCUS PLAN
NYANZA CHEMICAL WASTE DUMP
SUPERFUND SITE - OPERABLE UNIT II
ASHLAND, MASSACHUSETTS

PREPARED BY: JH	CHECKED BY: JM
PROJECT NO. 80022	DATE: MARCH 2013

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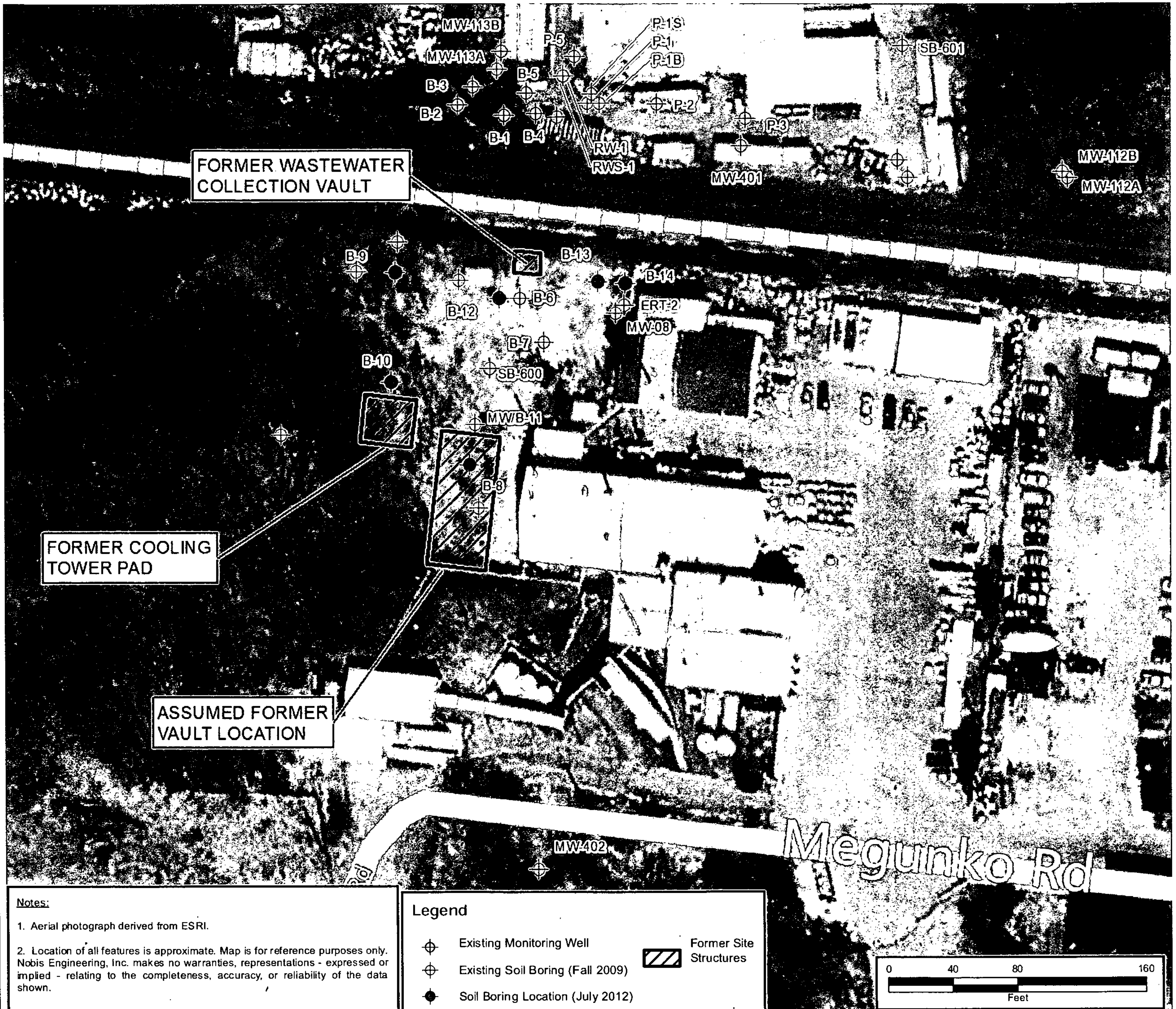
FIGURE 1-2	NYANZA CHEMICAL WASTE DUMP SUPERFUND SITE OPERABLE UNIT II AHSLAND, MASSACHUSETTS SITE PLAN / MONITORING WELL PLAN	Nobis Engineering a Sustainable Future Nobis Engineering, Inc. 18 Chenell Drive Concord, NH 03301 T(603) 224-4182 www.nobiseng.com Client-Focused, Employee-Owned	DATE: MARCH 2013 PROJECT NO. 80022 PREPARED BY: ML CHECK BY: JM



