FIVE YEAR REVIEW REPORT FOR BOFORS-NOBEL INC. SUPERFUND SITE MUSKEGON COUNTY, MICHIGAN

Prepared by

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LIST OF ACRONYMS

Agencies	MDEQ and U.S. EPA
ARARs	Applicable or Relevant and Appropriate Requirements
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
EPA	United States Environmental Protection Agency
FYR	Five-Year Review
gpm	gallons per minute
GSI	Groundwater Surface Water Interface
ICs	Institutional Controls
ICIAP	Institutional Controls Implementation and Assurance Planq
IRAP	Interim Remedial Action Plan
MCL	Maximum Contaminant Level
MCWMS	Muskegon County Wastewater Management System
mg/kg	milligrams per kilogram, or parts per million
MDEQ	Michigan Department of Environmental Quality
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O.U.	Operable Unit
O&M	Operation and Maintenance
PCOR	Preliminary Closeout Report
POA	Prospective Operators' Agreement
ppb	parts per billion
ppm	parts per million
PDD	Pre-Authorization Decision Document
PRP	Potentially Responsible Party
PSDs	Performing Settling Defendants
RA	Remedial Action
RAO	Remedial Action Objective
RD	Remedial Design
RI/FS	Remedial Investigation/ Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
Site	Bofors-Nobel Superfund Site
The State	The State of Michigan
TBCs	To-be-considered material, which are non-promulgated government advisories or guidance that are not legally binding but are considered along with ARARs.
USACE	United States Army Corps of Engineers
UU/UE	Unrestricted Use/ Unlimited Exposure
µg/L	micrograms per Liter, or parts per billion
VOCs	Volatile Organic Compounds
yd^3	Cubic Yards

EXECUTIVE SUMMARY

This is the fourth Five-Year Review (FYR) for the Bofors-Nobel Inc. Superfund (Site) located in Muskegon, Muskegon County, Michigan. The purpose of this FYR is to review information to determine if the remedy is and will continue to be protective of human health and the environment. The triggering action for this statutory five-year review is the signature date for the third five-year review completed on August 7, 2008.

The Bofors-Nobel Superfund Site is an 85 acre site comprised of a former specialty chemical production facility and 10 unlined disposal lagoons. The Site has been divided into two Operable Units (O.U.s): O.U. #1 addresses the contamination present in the approximately 46 acre Lagoon area (including groundwater), and O.U. #2 includes the approximately 39 acre former production area. The selected remedial alternative for O.U. #1 at the Bofors-Nobel Inc. Site consists of: addressing the threat to Big Black Creek through controlling contaminated groundwater using an underground Barrier Wall supplemented by extraction wells (as needed); a Groundwater Treatment Plant (GWTP) and treatment wetlands to treat contaminated groundwater contained on Site; monitoring of the Site until cleanup standards have been achieved; a soil cover to protect inadvertent trespassers; and Institutional Controls in the form of land use restrictions. The Potentially Responsible Parties (known as the "Performing Settling Defendants," or PSDs) have constructed the O.U. #1 Total In-Situ Containment (TIC) remedy components and operate and maintain the O.U. #1 systems at the Site. GWTP operation and maintenance is performed under a Prospective Operators' Agreement (POA) by Camus, LLC which is a partnership formed through the neighboring facility, Sun Chemical.

Contamination at and underneath the former operating plant area of the Site owned by Sun Chemical has been designated as O.U. #2. O.U. #2 is still under investigation, the O.U. #2 Record of Decision has not been issued, and a final remedy has not yet been selected. Therefore, protectiveness for O.U. #2 is not being evaluated in this FYR.

The O.U. #1 area was found to be in satisfactory condition during recent Site inspections. The Site showed no signs of vandalism or other disturbances. Where inspected, the access fence was properly in place, and the Barrier Wall and weir/sump structure was still in place. All Site areas were clean and free of debris. Extraction and monitoring well locations that were observed appeared intact, including vehicular barriers and padlocks. Contamination source materials on Site and groundwater flow are such that there is no use by residents living near the Site of groundwater for drinking water or other domestic use.

The remedy at Operable Unit #1 of the Bofors-Nobel Site is protective of human health and the environment in the short term. Exposure pathways that could result in unacceptable risks are being controlled. ICs are in place and groundwater extraction wells generally provide capture of contaminated groundwater between the Barrier Wall and Big Black Creek. To ensure long-term protectiveness, the following actions need to be taken: continued monitoring of groundwater at and around the Barrier Wall and between the Barrier Wall and Big Black Creek; implementation of Contingent Remedial Actions to address lack of complete groundwater capture; provide a site-specific determination on Act 190 as to its requirements; and, effectively implement Contingent

Remedial Actions to satisfy Performance Standards and Remedial Action Objectives for the remedy at the Site.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Bofors-Nobel		
EPA ID: MID006030373		
Region: 5	**State:** MI	**City/County:** Muskegon, Muskegon County
SITE STATUS		
NPL Status: Final		
Remediation status (choose all that apply): ☐ Under Construction ☒ Operating ☐ Complete		
Multiple OUs? Yes	**Has the site achieved construction completion?** No	
REVIEW STATUS		
Lead agency: EPA		
Author name (Federal or State Project Manager): John V. Fagiolo, Timothy Fischer		
Author affiliation: U.S. EPA		
Review period: January 2, 2013 - July 31, 2013		
Date(s) of Site inspection: May 16, 2013		
Type of review: Statutory		
Review number: 4		
Triggering action date *(from WasteLAN)*: August 7, 2008		
Due date *(five years after triggering action date)*: August 7, 2013		

Five-Year Review Summary Form (continued)

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:

None.

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 1	Issue Category: Remedy Performance.			
	Issue: The containment effectiveness of the Barrier Wall and the capture effectiveness of the three groundwater extraction wells outside the Barrier Wall must be confirmed.			
	Recommendation: Continue sampling monitoring wells at and around the Barrier Wall and between the Barrier Wall and Big Black Creek.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	June 2015

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 1	Issue Category: Remedy Performance.			
	Issue: The containment effectiveness of the Barrier Wall and the capture effectiveness of the three groundwater extraction wells outside the Barrier Wall must be confirmed.			
	Recommendation: Implement Contingent Remedial Actions proposed in the PSDs' 3/19/12 report and revised as required by EPA (with consultation by MDEQ) if wells' capture continues to fluctuate.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	December 2013

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 1	Issue Category: Changed Site Conditions.			
	Issue: Public Act 190 revisions may support changes to the acceptable measurement of compliance with the remedy's Performance Standards and Remedial Action Objectives.			
	Recommendation: Review Act 190 and provide a site specific determination on its requirements for the remedy at the Site.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**

No	Yes	State	EPA	December 2013

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 1	Issue Category: Changed Site Conditions.			
	Issue: Public Act 190 revisions may support changes to the acceptable measurement of compliance with the remedy's Performance Standards and Remedial Action Objectives.			
	Recommendation: Effectively implement Contingent Remedial Actions to satisfy Performance Standards and Remedial Action Objectives.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA/State	December 2013

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 1	Issue Category: Institutional Controls.			
	Issue: Additional IC evaluation activities should be performed to ensure that implemented ICs are effective and properly maintained, monitored, and enforced, and to explore whether additional ICs are needed.			
	Recommendation: Develop an Institutional Control Implementation and Assurance Plan or incorporate equivalent procedures and protections into a site operations and maintenance plan.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA/State	December 2014

Protectiveness Statement(s)

Operable Unit:	*Protectiveness Determination:*
1	Short-term Protective

Protectiveness Statement:

The remedy at Operable Unit #1 of the Bofors-Nobel Site is protective of human health and the environment in the short term. Exposure pathways that could result in unacceptable risks are being controlled. ICs are in place and groundwater extraction wells generally provide capture of contaminated groundwater between the Barrier Wall and Big Black Creek. However, consistent groundwater capture is a concern. To ensure long-term protectiveness, the following actions need to be taken: continued monitoring of groundwater at and around the Barrier Wall and between the Barrier Wall and Big Black Creek; implementation of Contingent Remedial Actions to address lack of complete groundwater capture; provide a site-specific determination on Act 190 as to its requirements; and, effectively implement Contingent Remedial Actions to satisfy Performance Standards and Remedial Action Objectives. Long-Term protectiveness requires compliance with the institutional controls. Although the ICs for OU #1 are in-place, additional work is needed to ensure the ICs are effective and that compliance with ICs will be achieved. To that end, an Institutional Controls Implementation and Assurance Plan (ICIAP) or equivalent document will be developed to ensure that existing ICs and Long-Term Stewardship (LTS) procedures are effective. The purpose of the ICIAP is to conduct additional IC evaluation activities to ensure that the implemented ICs and LTS procedures are effective so that the ICs are properly maintained,

monitored, and enforced.

I. INTRODUCTION

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) prepares FYRs pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121 and the National Contingency Plan (NCP). CERCLA 121 states:

> *"If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews."*

EPA interpreted this requirement further in the NCP; 40 Code of Federal Regulations (CFR) Section 300.430(f)(4)(ii), which states:

> *"If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such actions no less often than every five years after the initiation of the selected remedial action."*

The United States Environmental Protection Agency (EPA), with consultation from the Michigan Department of Environmental Quality (MDEQ), has conducted a five-year review of the remedial actions implemented at the Bofors-Nobel Superfund Site in Muskegon, Michigan. EPA is the lead agency for developing and implementing the remedy for the Site. MDEQ, as the support agency representing the State of Michigan, has reviewed all supporting documentation and provided input to EPA during the FYR process.

This is the fourth FYR for the Bofors-Nobel Superfund Site. The triggering action for this statutory review is the August 7, 2008 completion date of the previous FYR. The FYR is required due to the fact that hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure. The Site consists of two Operable Units, one of which is addressed in this FYR, O.U. #1. The other Operable Unit, O.U. #2, does not yet have a Record of Decision.

II. PROGRESS SINCE THE LAST REVIEW

Table 1: Protectiveness Determinations/Statements from the 2008 FYR

OU #	2008 Protectiveness Determination	2008 Protectiveness Statement
1	Protective	The remedy at O.U. #1 is expected to be protective of human health and the environment upon completion, and in the interim, there is no evidence of exposure pathways that could result in unacceptable risks. Long-term protectiveness will be assured by: conducting IC evaluation activities and implementing ICs, along with evaluating long-term stewardship procedures; confirmation of the effectiveness of extraction wells currently on site; confirmation of the containment effectiveness of the Barrier Wall; continued maintenance of exterior extraction wells to achieve hydraulic and chemical capture through efficient pumping; and, continued short and long-term monitoring of the O.U. #1 remedy. Long-term stewardship will assure that effective ICs will be maintained and monitored
Sitewide	Protective	The remedy at O.U. #1 is expected to be protective of human health and the environment upon completion, and in the interim, there is no evidence of exposure pathways that could result in unacceptable risks. Long-term protectiveness will be assured by: conducting IC evaluation activities and implementing ICs, along with evaluating long-term stewardship procedures; confirmation of the effectiveness of extraction wells currently on site; confirmation of the containment effectiveness of the Barrier Wall; continued maintenance of exterior extraction wells to achieve hydraulic and chemical capture through efficient pumping; and, continued short and long-term monitoring of the O.U. #1 remedy. Long-term stewardship will assure that effective ICs will be maintained and monitored.

No protectiveness determination was provided in the 2008 Five Year Review Report for O.U. #2 because the O.U. #2 Record of Decision has not yet been issued.

Table 2: Status of Recommendations from the 2008 FYR

O.U.	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Party	Original Milestone Date	Current Status	Completion Date (if applicable)
1	A. Institutional Controls for the Bofors-Nobel Site as required by the 1990 ROD as amended in 1992 and 1999 are not in place.	Implement the Declaration of Restrictive Covenant and Access Agreement.	PSDs after EPA review & approval with MDEQ consultation.	EPA	Dec. 2008	Complete.	5/4/12

O.U.	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Party	Original Milestone Date	Current Status	Completion Date (if applicable)
	A (cont'd.). Institutional Controls for the Bofors-Nobel Site as required by the 1990 ROD as amended in 1992 and 1999 are not in place.	An IC Plan will be prepared. The IC Plan will identify activities to be undertaken by the PSDs, MDEQ, and EPA to: evaluate existing ICs' effectiveness, assure the effectiveness of ICs that will be implemented, and identify required steps to plan for long-term stewardship	U.S.EPA	EPA (with MDEQ consult)	Dec. 2008		N/A
1	B. The containment effectiveness of the Barrier Wall and the capture effectiveness of the three groundwater extraction wells outside the Barrier Wall must be confirmed with adequate chemical and hydraulic data.	Complete near-term monitoring to confirm the Site's hydraulic characteristics.	PSDs	EPA	Quarterly, starting in June 2008	Ongoing.	
		Develop the PSVP and Contingent Remedial Action Plan. Implement PSVP, including installation and sampling of new monitoring locations.	PSDs	EPA	June 2009	Ongoing.	
		Implement Contingent Actions if wells' capture is ineffective.	PSDs	EPA	As Needed	Ongoing.	

Issue A: Institutional Controls for the Bofors-Nobel Site as required by the 1990 ROD as amended in 1992 and 1999 are not in place. Recommendation 1: Implement the Declaration of Restrictive Covenant and Access Agreement. On May 4, 2012, the Muskegon County Register of Deeds recorded the signed document "Declaration of Restrictive Covenant and Grant of Environmental Protection Easement" for the property within which O.U. #1 is located. May 4, 2012 is therefore considered to be the date on which this recommendation was successfully completed. Since ICs have been implemented and will be enforced and maintained, there is no need for an IC Plan. The O&M activities at the Site will include periodic verification that the ICs remain in place.

Issue B. The containment effectiveness of the Barrier Wall and the capture effectiveness of the three groundwater extraction wells outside the Barrier Wall must be confirmed with adequate chemical and hydraulic data.

Recommendation 1: Complete near-term monitoring to confirm the Site's hydraulic characteristics.

On March 19, 2012, the PSDs provided a report that presented the results of hydraulic pump tests on the groundwater extraction wells exterior to the Barrier Wall. This report concluded that the diffuser wetland located outside of the southeast corner of the Barrier Wall serves as a conduit for groundwater that travels outside of the easternmost end of the Barrier Wall. Groundwater can potentially travel around the eastern end of the Barrier Wall, straight through the diffuser wetland directly toward the three groundwater extraction wells exterior to the Barrier Wall. (see Figures 4 and 5). In 2011, the diffuser wetland was filled in to eliminate this circumvention. Based on hydraulic and chemical data collected since 2009, the PSDs concluded that some

additional groundwater extraction outside of the Barrier Wall would provide more effective capture of contaminated groundwater.

In September 2008 and April 2009, the PSDs provided groundwater elevation contour data that outlined the hydraulic effect of the Barrier Wall (see Figure 6). The Barrier Wall impacts groundwater by slowing it down within the wall's boundary. The influence of the Barrier Wall is also shown by the differences in groundwater elevation measurements taken inside and outside of the wall.

However the continued presence of contaminants outside of the Barrier Wall between the wall and Big Black Creek at the southeastern corner of the Site suggests that contaminated groundwater inside the Barrier Wall may possibly penetrate the wall, or circumvent the northeast tip of the wall. Likewise as noted in the March 19, 2012 report, this circumventing may also adversely affect the capture effectiveness of the three groundwater extraction wells outside of the Barrier Wall.

In 2009, toluene and other contaminants were discovered along the exterior of the western side of the Barrier Wall, migrating southward toward Big Black Creek. These contaminants have not yet migrated far enough to threaten Big Black Creek or human receptors. Possible locations of the source of these contaminants may be in the O.U. #2 area (being addressed by EPA in the short-term), or at and near (former) Lagoons #1, #2, and #3 in the O.U. #1 area. Investigation is ongoing to further evaluate and assure containment of this contamination.

Recommendation 2: Develop the PSVP and Contingent Remedial Action Plan. Implement PSVP, including installation and sampling of new monitoring locations.

The PSDs submitted a Draft PSVP on June 4, 2010, and a "PSVP Investigation Work Plan" on June 21, 2011, however these documents were not acceptable to the Agencies. The monitoring programs that were proposed did not have an adequate number of sampling locations, analytical parameters, or sampling frequency. Additional data however has been collected at the Site since 2008 using Vertical Aquifer Sampling and Membrane Interface Probe techniques to address some of the Agencies' concerns. EPA, MDEQ, and the PSDs continue to work toward development of an adequate PSVP. The PSVP will evaluate the data, and identify and address data gaps, in order to determine the effectiveness of the capture and containment measures at the Site and to aid in development of Contingent Remedial Actions. Completion of these measures depends in part on the results of the evaluation of the impact of the Act 190 revisions.

Recommendation 3: Implement Contingent Actions if capture of extraction wells is ineffective.

Data collected since the 2008 Five Year Review Report shows that there is still contamination in groundwater located outside of the Barrier Wall. Some of that contaminated groundwater appears to be reaching Big Black Creek. On January 31, 2012 the PSDs submitted a work plan for the Contingent Remedial Action of installation of one extraction well on the west side of the Barrier Wall to capture toluene and other contaminants recently discovered in that area. Based on comments and additional requirements from the Agencies, on May 18, 2012 the PSDs submitted a follow-up toluene investigation work plan. As part of the March 19, 2012 pump test

report, the PSDs submitted a Contingent Remedial Action plan for additional extraction in the southeast corner of the Site. None of these proposals were acceptable to the Agencies since the proposed actions did not adequately address the problem. In a subsequent April 3, 2013 letter, the PSDs suggested deferring further development of the proposals for Contingent Remedial Actions until the Agencies have determined the potential impact of amendments to Michigan Public Act 190. EPA has communicated to the PSDs that action is still required to address the toluene and other contaminants present at the west side of the Barrier Wall.

Remedy Implementation Activities

Remedy implementation activities that have taken place since 2008 include the installation of a series of new wells immediately adjacent to Big Black Creek, the successful recording of institutional controls for the O.U. #1 area, and routine operation and maintenance of the Barrier Wall, treatment wetlands, and protective soil cap. In January 2010, the PSDs completed installation of 5 well nests located immediately adjacent to Big Black Creek. These well locations contained data loggers and transducers to provide information rapidly and in greater detail. However, as of the date of the May 16, 2013 site inspection, this equipment has been removed. The wells were installed as an enhancement to the Site monitoring for more immediate knowledge of the conditions of Big Black Creek. On May 4, 2012, the Muskegon County Register of Deeds recorded the signed document "Declaration of Restrictive Covenant and Grant of Environmental Protection Easement" for the property within which O.U. #1 is located.

Institutional controls (ICs) are required for O.U. #1 to ensure the protectiveness of the remedy. ICs are non-engineered instruments (such as administrative and/or legal controls) that help minimize the potential for exposure to contamination and protect the integrity of the remedy. Compliance with ICs is required to assure long-term protectiveness for any areas which do not allow for unlimited use or unrestricted exposure (UU/UE). For O.U. #1, cleanup goals for the area are based on limited commercial or industrial (containment). Although ICs for O.U. #1 are in-place, additional work is needed to ensure the ICs are effective and that compliance with ICs will be achieved. IC evaluation activities should include the following:

- Development of an Institutional Controls Implementation and Assurance Plan (ICIAP) or an equivalent document to ensure that existing ICs and Long Term Stewardship (LTS) procedures are effective. The purpose of the ICIAP is to conduct additional IC evaluation activities to ensure that the implemented ICs are effective, to ensure that a Long Term Stewardship plan is reviewed and developed so that ICs are properly maintained, monitored, and enforced. Long-Term protectiveness requires compliance with the ICs. The purpose of the ICIAP is to conduct additional IC evaluation activities to ensure that the implemented ICs are effective and properly maintained, monitored, and enforced and to explore whether additional ICs are needed.

- Review of recordation and title work by EPA. Title work has been performed and has been reviewed by EPA. Title work should be periodically examined to ensure the restriction is still recorded. EPA should also work with the PSDs to determine if any prior-in-time recorded encumbrances (such as utility easements) may interfere with the ICs. If prior-in-time encumbrances exist, then additional work is needed to ensure

protectiveness of the remedy and to protect human health and the environment regarding any future repair work (such as excavation).

- Long-Term Stewardship (LTS) plans and procedures should be reviewed by EPA to ensure that the long-term stewardship procedures are clear. Long-term protectiveness requires continued compliance with the land and groundwater use restrictions to ensure that the remedy continues to function as intended. LTS will ensure that the ICs are maintained, monitored and enforced. Existing plans such as an LTS plan or a portion of the O&M Plan should include the mechanisms and procedures for inspecting and monitoring compliance with the ICs. For example, ICs should be regularly inspected. The LTS plan should require that an annual report be submitted to EPA to demonstrate: that the O.U. #1 area was inspected to ensure no inconsistent uses have occurred; that ICs remain in place and are effective; and that any necessary contingency actions have been executed. Results of IC reviews should be provided to EPA annually and with a certification that the ICs remain in-place and are effective.

Table 3: Summary of Planned and/or Implemented Institutional Controls
Bofors-Nobel Superfund Site; Muskegon, Michigan

Media, Engineered Controls and Areas that do not support UU/UE* for Current Conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented (or planned)
Former Waste Lagoon area. Soil cover that ensures prevention of contact with contaminated soil and sludge and associated emissions, site fencing, and posted warnings.	Yes.	Yes.	O.U. #1	ICs to prohibit the use of contaminated groundwater or soil, and prohibition of any activities that may damage any remedial action component or otherwise impair the effectiveness of any work to be performed.	The "Declaration of Restrictive Covenant and Grant of Environmental Protection Easement" for the property on which O.U. #1 is located was recorded on May 4, 2012.
Covered and Below-grade Chemical Sludge and Contaminated Soil. Below grade Barrier Wall around the Lagoon Area to contain contaminated material.	Yes.	Yes.	O.U. #1	ICs to prohibit the use of contaminated groundwater or soil, and prohibition of any activities that may damage any remedial action component or otherwise impair the effectiveness of any work to be performed.	The "Declaration of Restrictive Covenant and Grant of Environmental Protection Easement" for the property on which O.U. #1 is located was recorded on May 4, 2012.

Table 3: Summary of Planned and/or Implemented Institutional Controls Bofors-Nobel Superfund Site; Muskegon, Michigan					
Media, Engineered Controls and Areas that do not support UU/UE* for Current Conditions	**ICs Needed**	**ICs Called for in the Decision Documents**	**Impacted Parcel(s)**	**IC Objective**	**Title of IC Instrument Implemented (or planned)**
Contaminated groundwater in O.U. #1 and O.U. #2 areas. Below grade Barrier Wall around the Lagoon Area to contain and direct contaminated groundwater to a central collection point, and pumping of collected groundwater to a treatment system. Exterior extraction well(s) between the Barrier Wall and Big Black Creek to capture contaminated groundwater that is treated at a groundwater treatment plant.	Yes.	O.U. #1: Yes. O.U. #2: No (There is no O.U. #2 ROD yet)	O.U. #1 O.U. #2.	ICs to prohibit the use of contaminated groundwater or soil, and prohibition of any activities that may damage any remedial action component or otherwise impair the effectiveness of any work to be performed. Water use restrictions will be implemented with these deed restrictions, so that contact with Site related contamination would be restricted as a supplement to physical constraints.	The "Declaration of Restrictive Covenant and Grant of Environmental Protection Easement" for the property on which O.U. #1 is located was recorded on May 4, 2012.
Contaminated groundwater at the boundary of the Site property. Achieve ARARs at the Site boundary by containing contaminated groundwater with the Barrier Wall and extraction wells. Monitoring is performed to determine if ARARs are achieved.	Yes.	Yes.	O.U. #1	ICs to prohibit interfering with on-site remedy components, including components of the Barrier Wall and the extraction and treatment systems for contaminated groundwater.	The "Declaration of Restrictive Covenant and Grant of Environmental Protection Easement" for the property on which O.U. #1 is located was recorded on May 4, 2012.

Table 3: Summary of Planned and/or Implemented Institutional Controls
Bofors-Nobel Superfund Site; Muskegon, Michigan

Media, Engineered Controls and Areas that do not support UU/UE* for Current Conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented (or planned)
Groundwater aquifer that may potentially discharge into Big Black Creek (south end of the Site property). Below grade Barrier Wall constructed around the Lagoon Area that contains and directs contaminated groundwater to a central collection point, and pumping of collected groundwater to an acceptable treatment system. Exterior extraction wells between the Barrier Wall and Big Black Creek to capture contaminated groundwater.	Yes.	Yes.		ICs to prohibit interfering with on-site remedy components, including components of the Barrier Wall and the extraction and treatment systems for contaminated groundwater.	The "Declaration of Restrictive Covenant and Grant of Environmental Protection Easement" for the property on which O.U. #1 is located was recorded on May 4, 2012.

System Operation/Operation and Maintenance Activities

Lagoon Area and Groundwater

O&M of the TIC Remedy in the (former) lagoon area is the responsibility of the PSDs, who have agreed to a long term commitment to continue O&M until all remedial objectives are met and maintained. EPA and MDEQ will also continue to monitor the Site's activities to make sure that Consent Decree requirements are being satisfied.

As the Barrier Wall is a below grade containment structure, there is minimal maintenance required for that remedy component. The protective soil cover, phytoenhancement components, and treatment wetland/diffuser trench also require maintenance. Because monitoring data has not demonstrated satisfactory containment of contaminated groundwater between the Barrier Wall and Big Black Creek, it has not been possible to certify that the lagoon area and groundwater containment aspects of the O.U. #1 remedy are fully operational and functional (O&F). Regardless of the O&F status of this O.U. #1 remedy, the PSDs routinely perform the following for the TIC Remedy:
- upkeep, monitoring, and routine inspection of the vegetative portion of the TIC Remedy, including introduction of nutrients and irrigation, if needed;
- regular inspections of the O.U. #1 lagoon area cover to assure the protectiveness of the cover, to prevent disturbance and exposure to contaminated soils remaining underneath the cover, and to assess whether adverse ecological effects are occurring at the Site;
- removal or replacement of vegetation if needed;
- maintain Site drainage and roadways, and;
- upkeep of any additional extraction system components installed to augment groundwater containment provided by the Barrier Wall.

For the (former) lagoon area of O.U. #1, additional individual O&M events since the last five-year review in 2008 included drainage repairs in August 2010 to certain portions of specific (former) lagoon and access road areas to address excess surface water flow and unacceptable erosion issues, and a summer 2012 action to eliminate phragmites from the O.U. #1 area. Phragmites is an aggressive, non-native plant known to overrun wetlands.

The groundwater containment and pump and treat portion of the O.U. #1 remedy continues to be operated by the PSDs and Camus. GWTP operation and maintenance is performed under a Prospective Operators' Agreement (POA) by Camus, LLC which is a partnership formed through the neighboring facility, Sun Chemical. O&M of the GWTP by Camus has not changed since the third five-year review in 2008. Extraction wells exterior to the Barrier Wall continue to operate, and attempt to capture groundwater between the Barrier Wall and Big Black Creek. In addition to operating the extraction and treatment processes, O&M tasks for the GWTP and currently operating extraction wells include:
- procurement of utilities such as gas, water, communications, and electricity;
- extraction well cleaning, rehabilitation, and preventive maintenance;
- re-development of wells as needed;
- continued groundwater sampling and analysis;
- general repair, maintenance, and minor improvements to the system(s) and GWTP

buildings and grounds; and
- repair and upgrade of: groundwater collection piping and valving, emission control equipment, residuals handling equipment, monitoring and extraction wells, and extraction well buildings and associated equipment.

Since approximately 2001, treated water has been sent to Sun Chemical from the GWTP with no effluent discharge to Big Black Creek. Therefore there have not been any unacceptable exceedances of NPDES discharge permit limits. Review of monthly GWTP reports from 2008 to 2013 reveal that there have been no substantial breakdowns or major repairs. A discharge permit from the Muskegon County Wastewater Management System (MCWMS) is required for disposal of extracted groundwater into the County sewer system. The GWTP currently treats approximately 200 to 300 gallons per minute. There have been no problems noted with any of the discharge permit procedures for the Site. Long-term maintenance of the GWTP will be continued and is required to ensure that the remedy remains effective, and ensures containment of Site waste material.

Operable Unit #2

For O.U. #2 areas, asphalt capping of contaminated soil areas was completed and hygienic groundwater sampling occurs under the requirements of an Interim Remedial Action Plan (IRAP), approved and overseen by MDEQ. EPA has not yet issued a remedy decision for O.U. #2; therefore, there are no remedy O&M considerations for this portion of the Site. Sun Chemical's current warehousing and storage activity within O.U. #2 pose no threat of interference with the work completed for the IRAP. Land use in O.U. #2 by Sun Chemical presents no threat of causing any unacceptable exposure pathways. Continued deterioration of the buildings in the O.U. #2 area, however, could cause releases in the event of building collapse.

III. FIVE-YEAR REVIEW PROCESS

Administrative Components

The PSD Group was notified of the initiation of the five-year review on March 7, 2013. The Bofors-Nobel Superfund Site Five-Year Review was led by John V. Fagiolo and Timothy Fischer of the EPA, Remedial Project Managers for the Site, as well as Dave Novak, EPA Community Involvement Coordinator (CIC). Walelign Wagaw of the MDEQ assisted in the review as the representative for the support agency.

The review, which began on January 2, 2013, consisted of the following components:

- Community Involvement;
- Document Review;
- Data Review;
- Site Inspection; and
- Five-Year Review Report Development and Review.

Community Notification and Involvement

Activities to involve the community in the five-year review process were initiated with discussion between the RPM and CIC for the Site. A notice was published in the local newspaper, the Muskegon Chronicle on May 28, 2013, stating that there was a five-year review and inviting the public to submit any comments to the EPA. The results of the review and the report will be made available at the Site information repositories located at:

Egelston Township Hall
5382 East Apple Avenue
Muskegon, MI 49442

Hackley Library
316 West Webster Street
Muskegon, MI 49440

The Administrative Record may also be reviewed at:

U.S. EPA Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604

Document Review

This five-year review consisted of a review of relevant documents including O&M records and monitoring data. Applicable groundwater, surface water, and soil cleanup standards, as listed in the July 1999 Second Amendment to the O.U. #1 Record of Decision were also reviewed. Table 6 is a list of the documents that were reviewed.

Data Review

Because the TIC remedy has been subject to design, construction, and start-up since 2000, no permanent long-term groundwater monitoring program has yet been established for this Site. However since 2000, Interim Monitoring (IM) of groundwater has been conducted at the Site at various wells throughout the O.U. #1 area. IM events have occurred at the Site on a regular basis; generally every 3 months.

Since the third Five Year Review Report in 2008, the focus of sampling has been the effectiveness of the groundwater containment provided by the Barrier Wall and the effectiveness of the groundwater extraction wells exterior to the Barrier Wall in their protection of Big Black Creek. In January 2010, the PSDs completed installation of 5 well nests located immediately adjacent to Big Black Creek (the "GSI Wells"). These GSI Wells contained data loggers and transducers and allow for collection of samples representative of groundwater that is 10, 20, and 30 feet underground. IM data does not include samples of the surface water or the sediment of Big Black Creek. However, as part of IM events, the water accumulation location inside the treatment wetlands (the "Weir") is sampled. Groundwater flowing through the O.U. #1 area from the north is forced upward to ground level by the effect of the Barrier Wall and is sampled at location WT-1 (see Figure 7).

For this Five Year Review, IM data was examined for selected organic and inorganic parameters. EPA has tried to determine if there are any distinct trends of the presence and locations of contamination in groundwater around and outside of the Barrier Wall and along Big Black Creek. IM data since 2008 shows the continued presence of contaminants in groundwater at both shallow and deeper depths in the southeast corner of the Site outside of the Barrier Wall between the wall and Big Black Creek, as discussed below. In general, the containment effect of the Barrier Wall has been documented by chemical and hydraulic groundwater data; however there remains some uncertainty as to the effectiveness of groundwater extraction exterior to the Barrier Wall. In addition, there are uncertainties regarding the effectiveness of the wall in containing groundwater contamination on the western side, and at points on the southeast and southwest corners.

Table 7 provides a limited summary of data collected from the GSI Wells. Because the GSI Wells are located between the extraction wells and Big Black Creek, and because sampling results show continuing contamination within the GSI Wells, uncertainty remains as to the capture effectiveness of the system. A chronology of analytical data from location WT-1 is also included in Table 7. Samples from WT-1 are of water that has flowed through the treatment wetland. Data collected since the 2008 five-year review shows that contaminant levels within the area of O.U. #1 contained within the Barrier Wall have not reduced in concentrations over the past five years. For example, the contaminant toluene is at a concentration within the treatment wetland (which is located inside the containment area created by the Barrier Wall) at a level approximately ten times higher in 2013 than what was present in 2008. This suggests that the treatment component of the O.U. #1 remedy within the contained areas may not be effective in reducing contaminant concentrations within a reasonable timeframe.

Contaminants in the groundwater in some areas between the Barrier Wall and Big Black Creek are at concentrations above GSI criteria protective of Big Black Creek. Groundwater extraction wells are intended to capture groundwater that would otherwise reach Big Black Creek. Recent data shows this extraction system generally provides protection but at times provides inconsistent capture. The data shows groundwater is retained in this location as a result of the effect of the extraction wells. Recent analysis of Creek water samples has not shown levels of contamination in the water above standards for protection of Big Black Creek. Figure 8 shows groundwater elevations at and around the extraction wells and this hydraulic data suggests that groundwater does not appear to continuously flow toward the extraction wells in all directions. Groundwater chemical data collected since the 2008 five-year review shows concentrations above GSI cleanup criteria for certain contaminants outside of the Barrier Wall at depths below the level of Big Black Creek. These compounds include 3,3-dichlorobenzidine and benzidine. In addition, in the area southwest of the Barrier Wall and to the west of the Barrier Wall, Interim Monitoring data suggests the presence of inorganic contaminants at levels above cleanup criteria. These inorganic contaminants include silver and zinc.