Notes:

1. Aerial photograph derived from ESRI.

2. Location of all features is approximate. Map is for reference purposes only. Nobis Engineering, Inc. makes no warranties, representations - expressed or implied - relating to the completeness, accuracy, or reliability of the data shown.

DATE: MARCH 2013
PROJECT NO. 80022.07

PREPARED BY: JH
CHECKED BY: JM

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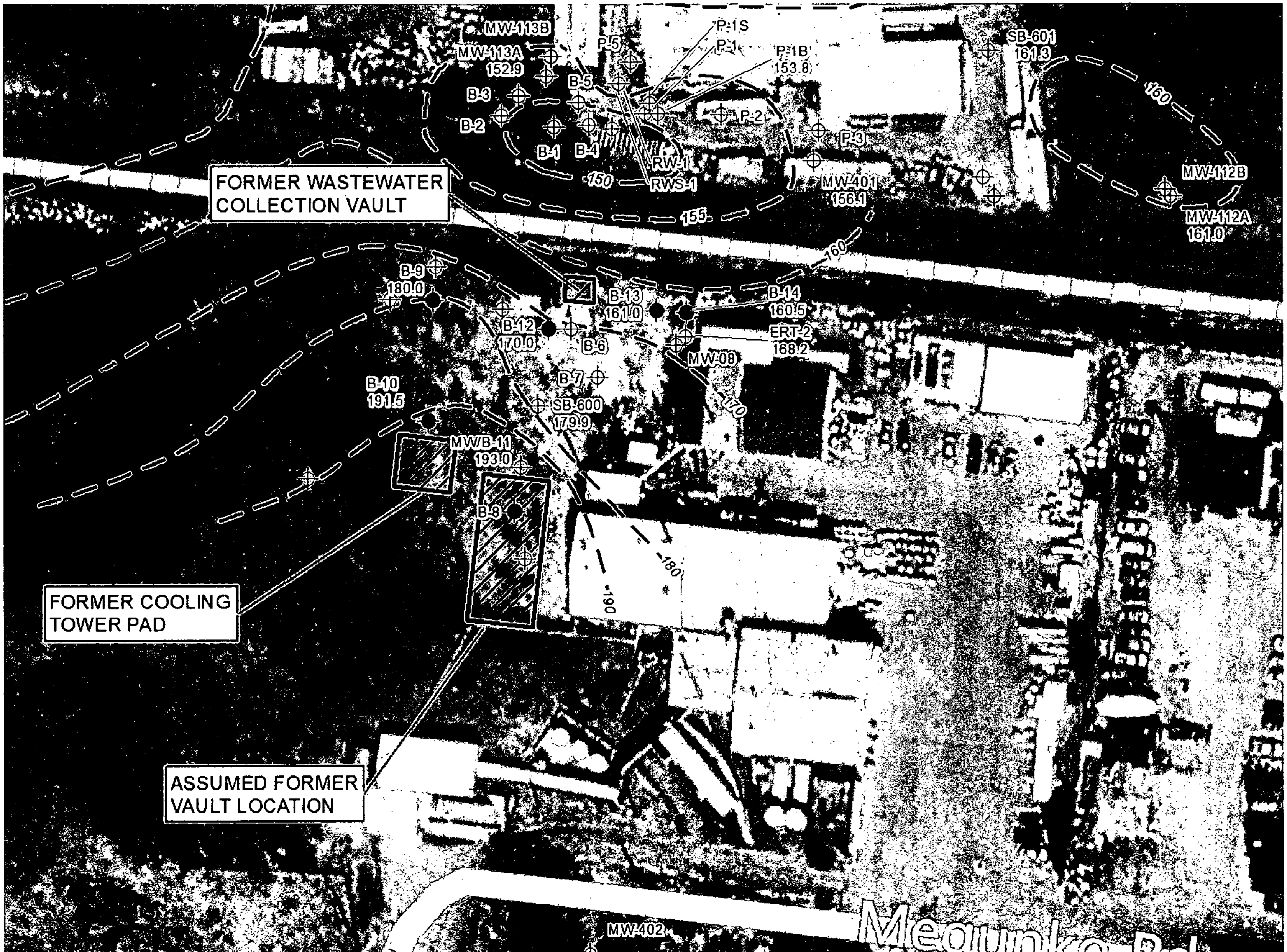
NYANZA CHEMICAL WASTE DUMP
SUPERFUND SITE
OPERABLE UNIT II
ASHLAND, MASSACHUSETTS