Although chemical and hydraulic data have been collected consistent with one of the recommendations of the last five-year review in 2008, compliance with the remedy's current performance standards for containment of groundwater and protection of Big Black Creek has not been demonstrated with adequate consistency by the PSDs. EPA, in consultation with

MDEQ, is considering the impact of recent changes to Michigan Act 190 on the point of compliance (POC) for determining whether the GSI ARAR is met.

Groundwater sampling and inspection of capped O.U. #2 areas is being performed by EPA for the upcoming final O.U. #2 Record of Decision. As the O.U. #1 TIC Remedy was designed to contain all site groundwater, contamination in the groundwater underneath O.U. #2 is to be captured by the O.U. #1 containment systems.

Site Inspection

The inspection of the Site was conducted on May 16, 2013. In attendance were John Fagiolo with consultation by Timothy Fischer of the EPA, Remedial Project Managers for the Site, and Walelign Wagaw and Chuck Graff of the MDEQ. The purpose of the inspection was to assess the protectiveness of the remedy. The five-year review Site inspection checklist was completed using information from this inspection and is included as Table 11 in Appendix B of this report. Representatives of the Agencies walked the site access roads. The constructed wetlands, the weir/sump building, an extraction well pump house, and the protective soil cover over the (former) lagoon area surface were visually inspected. The Site perimeter (fence line) was also visually inspected at certain points. The O.U. #1 area was found to be in good condition during the inspection. There are no signs of erosion and access roads have recently been repaired and are in good condition. The Site showed no signs of any vandalism or other disturbances. Where inspected, the access fence was properly in place, and there was no visual evidence that the Barrier Wall and weir/sump structure were damaged. All Site areas were clean and free of debris. Extraction and monitoring well locations that were observed appeared intact, including vehicular barriers and padlocks. Since the last five-year review in 2008, EPA, MDEQ, and the PSDs consulted by electronic mail and telephone to discuss site issues.

Interviews

Most of the area surrounding the Site is undeveloped forest, with some industrial and commercial facilities interspersed. Residential areas nearby are semi-rural, with approximately 500 residents in a one-mile radius of the Site. Site contamination exists within the site boundary and no private residential wells near the Site are affected. Therefore, no community interviews were conducted for this five-year review. However, an advertisement notice regarding the five-year review process was placed in the Muskegon Chronicle newspaper for public review on May 28, 2013, and is included as Figure 9 in Appendix B of this report. Except for correspondence from the MDEQ and the PSDs, no public comments regarding the five-year review have been received.

During the FYR process, questions and other correspondence were submitted by electronic mail and telephone with the PSDs and MDEQ. The purpose of correspondence and discussions since January 2013 was to document any perceived problems or successes with the remedy that has been implemented to date. This information is summarized below.

No problems have arisen regarding access to the Site, and as previously noted, the PSDs have successfully implemented ICs for the O.U. #1 area. Site access is restricted with Sun Chemical

providing security and with access control on neighboring properties. The PSDs' contractors who sample wells and perform extraction well maintenance are on Site approximately every 3 months on average, providing visual observation and reporting of any irregularities on Site.

With regard to any successes or problems with the construction of the remedy or operation and maintenance, correspondence and discussions to date establish MDEQ's position that quality control and monitoring procedures may be inadequate to ensure an effective remedy.

IV. TECHNICAL ASSESSMENT

Question A: Is the remedy functioning as intended by the decision documents?

The barrier wall appears to be working for those contaminants that start their migration within its perimeter. Groundwater data shows that the exterior extraction wells are creating an area of stagnant groundwater flow and may preventing the migration of contaminated groundwater. However, recent data also shows this extraction system provides inconsistent capture. Data collected since the 2008 five-year review has documented that the O.U. #1 TIC Remedy has not successfully achieved the performance standards required by the 1999 ROD Amendment. Contaminant concentrations on site remain above cleanup standards. The constructed remedy has substantially achieved the Remedial Action Objectives of containing lagoon sludge and soils to prevent on-site exposure to hazardous substances and to prevent migration of contaminants at concentrations that would pose an unacceptable risk to human and/or environmental receptors off-site including to Big Black Creek and to the on-site wetlands between Big Black Creek and the Barrier Wall. The remedy is considered protective in the short term since no one is drinking contaminated groundwater and direct contact threats have been mitigated, but for long-term protectiveness Contingent Remedial Actions should be developed and implemented.

Based on cleanup standards included in the 1999 Second Amendment to the O.U. #1 Record of Decision, contaminants in the area between the Barrier Wall and Big Black Creek are at concentrations above criteria protective of Big Black Creek. Groundwater extraction wells are intended to capture groundwater that would otherwise reach Big Black Creek and as mentioned previously, the extraction system does not consistently provide capture. Contingent Remedial Actions as required by the 1999 Consent Decree must be implemented to ensure adequate capture of contaminated groundwater before it reaches Big Black Creek at unacceptable levels. These actions could entail re-starting extraction wells inside the Barrier Wall area, repair or maintenance of existing extraction wells outside the Barrier Wall, increasing pumping of existing or proposed extraction wells, or installation of additional extraction wells. The June 2012 change to State of Michigan environmental statutes means that Points of Compliance for the cleanup criteria for the groundwater/surface water interface must also be reviewed for this Site.

Recent inspections show no evidence of current exposure. There is no cracking, sliding, and settlement of the protective cover or other indicators of cover breaches. Collected site groundwater is adequately treated or disposed of. With continued maintenance and monitoring of the lagoon area protective cover, wetlands and vegetative remedy components, groundwater extraction, and groundwater treatment systems inside the security perimeter fences, the source

area remedies should generally contain any contamination and ensure protectiveness in the short term.

In order for the remedy to remain protective in the long-term, ICs that prevent disturbance of the cover, groundwater collection systems, and groundwater treatment systems have been executed and recorded and will be maintained. The PSDs will perform IC maintenance and verification as part of ongoing O&M, which ensures long term protectiveness of the remedy and prevention of exposure to existing contaminant levels. Site access and use is restricted by GWTP operations personnel, adequate security perimeter fencing, and locked gates.

O&M procedures will help ensure the short term protectiveness of the remedy. There have been no inordinate variances in O&M costs since the 2008 five-year review. Since their take-over of the Bofors-Nobel site in 2000, the PSDs have identified optimization opportunities and implemented performance improvements and cost reductions. As such, there are few additional optimization opportunities until Contingent Remedial Actions are implemented.

Early Indicators of Potential Issues. While there have been positive containment effects from the barrier wall and extraction wells, site data does not confirm complete capture. Groundwater monitoring needs to continue in order to evaluate the effectiveness of the O.U. #1 TIC Remedy. Long-term monitoring programs need to be finalized to ensure that groundwater monitoring adequately assesses the remedy components at the Site. No frequent equipment breakdowns have occurred that effect short term effectiveness.

Implementation of Institutional Controls and Other Measures. The 1990 ROD and 1992 and 1999 ROD Amendments require implementation of deed/access restrictions and/or other Institutional Controls to control future development of the Site, and assure the integrity of the remedial action. In order for the remedy to remain protective in the long-term, ICs that prevent use of groundwater and disturbance of the protective cover, wetlands/vegetative components, groundwater collection systems, and the groundwater treatment system have been implemented, are effective, and will be maintained. On May 4, 2012, the Muskegon County Register of Deeds recorded the signed document "Declaration of Restrictive Covenant and Grant of Environmental Protection Easement" for the property within which O.U. #1 is located. Consistent with the requirements of the 1999 Consent Decree, the PSDs will monitor and maintain ICs under the oversight of the EPA. IC maintenance will ensure the long-term protectiveness of the remedy and will prevent exposure to existing contaminants. Inappropriate site or media uses were not identified from the Site inspection or other project information, and access controls are in place and are effective in preventing exposure.

Current Use Compatibility with Land and Groundwater Use Restriction. Any use that interferes with any remedy components would not be protective of human health and the environment. According to inspections, there is no current use of the Site, which has access restricted by a locked gate and fencing. Land use on adjacent parcels is not anticipated to impact the Site. The remedy components must remain in place indefinitely to prevent exposure to underlying waste. The Site property is currently zoned as industrial.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy section still valid?

Yes, although EPA is re-evaluating the proper Points of Compliance for the GSI ARAR because of a recent change to Act 190, a State of Michigan law.

Changes in Standards and To Be Considereds" (TBCs). As noted elsewhere in this report, June 20, 2012 was the effective date of Michigan Public Act 190 ("Act 190"). Act 190 does not change the substantive standards established to identify groundwater contamination that may present a threat to surface water at the groundwater-surface water interface (GSI). The remedy identifies the GSI standards as an ARAR for containment of groundwater to prevent migration of contaminants at concentrations that would pose an unacceptable risk to human and/or environmental receptors off-site including to Big Black Creek and to the on-site wetlands between Big Black Creek and the Barrier Wall.

The Act 190 revisions focus mainly on procedural options for demonstrating compliance. While those procedural requirements are not considered to be part of the ARAR, they suggest that EPA may potentially allow the use of a mixing zone in developing the Point of Compliance for the Site. A mixing zone considers the dilution by Big Black Creek of contaminants in discharging groundwater. A mixing zone could allow a greater concentration of contaminants in groundwater to migrate into Big Black Creek because of the creek's ultimate dilution of those contaminants. Thus a change in the point of compliance to include a mixing zone calculation would adjust the GSI standards to be applied at the GSI compliance wells at the Creek's edge.

Changes in Exposure Pathways. No changes in the Site conditions that affect exposure pathways were identified as part of the five-year review. However, as noted previously concerns remain regarding the in ability to demonstrate groundwater capture. There are no current or known planned changes in the Site land use. Groundwater monitoring programs implemented and currently being developed are or will adequately assess the Site groundwater plume. Although there are contaminants identified in new locations since the 2008 five-year review, they have not yet migrated to create any new human health or ecological exposure off-Site. These new locations are being (or have been) assessed and will be addressed by a future remedial action or Contingent Remedial Action. No unanticipated toxic byproducts of the remedy were identified in this five-year review, nor were there any changes in physical site conditions identified.

Changes in Toxicity and Other Contaminant Characteristics. Toxicity factors, contaminant characteristics for contaminants of concern have not changed in any way that could affect the protectiveness of the remedy.

Changes in Risk Assessment Methods. Except for State of Michigan cleanup standards that are regularly updated as human health risk data are acquired, methodologies used to establish State of Michigan health-based standards and assess risk at the Bofors-Nobel Site since the 1999 Amendment to the Record of Decision have not changed. Any changes in the State of Michigan standards do not call into question the protectiveness of the remedy.

Expected Progress Towards Meeting RAOs. It is anticipated that Remedial Action Objectives may not be achieved in a time frame of 30 years or less by the current remedy without Contingent Remedial Actions. However the PSDs have agreed to a long-term commitment to continue work at the Site until all remedial objectives are met and maintained.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No. Contaminant toxicity and exposure pathways that would affect the protectiveness of the remedy have not changed. There have been no newly identified ecological risks nor have any natural disasters adversely impacted the O.U. #1 remedy.

Technical Assessment Summary

The O.U. #1 remedy is generally protective buts provides inconsistent capture of contaminated groundwater between the Barrier Wall and Big Black Creek. The remedy is considered protective in the short term, but for long-term protectiveness the Contingent Remedial Actions should be implemented. Recent inspections show no evidence of current exposure. There is no cracking, sliding, and settlement of the protective cover or other indicators of cover breaches. Collected site groundwater is adequately treated or disposed of. In order for the remedy to remain protective in the long term, ICs that prevent disturbance of the cover, groundwater collection systems, and groundwater treatment systems have been executed and recorded, are effective, and will be maintained. Site access and use is restricted by GWTP operations personnel, adequate security perimeter fencing, and locked gates. O&M procedures will maintain the effectiveness of the remedy. There have been no inordinate variances in O&M costs since the 2008 five-year review, and thus no indication of a potential remedy problem connected to O&M. No early indicators of potential remedy failure were noted during the review. No frequent equipment breakdowns or changes have occurred that would suggest any potential adverse effect to protectiveness. According to inspections, there is no current use of the Site, which has access restricted by a locked gate and fencing. Land use on adjacent parcels is not anticipated to impact the Site. There are no current or known planned changes in the Site land use.

The point of compliance for evaluating achievement of the RAOs used at the time of the remedy section may be reconsidered to be consistent with a recent change to a State of Michigan law. Act 190 potentially changes how the GSI pathway is evaluated under Part 201 of NREPA of 1994. The methods to measure compliance with GSI standards may potentially change because of Act 190.

Except for the possible loss of capture in the groundwater extraction wells outside of the Barrier Wall, no changes in the Site conditions that affect exposure pathways were identified as part of the five-year review. Groundwater monitoring programs implemented and currently being developed are or will adequately assess the Site groundwater plume. No unanticipated toxic byproducts of the remedy were identified in this five-year review, nor were there any changes in physical site conditions identified. Toxicity factors, contaminant characteristics for contaminants of concern have not changed in any way that could affect the protectiveness of the remedy.

Except for State of Michigan cleanup standards which are regularly updated as human health risk data is acquired, methodologies used to establish State of Michigan health-based standards and assess risk at the Bofors-Nobel Site since the 1999 Amendment to the Record of Decision have not changed, and do not call into question the protectiveness of the remedy.

It is anticipated that Remedial Action Objectives may not be achieved in a time frame of 30 years or less by the current remedy without Contingent Remedial Actions. However the PSDs have agreed to a long term commitment to continue work at the Site until all remedial objectives are met and maintained. No other information has come to light that could call into question the protectiveness of the remedy.

V. ISSUES/RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Table 4 shows recommendations and follow-up actions resulting from this five-year review, as well as an approximate completion schedule.

Table 4: Issues and Recommendations/Follow-up Actions

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 1	**Issue Category: Remedy Performance.**			
	Issue: The containment effectiveness of the Barrier Wall and the capture effectiveness of the three groundwater extraction wells outside the Barrier Wall must be confirmed.			
	Recommendation: Continue sampling monitoring wells at and around the Barrier Wall and between the Barrier Wall and Big Black Creek.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	June 2015

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 1	**Issue Category: Remedy Performance.**			
	Issue: The containment effectiveness of the Barrier Wall and the capture effectiveness of the three groundwater extraction wells outside the Barrier Wall must be confirmed.			
	Recommendation: Implement Contingent Remedial Actions proposed in the PSDs' 3/19/12 report and revised as required by EPA (with consultation by MDEQ) if wells' capture continues to fluctuate.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA	December 2013

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 1	Issue Category: Changed Site Conditions.			
	Issue: Public Act 190 revisions may support changes to the acceptable measurement of compliance with the remedy's Performance Standards and Remedial Action Objectives.			
	Recommendation: Review Act 190 and provide a site specific determination on its requirements for the remedy at the Site.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	State	EPA	December 2013

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 1	Issue Category: Changed Site Conditions.			
	Issue: Public Act 190 revisions may support changes to the acceptable measurement of compliance with the remedy's Performance Standards and Remedial Action Objectives.			
	Recommendation: Effectively implement Contingent Remedial Actions to satisfy Act 190 requirements.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA/State	December 2013

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 1	Issue Category: Institutional Controls.			
	Issue: Additional IC evaluation activities should be performed to ensure that implemented ICs are effective and properly maintained, monitored, and enforced, and to explore whether additional ICs are needed.			
	Recommendation: Develop an Institutional Control Implementation and Assurance Plan or incorporate equivalent procedures and protections into a site operations and maintenance plan.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	EPA/State	December 2014

In addition, the following recommendations were identified to improve the effectiveness of the remedy and accelerate Site close-out but do not affect current or future protectiveness:

- Assess the effectiveness of the treatment wetland, where contaminants are contained but concentrations are not decreasing. Recent data on contaminants inside the Barrier Wall suggests cleanup standards inside the Barrier Wall may not be achieved in a time frame of 30 years or less by the current remedy without Contingent Remedial Actions. The implementation of a Contingent Remedial Action is expected to improve the performance

of the contained treatment wetland. Because the treatment wetland is located within the containment area created by the Barrier Wall, and protection of human health and the environment is provided mainly through containment, for this five-year review this issue is not considered to affect short- or long-term protectiveness.

- Ensure that there is no standing water in the treatment wetland to prevent attraction of wildlife and other potential ecological receptors.

- Prevent migration of toluene and other contaminants located along the exterior of the western side of the Barrier Wall to Big Black Creek. These contaminants do not currently threaten Big Black Creek. Exposure pathways are controlled. The source may be the O.U. #2 area although portions of the O.U. #1 area may be contributing. The implementation of a Contingent Remedial Action to capture and treat these contaminants as part of the O.U. #1 remedy, and EPA's O.U. #2 Record of Decision will address this issue. As a result, this issue is not included in the table above as a separate issue affecting short- or long-term protectiveness.

VI. PROTECTIVENESS STATEMENT

Protectiveness Statement(s)	
Operable Unit: 1	*Protectiveness Determination:* Short-term Protective
Protectiveness Statement: The remedy at Operable Unit #1 of the Bofors-Nobel Site is protective of human health and the environment in the short term. Exposure pathways that could result in unacceptable risks are being controlled. ICs are in place and groundwater extraction wells generally provide capture of contaminated groundwater between the Barrier Wall and Big Black Creek. However, consistent groundwater capture is a concern. To ensure long-term protectiveness, the following actions need to be taken: continued monitoring of groundwater at and around the Barrier Wall and between the Barrier Wall and Big Black Creek; implementation of Contingent Remedial Actions to address lack of complete groundwater capture; provide a site-specific determination on Act 190 as to its requirements; and, effectively implement Contingent Remedial Actions to satisfy Performance Standards and Remedial Action Objectives. Long-Term protectiveness requires compliance with the institutional controls. Although the ICs for OU #1 are in-place, additional work is needed to ensure the ICs are effective and that compliance with ICs will be achieved. To that end, an Institutional Controls Implementation and Assurance Plan (ICIAP) or equivalent document will be developed to ensure that existing ICs and Long-Term Stewardship (LTS) procedures are effective. The purpose of the ICIAP is to conduct additional IC evaluation activities to ensure that the implemented ICs and LTS procedures are effective so that the ICs are properly maintained, monitored, and enforced.	

VII. NEXT REVIEW

The next five-year review report for the Bofors-Nobel Superfund Site is required five years from the completion date of this review.

APPENDIX A: EXISTING SITE INFORMATION

A. SITE CHRONOLOGY

Date	Event
1960	Lakeway Chemicals begins production at the Site, using unlined lagoons to dispose of process waste.
1976	Lagoon disposal was discontinued.
Sept. 1976	Lakeway Chemicals and the State of Michigan sign a Consent Order to address contamination. Eight extraction wells are installed along Big Black Creek.
1977	Lakeway Chemicals merges with Bofors Industries.
1980	Additional extraction wells are installed by Bofors.
Dec. 1981	Bofors-Lakeway merges with Nobel.
July 1983	Three groundwater extraction wells installed by Bofors (new and replacement wells).
Dec. 1985	Bofors-Nobel files for bankruptcy.
June 1986	Site Inspection report issued.
Sept. 1986	Documentation report for Hazard Ranking System (HRS) issued.
March 1987	The operating plant area (O.U.#2) is sold out of bankruptcy to Lomac, Inc. Proceeds of this sale and other Bofors assets are paid to the United States (who places this resource into a Special Account) and Michigan, who uses the money for site response actions including the RI/FS and continued groundwater extraction and treatment.
March 1987	Remedial Investigation/Feasibility Study (RI/FS) started.
April 1987	Three additional extraction wells are installed.
Mar. 1989	Bofors-Nobel site included on the National Priorities List (NPL).
Feb. 1990	RI completed.
May 1990	FS completed.
Sept. 17, 1990	O.U. #1 ROD issued by U.S. EPA.
Mar. 1991	Remedial Design (RD) of O.U. #1 GWTP started by USACE.
Nov. 1991	Supplemental FS completed.
May 1992	Remedial Design (RD) of O.U. #1 GWTP completed by USACE.
July 1992	GWTP construction contract awarded by USACE.
July 22, 1992	Amendment to the O.U. #1 ROD issued by U.S. EPA.
Oct. 1992	Construction of the GWTP starts.
March 1993	RD for the Landfill Remedy portion of O.U. #1 approved by U.S. EPA.
May 26, 1993	USACE postpones indefinitely the bid process for construction of the Landfill Remedy (later cancelled in 1994).
July 1993	U.S. EPA sends Special Notice Letter to PRPs.
October 1993	U.S. EPA instructs USACE to further delay landfill construction to allow for negotiations.
June 1994	General contractor completes on-site testing of GWTP process equipment as required by USACE.
July 1994	Formal alternative Lagoon Area remedy proposal (Total In-Situ Containment, or "TIC") presented to U.S. EPA.
Sept. 24,1994	GWTP begins treatment of contaminated groundwater.

March 1996	Leaks documented in C-5000 oxidation tanks of GWTP, beginning extended negotiations regarding equipment warranty.
May 6, 1996	Explanation of Significant Difference issued by U.S. EPA to explain cost increases during design and construction of the GWTP.
May 31,1996	U.S. EPA issues Re-Evaluation of Selected Remedy document.
Nov. 1996	First GWTP walk-through by MDEQ and U.S. EPA.
Nov. 20, 1996	MDEQ awards GWTP operations contract through a Cooperative Agreement.
Nov. 13, 1997	Second GWTP walk-through by MDEQ and U.S. EPA.
May 19, 1998	U.S. EPA and MDEQ declare the GWTP operational and functional.
Sept. 30,1998	First five-year review (Type la) completed by U.S. EPA.
July 16, 1999	Second amendment to the O.U. #1 ROD issued by U.S. EPA.
Nov. 1999	Consent Decree for RD/RA of TIC Remedy signed.
Dec. 2, 1999	Effective date of Prospective Operator's Agreement (POA) for take-over of GWTP operation by Sun/Lomac partnership.
Feb. 2000	Take-over of Extraction Well Field and GWTP by Sun/Lomac and PSDs.
April 12, 2000	Explosion at the operating Lomac production facility (O.U. #2).
Aug. 2000	Site Management Transition (to PSDs' control) Plan approved.
Oct. 2000	Interim Groundwater Monitoring started.
August 2002	TIC Remedial Design Work Plan approved.
August 2002	Barrier Wall (Phase 1) design started. Phase 1 design included geotechnical and compatibility testing of materials.
Dec. 2002	Eleven (11) new monitoring wells installed and lagoon area soil sampled.
March 2003	Second five-year review process started.
August 7, 2003	Second Five-Year Review Report is signed.
November 2003	Pre-Design Data and Treatability Report Completed. This Report included the results of studies on the viability of various plant species.
August 10, 2004	Barrier Wall (Phase 1) design completed.
September 13, 2004	Barrier Wall (Phase 1) construction started.
December 8, 2005	Final Inspection of Barrier Wall.
December 19, 2005	Demobilization of Barrier Wall construction contractor.
September 2003	Wetlands/Weir (Phase 2) design started.
March 2006	Wetlands/Weir (Phase 2) design completed.
April 2006	Wetlands/Weir (Phase 2) construction started.
November 14, 2007	Final Inspection of Phase 2 construction.
January 2, 2008	Third five-year review process is started.
January 18, 2008	Demobilization of Phase 2 construction contractor.
February 27, 2008	Site inspection by the PSDs, U.S. EPA, and MDEQ.
August 7, 2008	Third Five Year Review Report is signed.
June 2009	Quarterly groundwater sampling discovers elevated levels of toluene in piezometer PZ-111A, outside of the western portion of the barrier wall.
July 22, 2009	EPA issues correspondence and a technical memorandum specifying the requirements for a Performance Standard Verification Plan (PSVP).
October 16, 2009	An "Infrastructure Work Plan" is provided by the PSDs proposing new GSI monitoring wells with transducers and loggers adjacent to Big Black Creek.
November 23, 2009	EPA provides an electronic mail message stating that the new GSI wells may not provide information adequate to certify operational and functional status of the O.U. #1 remedy.

April 21, 2010	A report is provided by the PSDs documenting the completion of the GSI wells and a new proposal for revised monitoring of groundwater and Big Black Creek.
June 4, 2010	A Draft PSVP is provided by the PSDs that is unacceptable to EPA (with consultation from MDEQ).
September 7, 2010	The PSDs provide a proposal to address the toluene at PZ-111A and further revise the Site's monitoring programs.
October 1, 2010	The PSDs provide a proposal for evaluation of the southeast corner of O.U. #1 outside the barrier wall, known as the "Meander Bend."
November 18, 2010	The PSDs provide a report on the August 2010 drainage repairs to certain portions of (former) lagoon and access road areas, improvement of excess surface water flow, and repair of unacceptable erosion.
Dec. 2010 and Jan. 2011	MDEQ installs monitoring wells and samples and analyzes groundwater in the southwest corner of O.U. #1, outside of the barrier wall and between the wall and Big Black Creek.
March 14, 2011	The PSDs provide a proposal for evaluation of the Treatment Wetland inside the barrier wall. Contaminant concentrations had been increasing in this area since barrier wall installation in 2007.
May 26, 2011	The PSDs provide a response to EPA's July 22, 2009 PSVP Requirements memorandum but do not follow all of EPA's requirements.
June 9, 2011	The PSDs provide the Meander Bend Area Fall 2010 Data Report.
June 15, 2011	Hydraulic data and water level contours are provided using March 2009 and September 2010 data, however fluctuations in the capture of contaminated groundwater remain.
June 21, 2011	The PSDs provide a 2011 PSVP Investigation Work Plan that includes a pumping test for extraction wells in the Meander Bend.
August 16, 2011	The PSDs provide a Report of Results: Treatment Wetland June 2011 Sampling.
March 19, 2012	The PSDs provide a Pump Test Report and Contingent Remedial Action Plan that EPA (with consultation by MDEQ) deems incomplete.
June 20, 2012	The effective date of Michigan Public Act 190 ("Act 190"), which may revise the manner in which GSI compliance is measured.
January 2, 2013	Fourth five-year review process is started.
April 3, 2013	The PSDs communicate that they believe no Contingent Remedial Actions are necessary because of the changes brough forth by Act 190.
May 16, 2013	Site inspection by the PSDs, U.S. EPA, and MDEQ.

B. BACKGROUND

Physical Characteristics

The Bofors-Nobel site is located in the South 1/2 of Section 32, Township 10 North, Range 15 West, generally at 5307 Evanston Avenue in Egelston Township, Muskegon County, Michigan (see Figures 1 and 2). The 85-acre site includes a former specialty chemical production facility, an unused landfill cell, and 10 abandoned sludge lagoons, which were covered by a protective soil cover in November 2007 (see Figures 3 and 4). The former chemical plant area of the Site occupies approximately 39 acres. The southern portion of the Site is bounded by Big Black Creek. The site has been divided into two operable units (see Figure 3). The amended Record of Decision has designated the unlined sludge disposal lagoons and underlying contaminated soil

and groundwater as O.U. #1. Contamination at and underneath the operating plant area of the Site owned by Sun Chemical (formerly Lomac; "Sun/Lomac") is to be addressed as O.U. #2. After the 1985 to 1987 bankruptcy proceedings, the State of Michigan assumed control of site access and security until 2000 when the remedy was taken over by Sun/Lomac and the Potentially Responsible Parties for the Site, also known as the Performing Settling Defendants (PSDs).

Land and Resource Use

The site is a former specialty organic chemical production facility that operated under a series of owners from 1960 until 1985. Lakeway Chemicals, Inc. ("Lakeway") began producing industrial chemicals at the Site in or around 1960. The plant produced alcohol-based detergents, saccharin, pesticides, herbicides, and dye intermediates. Unlined lagoons were used for disposal of wastewater, sludge, and other residuals from chemical production until approximately 1976. Wastes disposed of in the lagoons included iron sludge, iron scale, 3,3'-dichlorobenzidine ("3,3-DCB"), benzidine, and other organic wastes, zinc oxide waste, wastes generated from spills, calcium sulfate sludge and detergent wastes. Lakeway Chemical was acquired by Bofors-Sweden, which was then later acquired by Nobel Industries. Nobel Industries was eventually acquired by Akzo Chemical.

In 1976, because of enforcement action by the State of Michigan ("the State"), extraction wells were installed by Lakeway to capture and contain contaminated groundwater before it reached Big Black Creek. This system of extraction wells has been upgraded and added to, and has continued in operation since 1976. To assist in the prevention of off-site migration of contaminants that may impact Big Black Creek, the PSDs installed extraction wells and a below grade Barrier Wall with a weir system. Extracted groundwater is sent for treatment to the Groundwater Treatment Plant (GWTP), constructed by U.S. EPA and MDEQ in 1994. During O.U. #1 construction work, a portion of collected groundwater was sent directly to the Muskegon County Wastewater Management System (MCWMS) through nearby pipelines for Egelston Township and Sun Chemical consistent with an approved discharge permit.

Residences in the immediate area of the Site are connected to the local public water system and groundwater is not used as potable water. If not contained, the contaminated groundwater discharges into the Creek system, contributing to degradation of this surface water body. Big Black Creek is a designated trout stream.

History of Contamination

Throughout the 1960s and early 1970s, ten on site lagoons were used for disposal of sludge, wastewater, and various waste liquids. This practice resulted in contamination of the groundwater underneath the Site and subsequently Big Black Creek.

As noted in the 1990 Record of Decision, approximately 454,200 cubic yards (yd3) of total contaminated solid media is estimated to be at this site. This solid media is comprised of approximately 100,000 yd3 of chemical sludge, with the remainder being contaminated soil beneath and around the lagoons. All contaminated solid media is underneath the soil protective

cover that was completed in November 2007. Soil beneath the lagoons extends from the bottom of the sludge to the average water table depth. Depth to groundwater ranges from approximately several to 40 feet below grade, with a groundwater confining layer located approximately 80 to 120 feet below grade.

Initial Response

In the 1970s, the State of Michigan performed investigations and enforcement actions because of reports of contamination of Big Black Creek (the "Creek"). In 1976, the State of Michigan required Lakeway Chemicals to install groundwater extraction wells to protect the Creek. Between 1985 and 1987, the requirement for Bofors to address contamination at the property by incinerating chemical sludge and constructing an on-site landfill cell for incineration residuals came about from the bankruptcy proceedings. In addition, an agreement between the State and the new operating plant owner, Lomac, was created whereby the State maintained the groundwater extraction system and reimbursed Lomac for treatment of that groundwater. The State used a portion of the resources received from the bankruptcy settlement for this agreement. U.S. EPA placed a portion of these resources into a Special Account, which is now being accessed to operate and maintain the current remedy. The Site was placed on the National Priorities List (NPL) in 1989 and the State of Michigan (with support from U.S. EPA) completed a Remedial Investigation and Feasibility Study (RI/FS) in 1990 with bankruptcy settlement resources.

In 1990, a Record of Decision was signed, and U.S. EPA and the State of Michigan had USACE concurrently begin design of phased incineration and groundwater pump and treat remedies. USACE completed the GWTP design and started its construction in 1992. In 1992, incineration was removed from the remedy and replaced with excavation and placement of soil and sludge in two landfill cells constructed on-site. Design of the Landfill Remedy phase was completed in 1993, but construction was not started because of new information brought to the attention of U.S. EPA and the State. In 1994, the State-Lomac treatment agreement was discontinued at the commencement of GWTP operation. In 1999, U.S. EPA amended the O.U.#1 remedy for the second time based on new information. U.S. EPA entered into a legal agreement (Consent Decree) with the PSDs for implementation of a Remedial Design and Remedial Action of a Total In-Situ Containment (TIC) remedy, which would provide protection that is similar to the Landfill Remedy.

The new information that was the basis for the 1999 ROD amendment included: increased experience (since the 1990 Feasibility Study) with slurry / Barrier Wall construction and operation, new environmental regulations for the State of Michigan, acceptance by the Site PSDs of the requirement that any Barrier Wall must be "keyed" into a confining layer (located approximately 80 to 120 feet below grade), and a commitment by the Site PSDs for long-term operation, maintenance, and monitoring of a Barrier Wall remedy. In 2000, the PSDs and Sun/Lomac assumed responsibility for operation and maintenance of the GWTP and control of site access. At the time of this five-year review, the construction portion of this TIC RD/RA had just been completed in late 2007.

Enforcement History

Pursuant to CERCLA § 122, U.S. EPA issued Special Notice letters to identified PRPs in July 1993, providing an opportunity for their construction of U.S. EPA's O.U. #1 Landfill Remedy. Most of the PRPs for this site were identified by their limited chemical production contracts with Lakeway Chemicals and Bofors-Nobel. Because of the unique remedy selection and ratification processes for this site, and because U.S. EPA agreed to develop the O.U. #1 ESD and re-evaluation documents, an extended research and negotiation period was granted. U.S. EPA reissued Special Notice letters again on May 30, 1997 and negotiations proceeded, resulting in the 1999 RD/RA Consent Decree and ROD amendment for the TIC Remedy alternative. In 2000, the Performing Settling Defendants (PSDs) assumed control of the Site. The RD/RA Consent Decree has provision for the reimbursement of some PRP remedy costs from a Special Account set up by U.S. EPA, established with the 1987 Bofors bankruptcy settlement funds. In accordance with the provisions of the Consent Decree, the PSDs may petition U.S. EPA annually for reimbursement from the Special Account for operation and maintenance work by providing detailed supporting documentation (such as invoices and descriptions of the work completed) that the work has been performed. Under the Consent Decree and a Pre-Authorization Decision Document (PDD), the PSDs may also, at established milestone dates, petition U.S. EPA for reimbursement from Superfund for a share of the completed remedial action costs. In addition, to promote wastewater recycling and reduce the need for pumping of groundwater at and near the Site, a Prospective Operator's Agreement (POA) was developed in 1999 between U.S. EPA, MDEQ, the PSDs, Lomac, and Sun Chemical (located adjacent to the Site). Sun/Lomac agreed to form a partnership, known as Camus LLC, to take over operations and maintenance of the GWTP constructed by U.S. EPA and MDEQ. Camus' sole responsibility is operation and maintenance of the wastewater systems present at the Sun / Lomac and GWTP facilities.