STEP DRILLING BORING LOCATIONS

FIGURE 2-1



Notes:

1. Aerial photograph derived from ESRI.

2. Location of all features is approximate. Map is for reference purposes only. Nobis Engineering, Inc. makes no warranties, representations - expressed or implied - relating to the completeness, accuracy, or reliability of the data shown.

Legend

- Existing Monitoring Well
- Existing Soil Boring (Fall 2009)
- Soil Boring Location (July 2012)
- Former Site Structures
- Approximate Bedrock Contour (ft msl)

Label Key

SB-601 - Well Name
161.3 - Bedrock Elevation (ft msl)

0 40 80 160
Feet

DATE: MARCH 2013
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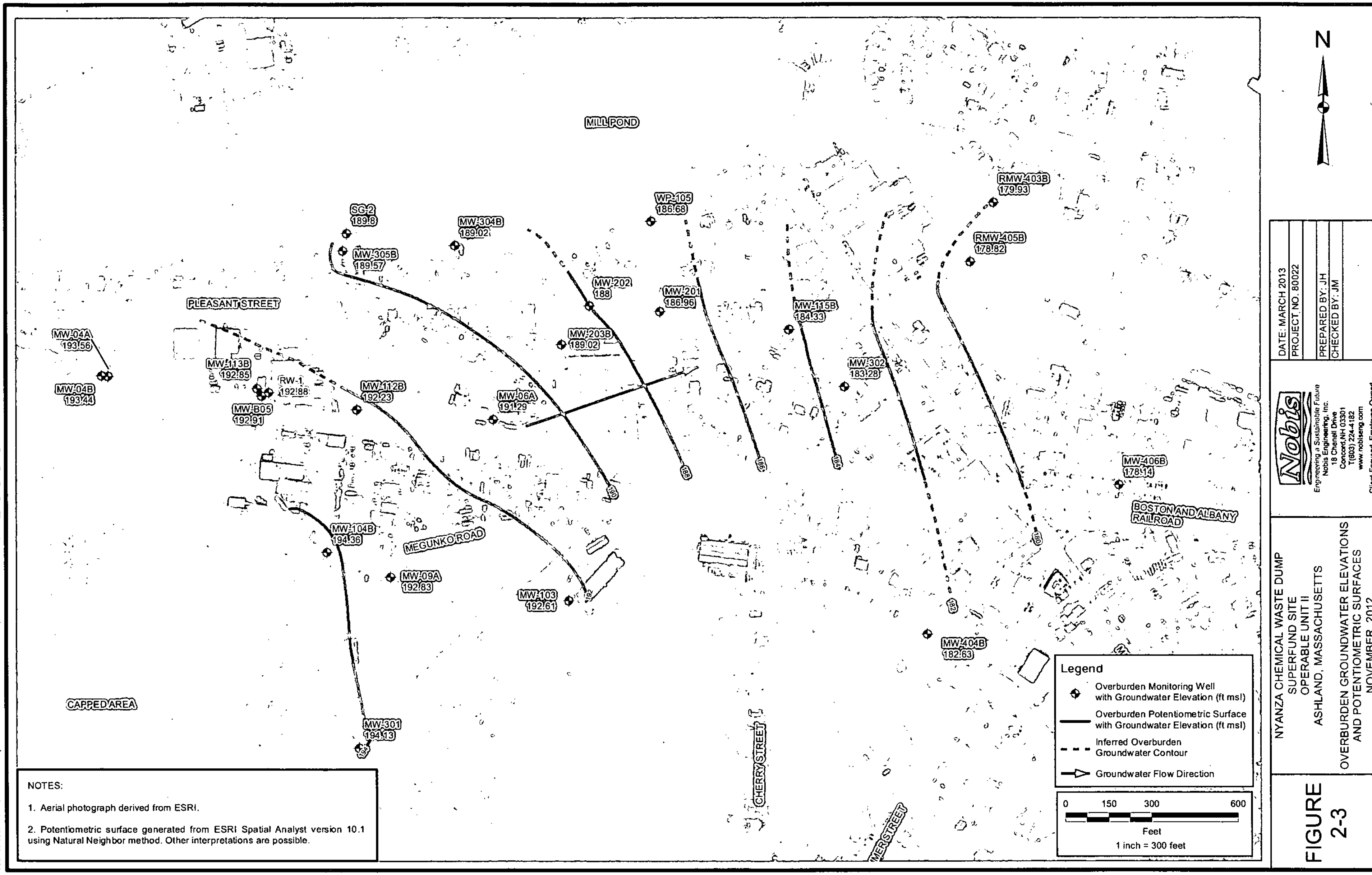
NYANZA CHEMICAL WASTE DUMP
SUPERFUND SITE
OPERABLE UNIT II
ASHLAND, MASSACHUSETTS