Basis for Taking Action

In 1989, a qualitative risk assessment was completed and identified human health hazards posed by current as well as future potential exposures to Site related contamination. The contaminants that are the main concern and driving the site's remedy include: azobenzene, benzidine, 3,3-dichlorobenzidine, toluene, aniline, and vinyl chloride. Each environmental exposure pathway is summarized below, with the status as influenced by the implemented remedy.

<u>Operable Unit #1; Lagoon Area and Groundwater</u>

Risk at the Site is summarized by the following excerpts from the O.U. #1 Record of Decision:

"Air inhalation risks...range from 1.2 x 10-3 to 7.9 x 10-9, with the lagoon sludge posing the highest risks and berms posing the lowest risks."

"Groundwater ingestion risks...range from 9.9 x 10-1 to 3.4 x 10-5. [T]otal groundwater ingestion risks resulting from sludge and soil beneath lagoons, soils around lagoons or berms are all above acceptable limits."

"Surface water ingestion risks...assume that the groundwater pumping and treatment system is turned off. The calculated risks range from 1 x 10-2 to 3.4 x 10-7. [E]ven though the surface water poses risks substantially lower than the groundwater, the risks from surface water ingestion are above the acceptable range."

"The highest excess cancer risks developed were associated with the groundwater exposure pathway. The combined carcinogenic risks reflecting all the contaminants of concern and all exposure pathways of concern are estimated to be approximately 10-1 excess cancer risk."

"Non-carcinogenic effects are estimated to be insignificant in this operable unit, since the metals in the sludges and soils do not appear to exhibit significant mobility."

Table 8 provides a summary of risks cited in the O.U. #1 ROD and 1999 second ROD Amendment. Because remedy components have been installed and are operating, and because access to the Site and the Lagoon Area is restricted, there are no immediate exposure pathways available to humans. Sludge and contaminated soil in the Lagoon Area has not been removed but has been mitigated by the installation of a soil protective cover. The contaminants and risk could reach unacceptable levels if this cover were disturbed. Permanent legal restrictions on future use of the Site property have been implemented in order to protect this component of the O.U. #1 remedy. The distance of the nearest buildings from the lagoon area and the flow direction of groundwater away from such buildings preclude groundwater vapor intrusion as a new or ongoing risk pathway to buildings at or near the Site. In the 1990 Record of Decision, it was noted that Site contamination did not appear to adversely affect critical habitats or endangered species. On-site wetlands in the floodplain on both sides of Big Black Creek (as noted in the RI/FS and 1990 Record of Decision) have been replaced by treatment wetlands inside the Barrier Wall and diffuser trench outside the Wall. The diffuser trench has since been filled in. Further, the 1990 Record of Decision noted that no wetland types or species encountered on the project site are unique or rare in the Upper Midwest, and no unique agricultural land or wildlife habitat exists around the Site.

Operable Unit #2; Operating Plant Area (Sun/Lomac)

In 1991, a baseline Risk Assessment calculated for the plant area of the Site concluded that concentrations of contaminants in soil underneath the Sun/Lomac facility were high enough to present a human health risk for certain exposure scenarios. That Risk Assessment concluded that, for an adult worker in the O.U. #2 area of the Site, exposure to contaminated soil presented a health risk as high as 3 x 10-3. For an adult who uses the O.U. #2 area for residence, ingestion of groundwater poses a 6 x 10-1 risk. Similarly, the non-carcinogenic health hazard for an adult who uses the O.U. #2 area for residence is over 1. Reasonable future land use for the O.U. #2 area of the Site, however, will likely not be residential. The former Lomac property is currently owned by neighboring Sun Chemical, and except for the wastewater treatment area operated by Camus, the property is currently used only for warehousing and parking for vehicles. No Record of Decision for O.U. #2 has been issued by U.S. EPA.

Summary

The Site groundwater flow regime is such that groundwater contaminants will discharge into Big Black Creek if not intercepted. Although contaminants are still being detected in groundwater samples taken at the Site, sampling and analysis from 2003 to 2007 had shown some reduction in contaminant concentrations in groundwater at some sampling locations. Contamination source material on site and groundwater flow are such that there is no use by residents living near the Site of site groundwater for drinking water or other domestic uses. Through visual observation and information supplied by the PSDs and construction and operations contractors, this five-year review confirmed that remedy components that eliminate the groundwater pathway are in place and appear to be operating, but the containment effectiveness of these components is currently under review. This five-year review confirmed that there is no unacceptable use of contaminated groundwater occurring at and near the Site.

Access to the Site is restricted, prohibiting trespassing by local residents. If access restrictions fail or are otherwise rendered ineffective, the current protective soil cover will prevent contaminated soil from being tracked off-site or inhaled as dust. Current remedy start-up activity and regular Site inspection and maintenance should ensure the integrity of this cover, preventing unacceptable erosion, cracking, or slides and in turn preventing the potential for direct contact exposure to sludge or contaminated soil. Through the site inspections of December 19, 2012 and May 16, 2013, this five-year review confirmed that there are no indications of degradation of the protective soil cover.

Site topography was changed between 2005 and 2007 to improve and control drainage, as part of installation of the protective soil cover, and to accommodate vegetative components of the site remedy. Storm run-off is currently not a pathway of concern. There is no evidence of unacceptable exposure to contaminated surface water or sediments at and near the Site. For this five-year review, it was confirmed through visual observation, information supplied by the PSDs and the construction and operations contractors, and the Site Inspection of May 16, 2013, that there is no indication of degradation in wetland areas at and around the Site.

Actual or threatened releases of hazardous substances from this Site, if not addressed by the response action selected in the 1990 ROD, 1992 and 1999 ROD Amendments, and 1999 Consent Decree, may present an imminent and substantial endangerment to public health, welfare, or the environment. Controls are necessary to protect public health, welfare, or the environment from the continuing releases of hazardous substances.

C. REMEDIAL ACTIONS

Remedy Selection

Operable Unit #1; Lagoon Area and Groundwater

A Record of Decision (ROD) for O.U. #1 was signed on September 17, 1990. The remedy requirements as discussed in the original O.U. #1 ROD were: upgrade and maintenance of existing extraction wells to intercept flow of contaminated groundwater which would otherwise

enter the Big Black Creek system; excavation and on-site thermal treatment of sludges and contaminated soils, and on-site landfilling of treatment residues; environmental monitoring to ensure the effectiveness of the remedial action, and; construction of an on site groundwater treatment plant for treatment of extracted groundwater.

The O.U. #1 ROD was amended on July 22, 1992 because of: more contaminated material at the Site than originally estimated; possible inconsistent incineration treatment of contaminated material with the same level of risk (the larger volume of materials would have lessened the reduction in risk achieved by incineration); and, greater cost and logistics involved with incineration than originally estimated. This amendment to the ROD: eliminated incineration as a treatment technology for the Site; required construction of larger on-site landfill cells for direct placement and containment of sludge and contaminated soils on-site (the "Landfill Remedy"); and, continued to require extraction and treatment of contaminated groundwater to restore groundwater to acceptable levels.

On May 6, 1996, U.S. EPA issued an Explanation of Significant Difference (ESD) to outline the circumstances and history of the O.U. #1 GWTP design and construction, and to explain the associated increase in remedy cost. On May 31, 1996, U.S. EPA issued a Re-Evaluation of Selected Remedy document certifying that the Landfill Remedy selected by the 1992 ROD amendment adequately satisfied remedy selection criteria. Specifically, this document concluded: the Landfill Remedy would be an adequately protective remedy if constructed; the Landfill Remedy was still the best remedy using the selection criteria, but; updates to remediation technology since the time of the ROD amendment could warrant re-evaluation of alternative technologies previously eliminated. U.S. EPA issued this document after receiving new information that there could be a more effective means to achieve the same cleanup goals as the original selected remedy. The new information included: increased experience (since the 1990 Feasibility Study) with slurry / Barrier Wall construction and operation, new environmental regulations in the State of Michigan, acceptance by the site PSDs of the requirement that any Barrier Wall must be "keyed" into a confining layer (approximately 80 to 120 feet below grade), and a commitment by the site PSDs for long-term operation, maintenance, and monitoring of a Barrier Wall remedy.

After the conclusion of the 1996 re-evaluation, U.S. EPA issued a second amendment to the O.U. #1 ROD on July 16, 1999. This second ROD amendment altered the site's remedy requirements as follows: replacement of excavation and disposal of contaminated source areas in on-site cells with a protective cover and Barrier Wall containment of the source areas; provision for phytoenhancement and wetlands within the Barrier Wall to enhance immobilization of wastes and control infiltration, and to promote groundwater treatment by biological means; establishment of long term groundwater remediation standards, soil cleanup goals, and requirements for deed restrictions for the Site; and, containment, extraction, and treatment of groundwater, short- and long-term, including containment and management of groundwater until groundwater remediation standards are met. Re-evaluation was performed primarily because: (1) since the time of U.S. EPA's remedy decision, more information had been developed both on the volume of contaminated soil and sludge and on Barrier Wall technology; and (2) the timing of U.S. EPA's identification and contact with new PRPs arguably did not allow them a full opportunity to comment on the previous remedy decisions.

The goal of the remedy is restoration of the aquifer to standards required by Part 201 of the Natural Resources and Environmental Protection Act (Environmental Remediation), PA 451 of 1994, as amended ("Part 201"). The design basis for the TIC Remedy is reduction of the on-site contaminants to cleanup criteria associated with a future industrial land use scenario. Physical construction of the Barrier Wall was completed in late 2005 and installation of the other elements of the TIC Remedy was completed in late 2007. The Remedial Action Objectives (cleanup goals) shown in the 1999 ROD Amendment and Consent Decree are:

i. a. Containment of lagoon sludge and soils to prevent on-site exposure to hazardous substances at concentrations that pose an unacceptable risk to human receptors under industrial land use scenarios via the following routes of exposure: (a) direct contact; (b) inhalation from volatilization to indoor air; (c) inhalation from volatilization to ambient air; (d) drinking water use of aquifer; (e) groundwater contact; and (f) surface water contact.

i. b. Containment of lagoon sludge and soils to prevent on-site exposure to hazardous substances at concentrations that pose an unacceptable risk to environmental receptors via the following routes of exposure and migration pathways: (a) contact with contaminants present in surface soils, plants, water or air on-site; (b) groundwater impacts on surface water; and (c) soil runoff impacts on surface water.

ii. Containment of lagoon sludge and soils to prevent off-site migration of contaminants to air, soil or groundwater at concentrations that would pose an unacceptable risk to human and/or environmental receptors [subject to Performing Settling Defendants demonstrating that, they qualify for waiver of Rule 705(5) pursuant to criteria identified in Section 20118(6) of NREPA] and

iii. Containment of groundwater to prevent migration of contaminants at concentrations that would pose an unacceptable risk to human and/or environmental receptors off-site including to Big Black Creek and to the on-site wetlands between Big Black Creek and the Barrier Wall.

The Performance Standards are, as defined in the Consent Decree, measures of achievement of the Remedial Action Objectives, and include cleanup standards, standards of control, quality criteria and other substantive requirements, criteria or limitations, including all Applicable or Relevant and Appropriate Requirements ("ARARs") set forth in the Second Amended ROD, SOW and/or Consent Decree. The Performance Standards for measuring the achievement of the Remedial Action Objectives are the following:

iv. a. For containment of lagoon sludge and soils to prevent on-site exposure to hazardous substances at concentrations that pose an unacceptable risk to human receptors under industrial land use scenarios via the routes of exposure identified in Remedial Action Objective #i.a, the Performance Standards are the Industrial Criteria for Soils set forth in Part 201, Environmental Remediation, of the Michigan Natural Resources and Environmental Protection Act (NREPA) as amended ("Part 201").

b. For containment of lagoon sludge and soils to prevent on-site exposure to and migration pathways from hazardous substances at concentrations that pose an unacceptable risk to environmental receptors, the Performance Standards to be applied to environmental

assessment endpoints are: (a) prevention of unacceptable acute toxic effects; (b) prevention of unacceptable observable chronic effects; and (c) prevention of other unacceptable chronic effects if documented through field measurement.

v. For containment of lagoon sludge and soils to prevent migration of contaminants off-site to groundwater and soils, the Performance Standards to be met at the off-site boundary are the Residential Criteria for Groundwater and Soils set forth in Part 201 of NREPA; for ambient air off-site, the Performance Standards will be established pursuant to Part 55 of NREPA.

vi. For containment of groundwater to prevent migration of contaminants at concentrations that would pose an unacceptable risk to human and/or environmental receptors off-site including to Big Black Creek and to the on-site wetlands between Big Black Creek and the Barrier Wall the Performance Standards to be met at the Groundwater-Surface Water Interface ("GSI") are the generic GSI Standards for Big Black Creek as established by MDEQ, or standards otherwise developed pursuant to Part 31 of NREPA and its administrative rules.

The O.U. #1 ROD requires land use restrictions to prohibit: (1) excavation of soil, (2) unacceptable construction on-site, (3) unacceptable groundwater extraction, and (4) interference with the components of the remedy. Institutional Controls (ICs) have been drafted and are currently under review by U.S. EPA and MDEQ. ICs that are implemented (developed and recorded) at the Site will run with the land. Section 4.3 of this Five-Year Review Report discusses the details of these ICs.

As required by the 1990 ROD, 1992 and 1999 ROD Amendments, except for the Institutional Controls, the PSDs have installed the components of this remedy. Reviews every five years of remedy performance are necessary and are required by CERCLA in order to evaluate all remedial actions undertaken at the Site compared to the cleanup objectives. These reviews provide recommendations regarding improvements, additions, or adjustments to implemented remedial actions and examine a remedy's progress toward achieving cleanup objectives.

Operable Unit #2: Operating Plant (Sun/Lomac) Area

As part of the second amendment to the O.U. #1 ROD and the associated TIC RD/RA Consent Decree, an Interim Remedial Action Plan (IRAP) was developed to provide an interim remedy for the O.U. #2 area, not inconsistent with the goals of the O.U. #1 TIC Remedy. A separate Consent Decree was entered into with the State of Michigan and included an agreement for increased interim response activities as a contingency measure in the event that additional remedial actions (such as excavation or groundwater extraction) are determined to be necessary. The O.U. #2 IRAP required asphalt capping of areas of contaminated soil to prevent human exposure, and continued sampling and analysis of groundwater within the Sun/Lomac area to ensure consistency with the work being performed for O.U. #1. Additional safety procedures and restrictions on operations and activity in the O.U. #2 area were implemented for the IRAP. Wastewater treatment equipment was also improved.

An explosion in April 2000 at the Lomac facility contributed to the cessation of production operations in the O.U. #2 area. In late 2002, Sun Chemical purchased the property and did not

re-start production of any chemicals. Groundwater sampling and inspection of capped O.U. #2 areas is performed annually under IRAP requirements.

Because the RI/FS and existing remedy decision documents have established that the Sun/Lomac area will eventually need to be addressed, an O.U. #2 ROD must be issued to make a final determination as to the fate of contamination within the O.U. #2 area. Additionally, since O.U. #2 will not likely achieve unlimited/unrestricted exposure (UU/UE), ICs will be required to protect the remedy components and assure no unacceptable land uses occur.

Remedy Implementation

From March 1991 to May 1992, the U.S. Army Corps of Engineers (USACE) completed the GWTP design, intended to treat the maximum possible flow rate expected from the Landfill Remedy. USACE awarded a contract for construction activities for this first phase of the O.U. #1 remedy in October 1992. In September 1994 after appropriate testing, treatment of contaminated groundwater started. The GWTP was designed to discharge treated groundwater to Big Black Creek. Until recycling of treated water to Sun Chemical was initiated in 2000, the GWTP successfully met surface water discharge standards established by the MDEQ. The complexity of the GWTP system resulted in an extended shakedown period, and U.S. EPA and MDEQ declared the GWTP fully operational and functional on May 19, 1998. Treated water from the GWTP is currently re-directed to Sun Chemical for use in their production processes. U.S. EPA approved the RD for the Landfill Remedy in March 1993. Landfill construction was delayed in order to develop the 1996 remedy re-evaluation document and consider the TIC Remedy made available after landfill design was completed. Design of the TIC Remedy started in 2002, and construction started in 2004. A final inspection of the physical construction of the Phase 1 portion of the TIC Remedy (Barrier Wall) was performed on December 8, 2005 and on November 14, 2007, a final inspection of the physical construction of Phase 2 of the TIC Remedy was performed (protective cover, phytoenhancement components, and treatment wetland/diffuser trench).

From 1999 to 2002, an outdoor trial pilot study was completed to determine agronomic conditions and assess the tolerance and suitability of tree species to site conditions and lagoon area soil/sludge. This pilot study concluded only that most tree species could not thrive in lagoon area soils and therefore, treatment by phytoremediation may be unlikely. Subsequent design and construction documents required installation of willow/ poplar trees, prairie plantings (such as grasses), deciduous upland trees, and shrub perimeter planting. This augments the containment strategy at the Site and is referred to as "phytoenhancement" or as "vegetative components" of the remedy. Performance Standards noted in this Five Year Review Report summarize the primary remedy goal of continued groundwater containment in order to protect Big Black Creek. It has yet to be determined whether vegetation installed at the Site enhances groundwater containment or assists with immobilization of contaminants.

For O.U. #2 areas, asphalt capping of contaminated soil areas was completed in 1999. As noted previously, groundwater sampling and inspection of capped O.U. #2 areas is performed annually under IRAP requirements. Threats posed by the O.U. #2 area have been mitigated under the IRAP consistent with O.U. #1 activity, and the land use in the O.U. #2 area by Sun Chemical

presents no threat of causing any unacceptable exposure pathways due to the placement of asphalt over contaminated soil areas. O.U. #2 IRAP requirements have been implemented under the enforcement authority of the MDEQ. MDEQ ensured adequate quality assurance and quality control by monitoring each step of the IRAP. Appropriate quality assurance and quality control was performed during all phases of remedy construction. Throughout construction activities for all operable units, there has been monitoring of contaminated media.

The groundwater pump and treat phase of the O.U. #1 remedy continues to be operated by the PSDs and Camus. Contaminated groundwater flows from the covered Lagoon Area to the treatment wetland inside the Barrier Wall, which re-directs its flow to a collection sump and weir structure. There are also three operating extraction wells between the Barrier Wall and Big Black Creek intended to prevent further migration of contaminated groundwater to the creek. Over the past few years, capacity has become available at the Muskegon County Wastewater Management System (MCWMS). This extra capacity allowed a portion of the contained and extracted Lagoon Area contaminated groundwater to be pumped directly to the Muskegon County system instead of to the GWTP during recent O.U. #1 construction. It was anticipated that the interior treatment wetland would effectively reduce contaminant concentrations in groundwater for eventual discharge into the diffuser trench. Since the last five-year review in 2008, the diffuser trench has been filled in.

As mentioned previously, most components of the O.U. #1 TIC Remedy have been installed but adequate monitoring data must demonstrate that operational and functional status can be verified. In concert with near-term monitoring, a Performance Standard Verification Plan (PSVP) is required to ensure that operation of the TIC Remedy remains in compliance with applicable cleanup criteria. Contingent Remedial Actions must be implemented in the event any TIC Remedy component fails. Quality assurance and quality control was performed during construction of the TIC Remedy. Start-up activity, operation, maintenance, and monitoring of the remedy by the PSDs and Camus with oversight by MDEQ and U.S. EPA provides a regular on-site presence that assists in the protection of human health and the environment. In late 2007, groundwater extraction wells in the interior of the Barrier Wall were turned off. Three extraction wells exterior to the Barrier Wall continue to operate between the Barrier Wall and Big Black Creek. O&M of the GWTP by Camus has not changed since the 2008 five-year review.

System Operation/Operation and Maintenance

Lagoon Area and Groundwater

The wetland portions of the TIC Remedy have been allowed to mature however monitoring data has not been satisfactorily completed to certify operational and functional status. As the Barrier Wall is a below grade containment structure, there is minimal maintenance required. However, groundwater monitoring at wells alongside the wall is necessary to indicate any breaches. O&M of the TIC Remedy in the (former) lagoon area is the responsibility of the PSDs, who have agreed to a long term commitment ensuring O&M continues for a time period as long as necessary until all Remedial objectives are met and maintained. U.S. EPA and MDEQ will also continue to monitor the site's activities to make sure that Consent Decree requirements are being satisfied. O&M tasks for the TIC Remedy include:

- upkeep, monitoring, and routine inspection of the vegetative portion of the TIC Remedy, including introduction of nutrients and irrigation, if needed;
- regular inspections of the O.U. #1 lagoon area cover to assure the protectiveness of the cover, to prevent disturbance and exposure to contaminated soils remaining underneath the cover, and to assess whether adverse ecological effects are occurring at the site;
- removal of vegetation if needed, and;
- upkeep of any additional extraction system installed to augment groundwater containment provided by the Barrier Wall.

Extraction wells exterior to the Barrier Wall continue to operate, and serve to capture groundwater between the Barrier Wall and Big Black Creek. O&M of the GWTP by Camus has not changed since the thid five-year review in 2008. With approval of the POA and the take-over of GWTP operations by Camus in 2000, the Agencies no longer have the responsibility of GWTP O&M. The groundwater containment and pump and treat phases of the O.U. #1 remedy continue to be operated by the PSDs and Camus. Use of the MCWMS has reduced the use of the GWTP constructed by the Agencies. In addition to operating the extraction and treatment processes, O&M tasks for the GWTP and currently operating extraction wells include:
- procurement of utilities such as gas, water, communications, and electricity;
- extraction well cleaning and preventive maintenance;
- re-development of wells as needed;
- continued groundwater sampling and analysis;
- general repair, maintenance, and minor improvements to the system(s) and GWTP buildings and grounds; and,
- repair and upgrade of: groundwater collection piping and valving, emission control equipment, residuals handling equipment, monitoring wells, and extraction well vaults and associated equipment.

Since treated water is sent to Sun Chemical from the GWTP with no effluent discharge to Big Black Creek, there have not been any unacceptable exceedances of discharge permit limits. Review of monthly GWTP reports from 2008 to 2013 reveal that there has been no major disrepair or substantial breakdowns or repairs. A discharge permit from MCWMS is required for disposal of extracted groundwater into the County sewer system. During construction, the PSDs adhered to all MCWMS requirements for effluent discharge and renewed all required permits as required. There have been no problems noted with any of the discharge permit procedures for the Site.

Operable Unit #2

For O.U. #2 areas, asphalt capping of contaminated soil areas was completed and groundwater sampling occurred from 1999 to 2002. U.S. EPA has not yet issued a remedy decision for O.U. #2, therefore there are no O&M considerations for this portion of the Site. Sun Chemical's current warehousing and storage activity do not pose any threat of interference with the work completed for the O.U. #1 IRAP. Land use in the O.U. #2 area by Sun Chemical presents no threat of causing any unacceptable exposure pathways.

As noted, site access is restricted by Camus with Sun Chemical providing security and access control on neighboring properties. The PSDs' contractors sampling wells and performing extraction well maintenance are on site at least every 3 months on average, providing visual observation and reporting of any irregularities on site.

Remedy Costs

As per the terms of the legal agreement negotiated for the Site, the PSDs can request reimbursement for site activities from a Special Account set up for that purpose. Due to proprietary consideration of confidential business information, this Five-Year Review Report cites general amounts for remedy costs to date. For TIC Remedy design and construction, U.S. EPA estimates that approximately $15 million in combined capital costs have been expended. An approximate average of $700,000 has been expended annually since 2008 for continued operation of the GWTP, costs for operation, repair, and replacement of groundwater extraction wells, and site monitoring (including laboratory analyses).

APPENDIX B: FIGURES AND TABLES

Figure 1	County Location of Bofors-Nobel Site
Figure 2	Local Location of Bofors-Nobel Site
Figure 3	Bofors-Nobel Site Layout
Figure 4	Bofors-Nobel Site Layout
Figure 5	Bofors-Nobel Groundwater Containment
Figure 6	2008 Groundwater Flow Contours
Figure 7	Some Sampling Locations in the O.U. #1 Area
Figure 8	2010 Groundwater Flow Elevations and Contours
Figure 9	Five Year Review Advertisement
Table 6	List of Documents Reviewed
Table 7	Limited Summary of O.U. #1 Groundwater Data Along Big Black Creek
Table 8	Summary of Risk: O.U. #1 ROD and 1999 Second ROD Amendment
Table 9	Contaminants In Groundwater & Cleanup Criteria: 1999 ROD Amendment
Table 10	Contaminants In Sludge/Soil & Cleanup Criteria: 1999 ROD Amendment
Table 11	Completed Site Inspection Checklist