BEDROCK CONTOUR MAP

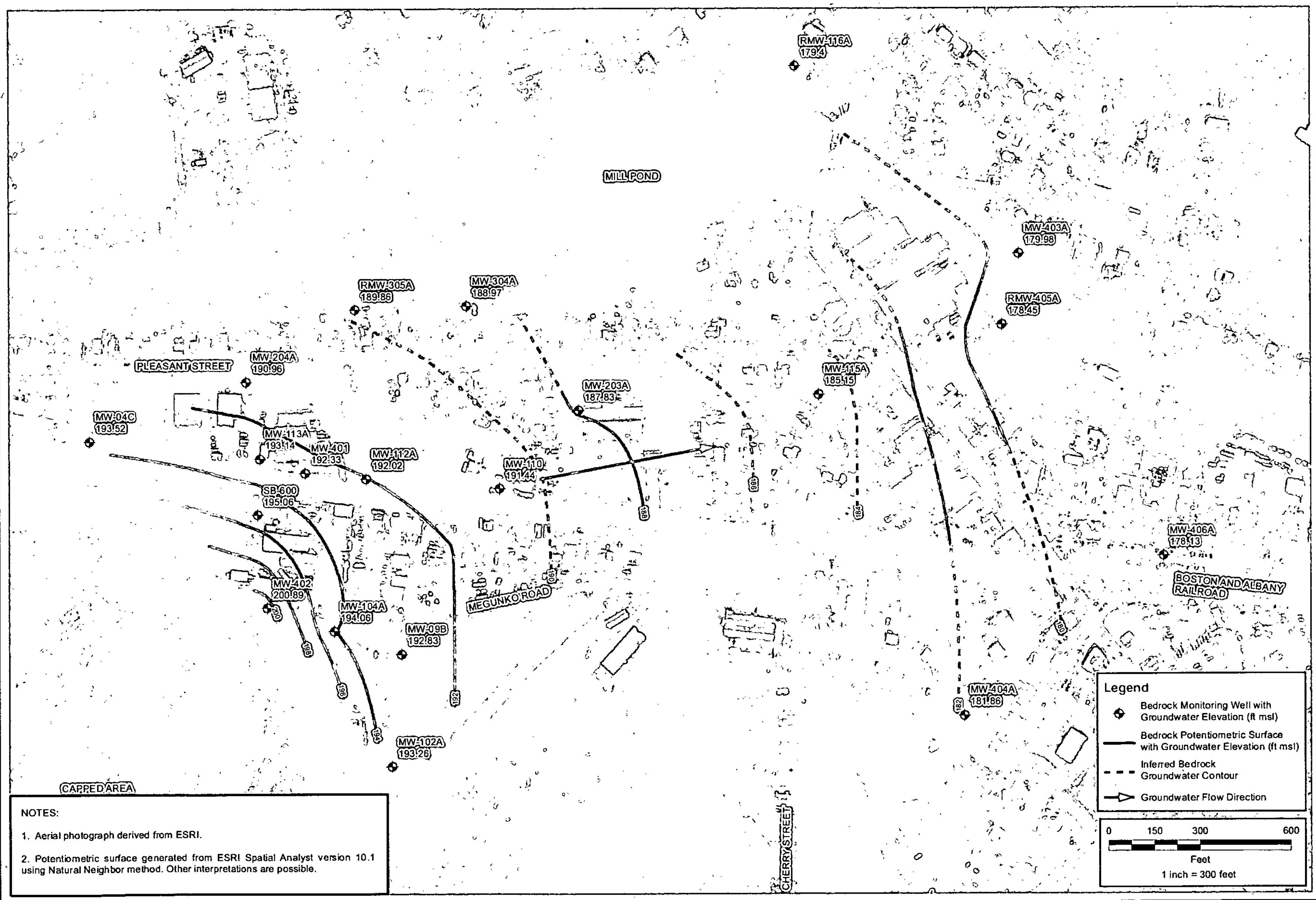
FIGURE
2-2



NOTES:

1. Aerial photograph derived from ESRI.

2. Potentiometric surface generated from ESRI Spatial Analyst version 10.1 using Natural Neighbor method. Other interpretations are possible.



NOTES:

1. Aerial photograph derived from ESRI.

2. Potentiometric surface generated from ESRI Spatial Analyst version 10.1 using Natural Neighbor method. Other interpretations are possible.

DATE: MARCH 2013
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CHECKED BY: JM