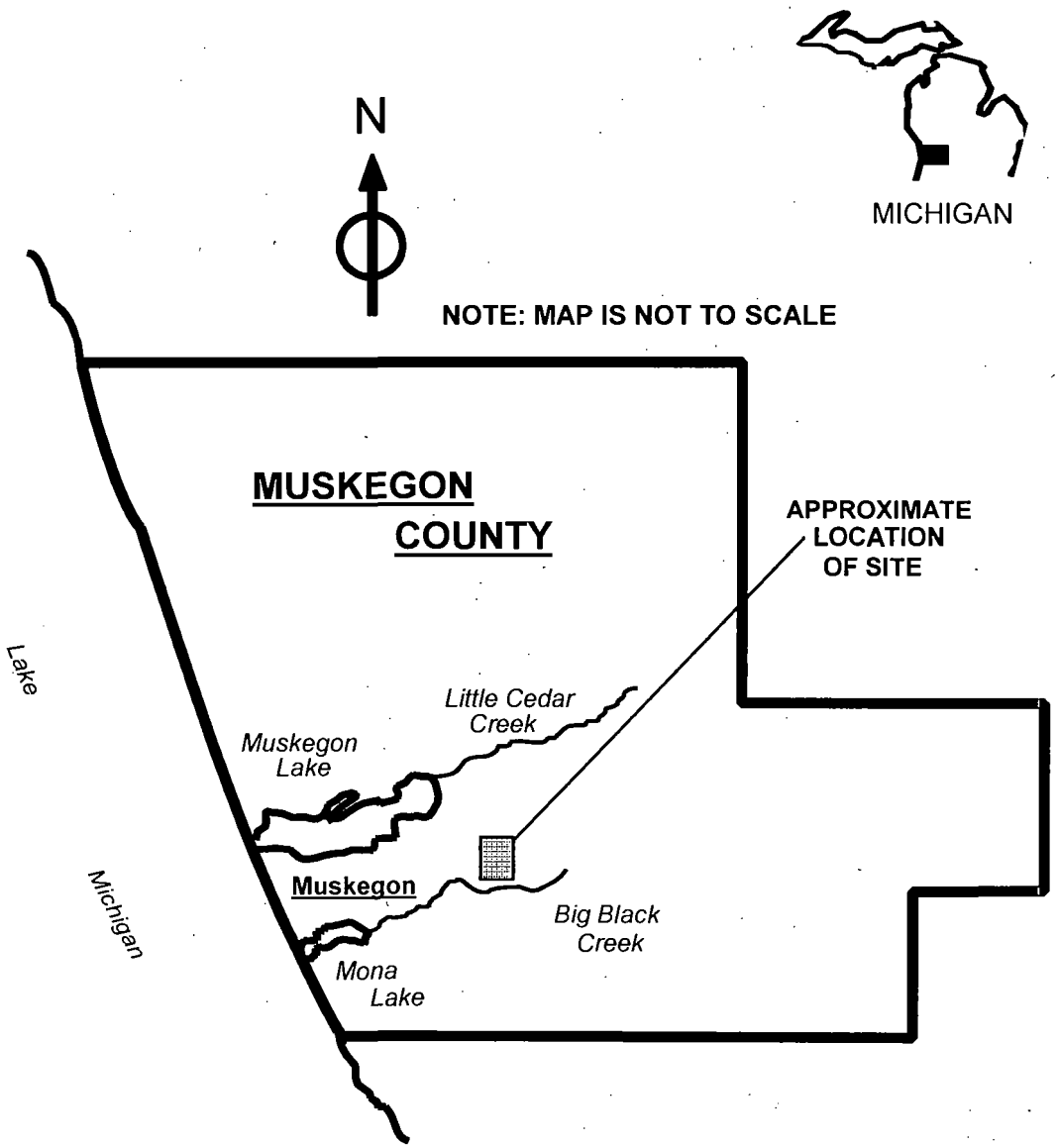


FIGURE 1 - COUNTY LOCATION OF BOFORS-NOBEL SITE

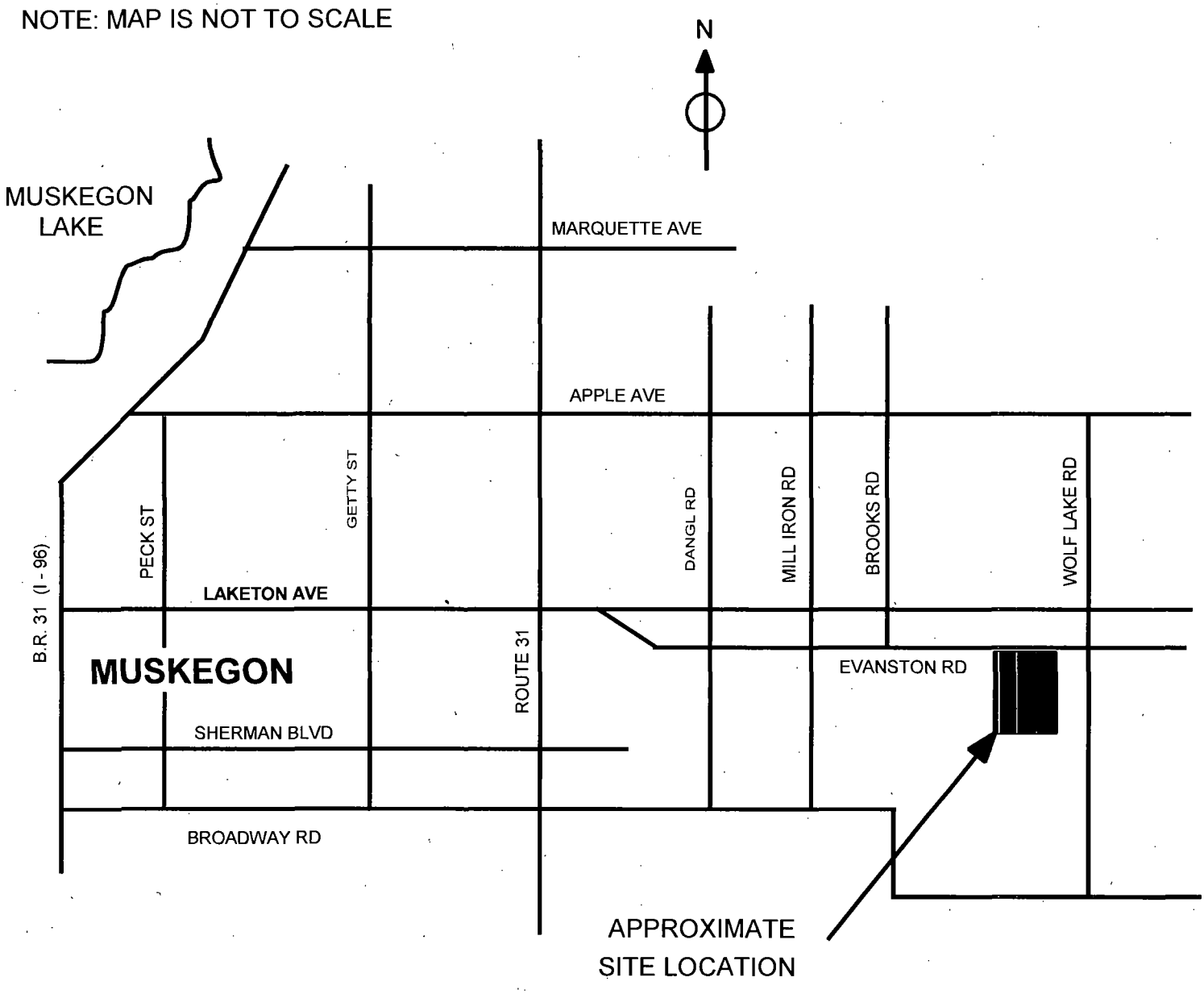


FIGURE 2 - SITE LOCATION MAP
BOFORS - NOBEL SUPERFUND SITE;
EGELSTON TOWNSHIP, MICHIGAN

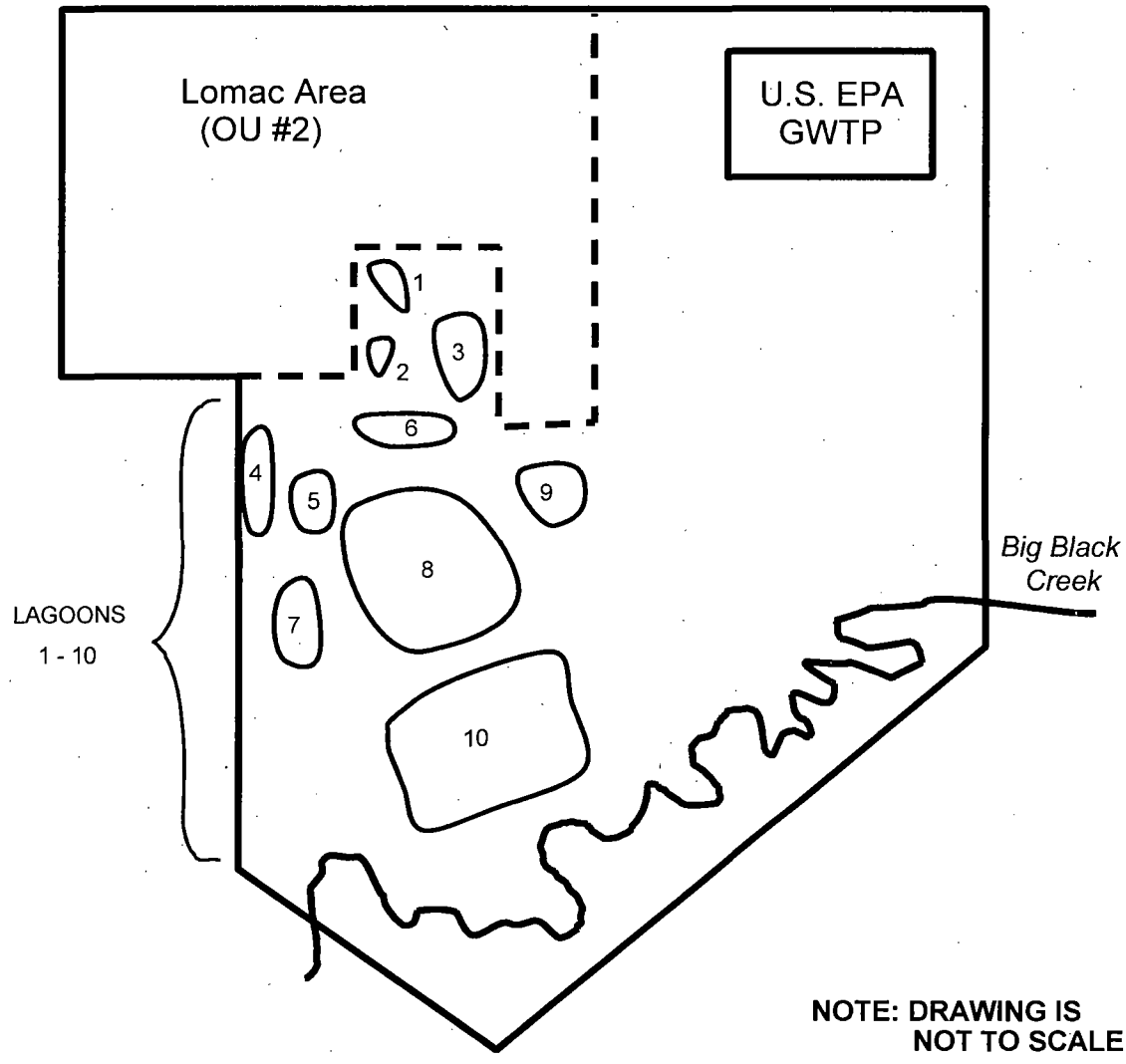


FIGURE 3 - BOFORS-NOBEL SITE LAYOUT

FIGURE 4 - LAYOUT OF O.U. #1 TOTAL IN-SITU CONTAINMENT (TIC) REMEDY

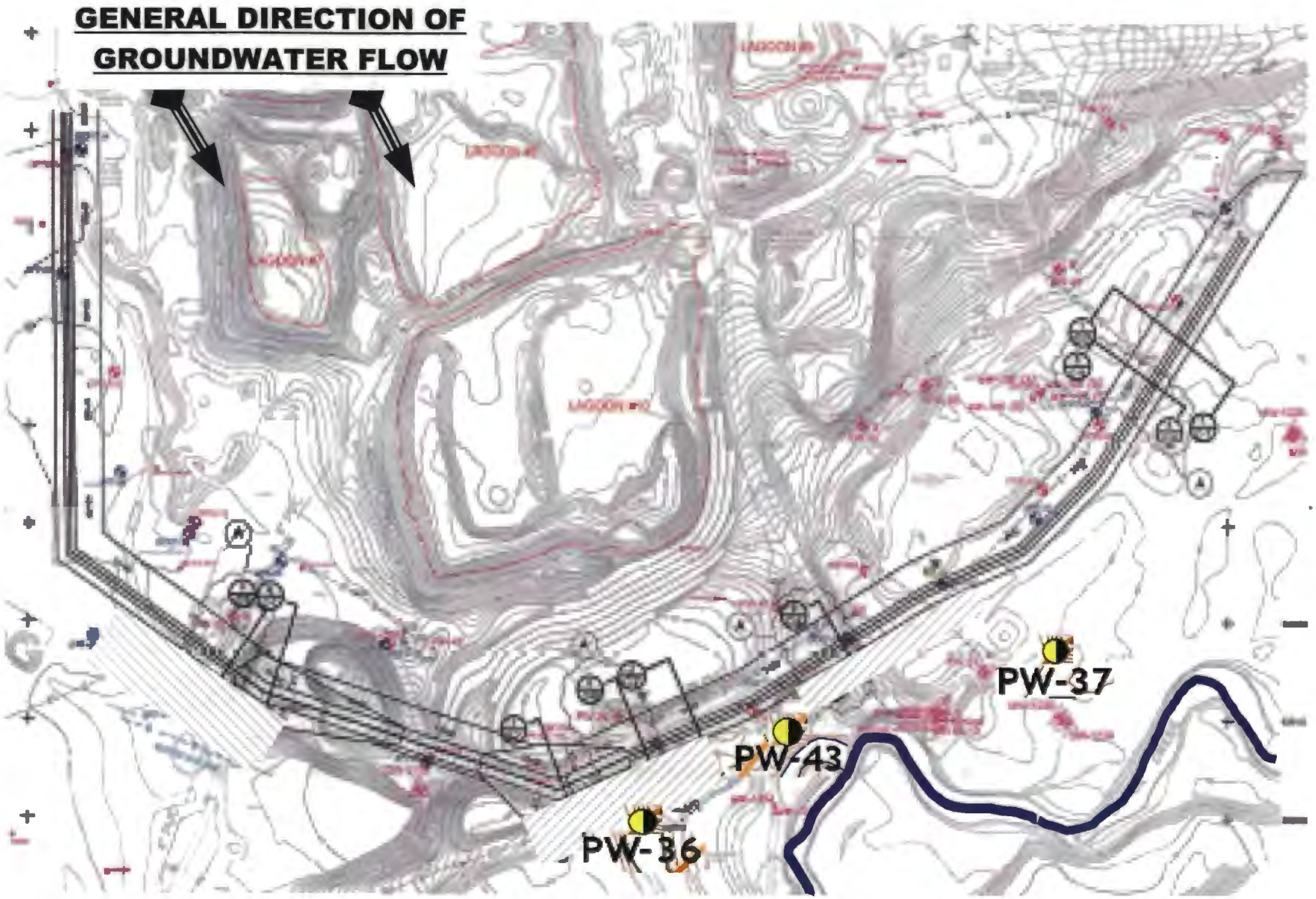


FIGURE 5: BOFORS-NOBEL GROUNDWATER CONTAINMENT

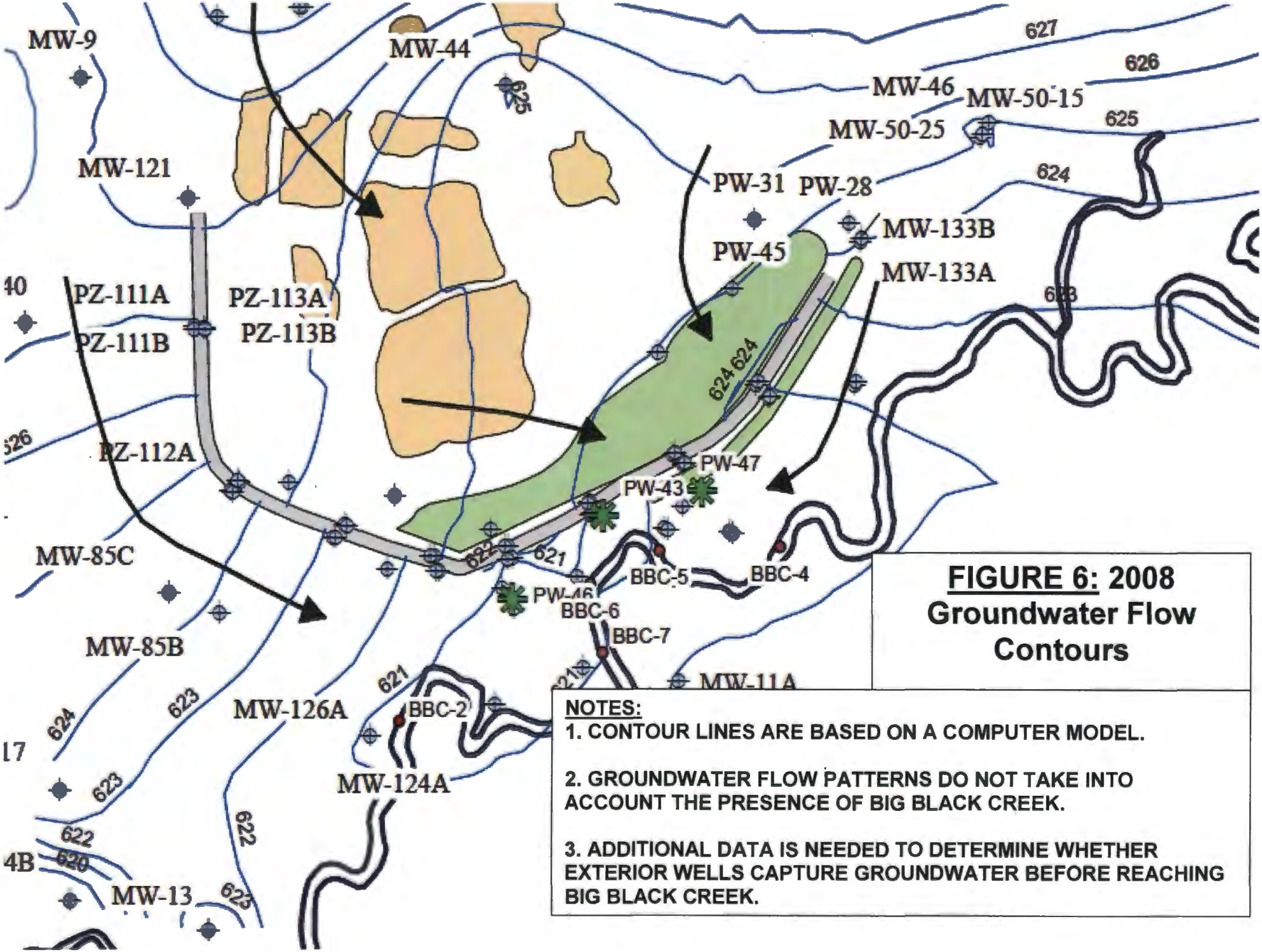


FIGURE 6: 2008 Groundwater Flow Contours

NOTES:

1. CONTOUR LINES ARE BASED ON A COMPUTER MODEL.

2. GROUNDWATER FLOW PATTERNS DO NOT TAKE INTO ACCOUNT THE PRESENCE OF BIG BLACK CREEK.

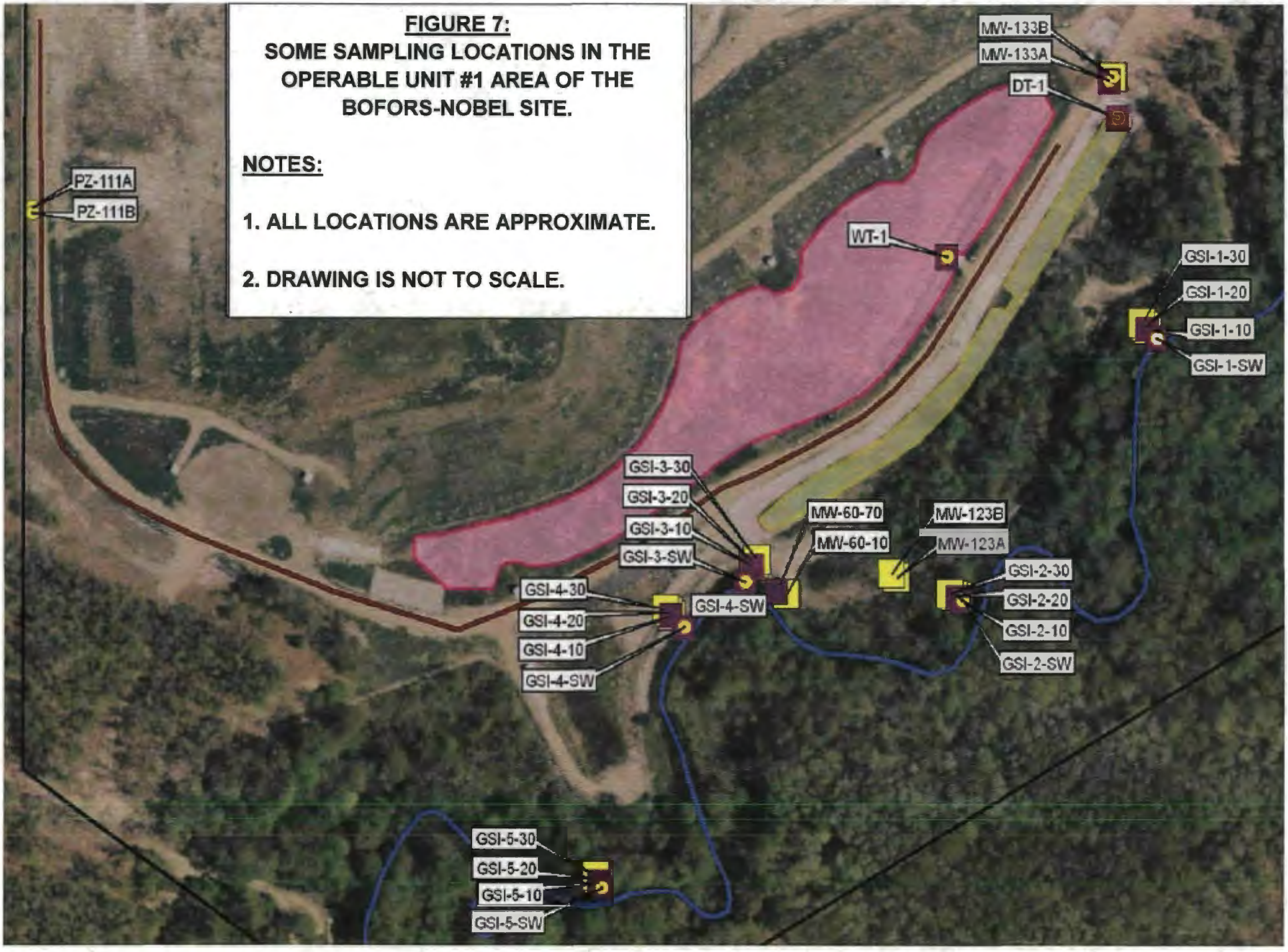
3. ADDITIONAL DATA IS NEEDED TO DETERMINE WHETHER EXTERIOR WELLS CAPTURE GROUNDWATER BEFORE REACHING BIG BLACK CREEK.

FIGURE 7:
SOME SAMPLING LOCATIONS IN THE OPERABLE UNIT #1 AREA OF THE BOFORS-NOBEL SITE.