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NYANZA CHEMICAL WASTE DUMP
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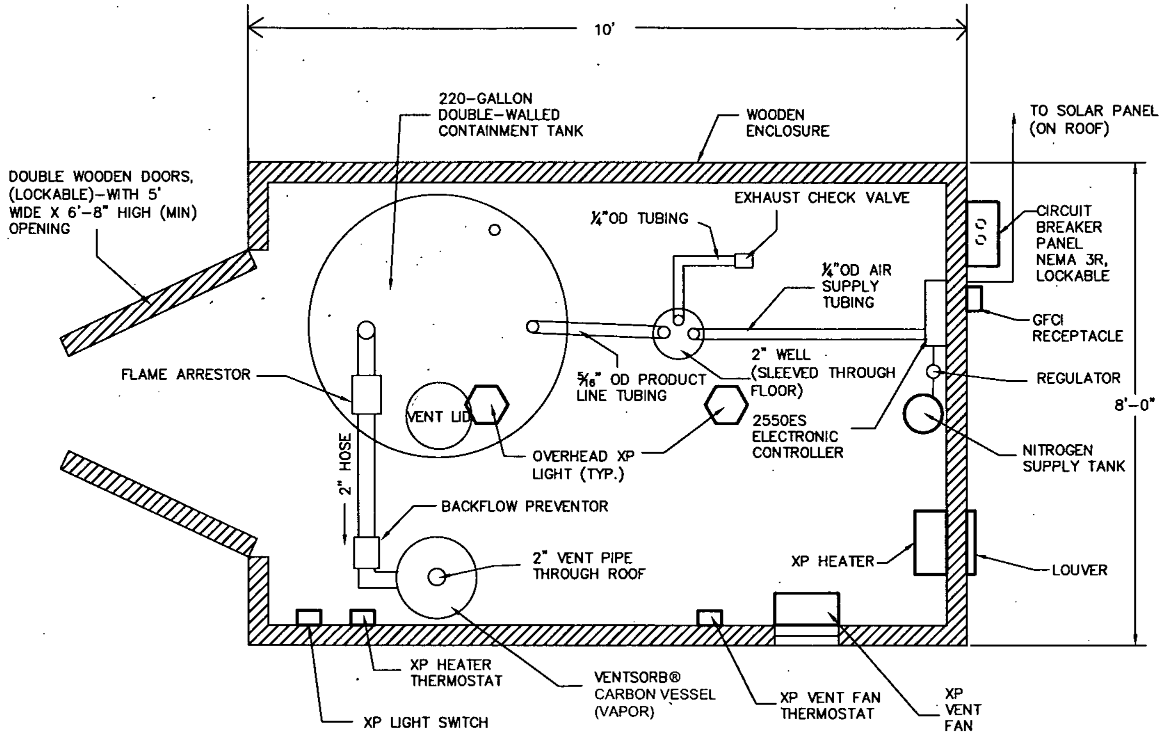
BEDROCK GROUNDWATER ELEVATIONS
AND POTENTIOMETRIC SURFACES
NOVEMBER, 2012

FIGURE 2-4



NOTES:
1.) TREATMENT SYSTEM ENCLOSURE:
- WOODEN ENCLOSURE WITH FULL OPENING, LOCKABLE DOORS OR PRE-ENGINEERED ENCLOSURE
- INSULATED AND FRAMED
2.) INTERIOR OF ENCLOSURE TO BE NEC CLASS 1 DIVISION 2 CLASSIFIED FOR HAZARDOUS LOCATIONS, AS WELL AS:
- 10 FT. RADIUS FROM ALL DOORS, FLOOR, AND WALL PENETRATIONS UP TO 18 IN. ABOVE GROUND
- ALL EQUIPMENT AND WIRING WITHIN THESE CLASSIFIED AREAS TO MEET CLASS 1 DIVISION 2 REQUIREMENTS
3.) ALL EQUIPMENT TO BE FACTORY TESTED BY SUPPLIER. OFF-LOADING, PLACEMENT, EXTERIOR WIRING, AND PLUMBING TO BE THE RESPONSIBILITY OF CONTRACTOR.
4.) ENCLOSURE TO BE PLACED ON 6 IN. MIN. REINFORCED SLAB WITH COMPACTED GRAVEL BASE, WITH SLIGHT SLOPE TO DRAIN.

PLAN VIEW

APPROXIMATE SCALE
0' 1' 2' 4'

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FIGURE 4-1
DNAPL EXTRACTION SYSTEM ENCLOSURE LAYOUT - PLAN VIEW
NYANZA SUPERFUND SITE OU2
ASHLAND, MA

PROJECT 80022.05 | MARCH 2013

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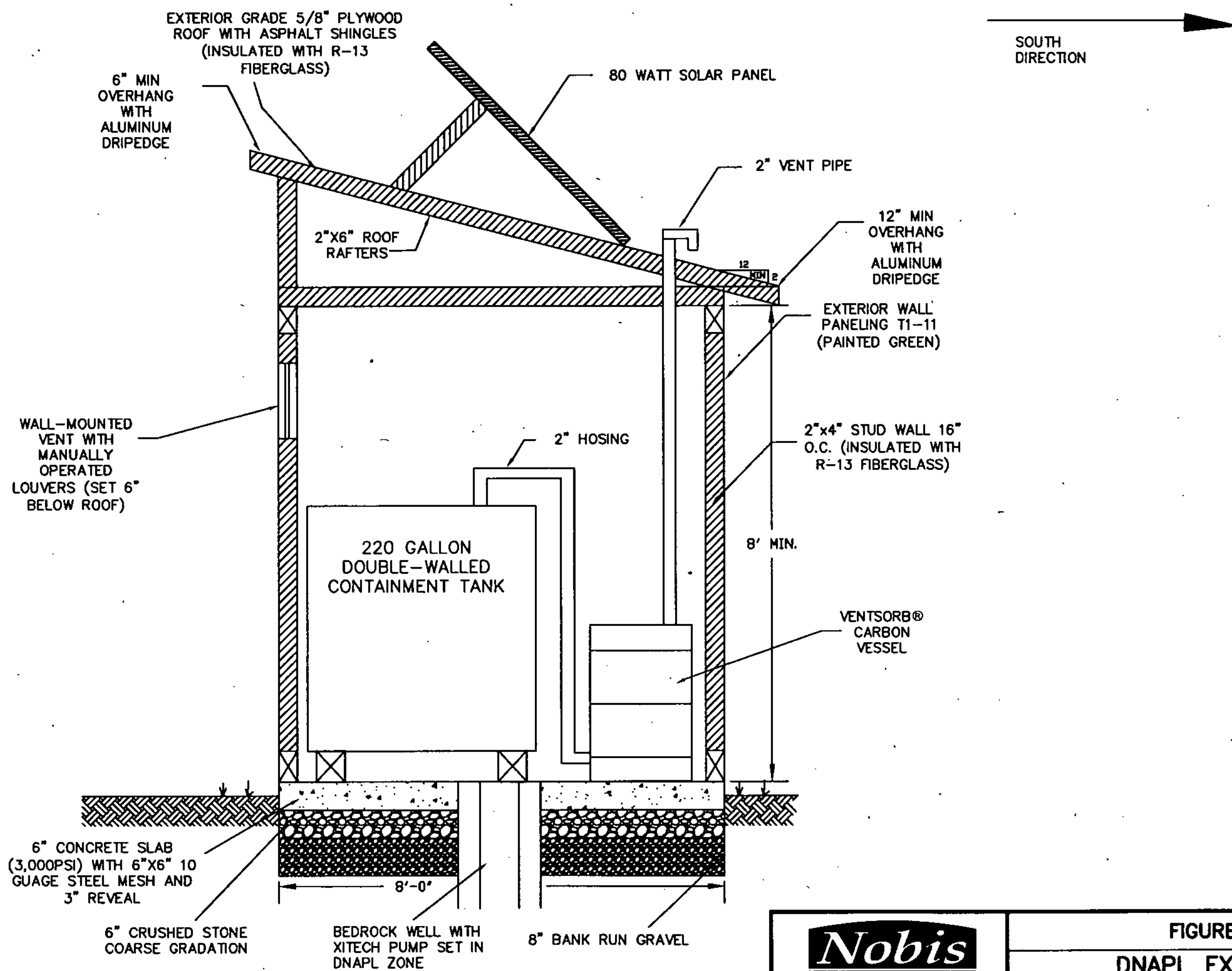

PROFILE VIEW

NOT TO SCALE

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FIGURE 4-2

DNAPL EXTRACTION SYSTEM ENCLOSURE LAYOUT – PROFILE VIEW

NYANZA SUPERFUND SITE OU2
ASHLAND, MA

PROJECT 80022.05 | MARCH 2013

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APPENDIX A