NOTES:

1. ALL LOCATIONS ARE APPROXIMATE.

2. DRAWING IS NOT TO SCALE.



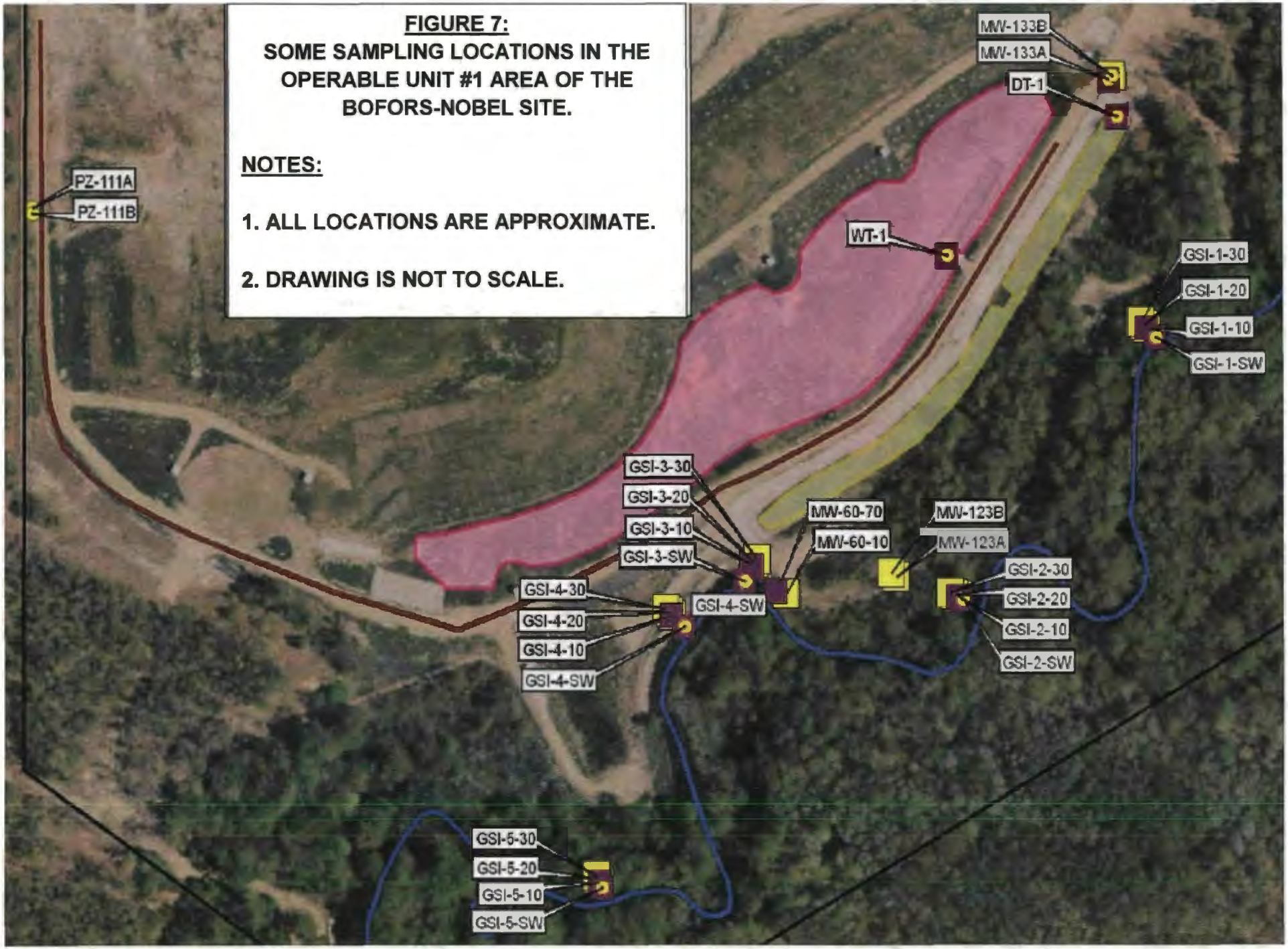


FIGURE 7:
SOME SAMPLING LOCATIONS IN THE OPERABLE UNIT #1 AREA OF THE BOFORS-NOBEL SITE.
NOTES:
1. ALL LOCATIONS ARE APPROXIMATE.
2. DRAWING IS NOT TO SCALE.
MW-133B
MW-133A
DT-1
PZ-111A
PZ-111B
WT-1
GSI-1-30
GSI-1-20
GSI-1-10
GSI-1-SW
GSI-3-30
GSI-3-20
GSI-3-10
GSI-3-SW
MW-60-70
MW-60-10
MW-123B
MW-123A
GSI-2-30
GSI-2-20
GSI-2-10
GSI-2-SW
GSI-4-30
GSI-4-20
GSI-4-10
GSI-4-SW
GSI-4-SW
GSI-5-30
GSI-5-20
GSI-5-10
GSI-5-SW

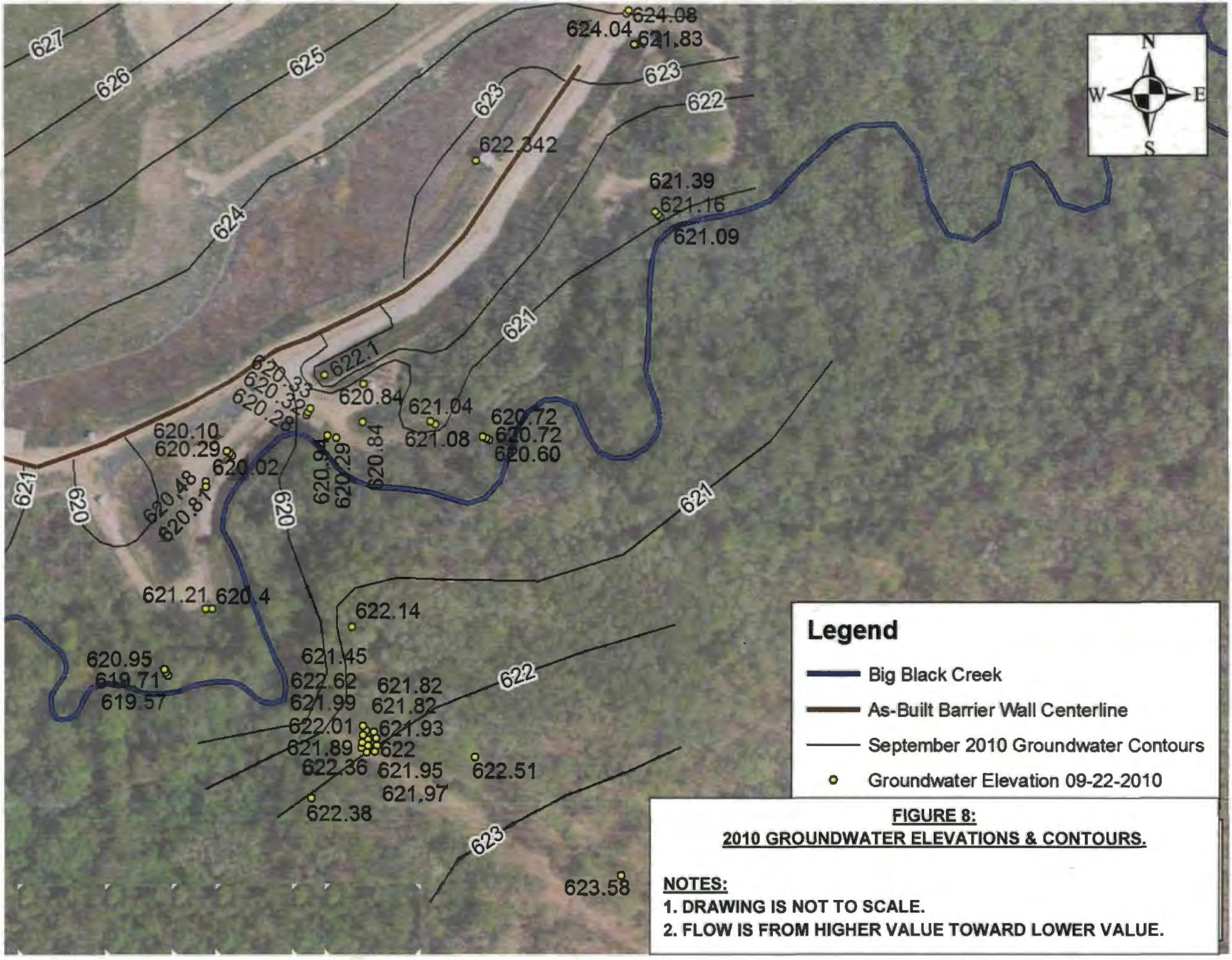


FIGURE 8:
2010 GROUNDWATER ELEVATIONS & CONTOURS.

NOTES:
1. DRAWING IS NOT TO SCALE.
2. FLOW IS FROM HIGHER VALUE TOWARD LOWER VALUE.

Figure 9 - Five Year Review Advertisement

EPA Begins Review of Bofors-Nobel Superfund Site

Muskegon, Michigan

U.S. Environmental Protection Agency is conducting a five-year review of the Bofors-Nobel Superfund site, 5025 Evanston Ave., Muskegon, Mich. The Superfund law requires regular checkups of sites that have been cleaned up – with waste managed on-site – to make sure the cleanup continues to protect people and the environment. This is the fourth five-year review of this site.

This 85-acre site is a former specialty organic chemical production facility. Improper disposal of waste in unlined lagoons resulted in contamination of ground water that flows into adjacent Big Black Creek.

If not captured, contaminated ground water discharges into the creek. An underground barrier wall directs contaminated ground water to a sump. There is also a protective cap over the contaminated soil, as well as engineered treatment wetlands and vegetation to contain and treat waste on-site. The review is expected to be completed by August 2013.

More information is available at the Egelston Township Hall, 5382 E. Apple Ave., Muskegon, the Hackley Library, 316 W. Webster St., Muskegon, and at http://www.epa.gov/R5Super/npl/michigan/MID006030373.html.

The five-year review is an opportunity for you to tell EPA about site conditions and any concerns you have.
Contact:

Dave Novak
Community Involvement Coordinator
312-886-7478
novak.dave@epa.gov

John Fagiolo
Remedial Project Manager
312-886-0800
fagiolo.john@epa.gov

You may also call EPA toll-free at 800-621-8431, 9:30 a.m. to 5:30 p.m., weekdays.

Table 6: List of Documents Reviewed for the Fourth Five-Year Review Report
Bofors-Nobel Superfund Site; Muskegon, Michigan

Site documents reviewed in preparation of this Five Year Review Report include the following:

1. "Remedial Investigation Report for the Bofors Site, Michigan," February 1990.
2. Record of Decision (Operable Unit #1), signed September 17, 1990.
3. "Draft Public Comment Feasibility Study Report for the Groundwater/Plant Area Operable Unit, Bofors Site, Muskegon, Michigan," November 1991.
4. Amendment To The Record Of Decision (O.U. #1), signed July 22, 1992.
5. Second Amendment to the Record Of Decision (O.U. #1), signed July 16, 1999.
6. "2007 Interim Monitoring Report, Bofors-Nobel Superfund Site (O.U. #1)," dated March 2008.
7. Third Five Year Review Report; Bofors-Nobel Superfund Site, dated August 7, 2008.
8. Bofors-Nobel GWTP Monthly Reports, Camus LLC.: Sept. 2008 to March 2013.
9. Technical Memorandum: "Bofors-Nobel Superfund Site Groundwater Analytical Data Summary - June 2009 Near-Term Monitoring Event," dated July 15, 2009.
10. Bofors-Nobel Site; Quarterly Progress Reports: Jan. 2010 through March 2013.
11. "As-Built GSI Installation 2009/2010; Interim Groundwater and Surface Water Monitoring at the Bofors-Nobel Site in Muskegon, Michigan," dated April 21, 2010.
12. "Report for 2010 Maintenance Work for the Bofors-Nobel Superfund Site," dated November 2010.
13. "Toluene Plume Investigation Report and Extraction Well Work Plan," dated January 31, 2011.
14. "PZ-111A Investigation Data Report," dated 3/23/2011.
15. "Meander Bend Area Fall 2010 Data Report," dated June 9, 2011.
16. "Report of Results Interim Monitoring; April 2011," dated 7/14/2011.
17. "Report of Results Treatment Wetland; June 2011 Sampling," dated 8/16/2011.
18. "Report of Results Interim Monitoring; July 2011," dated 9/20/2011.
19. "Report of Results Interim Monitoring; October 2011," dated 1/16/2012.
20. "Pump Test Report and Meander Bend Area and Toluene Plume Contingent Remedial Action Plan," dated March 19, 2012.
21. "Declaration of Restrictive Covenant and Grant of Environmental Protection Easement, Bofors-Nobel Superfund Site, Muskegon County, Michigan," dated 5/4/2012.
22. "Report of Results Interim Monitoring; March 2012," dated 6/15/2012.
23. "Report of Results Interim Monitoring; June 2012," dated Sept. 2012.
24. "Report of Results Interim Monitoring; September 2012," dated Dec. 2012.
25. "Report of Results Interim Monitoring; December 2012," dated Mar. 2013.

Table 7: LIMITED* Summary of O.U. #1 Groundwater Data Along Big Black Creek: Bofors-Nobel Superfund Site Muskegon, MI

Well Number	Contaminant	Date	Concentration (ug/L or ppb)	Part 201 Industrial Drinking Water Standard (ppb)	Rule 57 Final Chronic Value (ppb)	Rule 57 Final Acute Value (ppb)	Pt 201 Generic GSI Cleanup Criteria (ppb)
GSI-3-10 (10 ft. deep)	3,3`-Dichlorobenzidine	12/10/12	98	7.7	4.5	81	0.3
		9/25/12	120				
		6/13/12	88				
		3/12/12	83				
		9/24/10	37				
		1/5/10	140				
		6/00/08	No Well				
	Benzidine	12/10/12		0.3	2.7	49	0.3 (Detect. Limit)
		9/24/12	140				
		6/13/12	92				
		3/12/12	88				
		9/24/10	89				
		1/5/10	220				
		6/00/08	No Well				
	o-Chloroaniline (2-Chloroaniline)	12/10/12	0	N/A	N/A	N/A	N/A
		9/25/12	0				
		6/13/12	13				
		3/12/12	20				
		9/24/10	42				
		6/00/08	No Well				
	Benzene	12/10/12	0	5	200	1,900	200
		9/25/12	0				
		6/13/12	0				
		3/12/12	0				
		9/24/10	0				
		6/00/08	No Well				
GSI-3-20 (20 ft. deep)	3,3`-Dichlorobenzidine	12/10/12	39	7.7	4.5	81	0.3
		9/25/12	36				
		6/13/12	38				
		3/12/12	52				
		9/24/10	130				
		6/00/08	No Well				
	Benzidine	12/10/12	16	0.3	2.7	49	0.3 (Detect. Limit)
		9/25/12	18				
		6/13/12	21				
		3/12/12	65				
		9/24/10	150				
		6/00/08	No Well				
	o-Chloroaniline (a.k.a. 2-Chloroaniline)	12/10/12	0	N/A	N/A	N/A	N/A
		9/25/12	0				
		6/13/12	0				

Table 7: LIMITED* Summary of O.U. #1 Groundwater Data Along Big Black Creek: Bofors-Nobel Superfund Site Muskegon, MI

Well Number	Contaminant	Date	Concentration (ug/L or ppb)	Part 201 Industrial Drinking Water Standard (ppb)	Rule 57 Final Chronic Value (ppb)	Rule 57 Final Acute Value (ppb)	Pt 201 Generic GSI Cleanup Criteria (ppb)
GSI-3-20 (20 ft. deep), continued.	o-Chloroaniline (a.k.a. 2-Chloroaniline)	3/12/12	0	N/A	N/A	N/A	N/A
		9/24/10	41				
		6/00/08	No Well				
	Benzene	12/10/12	0	5	200	1,900	200
		9/25/12	0				
		6/13/12	0				
		3/12/12	0				
		9/24/10	0				
		6/00/08	No Well				
GSI-3-30 (30 ft. deep)	3,3`-Dichlorobenzidine	12/10/12	20	7.7	4.5	81	0.3
		9/25/12	16				
		6/13/12	16				
		3/12/12	22				
		9/24/10	140				
		6/00/08	No Well				
	Benzidine	12/10/12	14	0.3	2.7	49	0.3 (Detect. Limit)
		9/25/12	13				
		6/13/12	8.8				
		3/12/12	15				
		9/24/10	170				
		6/00/08	No Well				
	o-Chloroaniline (a.k.a. 2-Chloroaniline)	12/10/12	0	N/A	N/A	N/A	N/A
		9/25/12	0				
		6/13/12	0				
		3/12/12	0				
		9/24/10	36				
		6/00/08	No Well				
	Benzene	12/10/12	0	5	200	1,900	200
		9/25/12	0				
		6/13/12	0				
		3/12/12	0				
		9/24/10	1				
		6/00/08	No Well				
GSI-4-10 (10 ft. deep)	3,3`-Dichlorobenzidine	12/10/12	15	7.7	4.5	81	0.3
		9/25/12	32				
		6/13/12	24				
		3/12/12	15				
		9/24/10	24				
		6/00/08	No Well				

Table 7: LIMITED* Summary of O.U. #1 Groundwater Data Along Big Black Creek: Bofors-Nobel Superfund Site Muskegon, MI

Well Number	Contaminant	Date	Concentration (ug/L or ppb)	Part 201 Industrial Drinking Water Standard (ppb)	Rule 57 Final Chronic Value (ppb)	Rule 57 Final Acute Value (ppb)	Pt 201 Generic GSI Cleanup Criteria (ppb)
GSI-4-10 (10 ft. deep), continued.	Benzidine	12/10/12	65	0.3	2.7	49	0.3 (Detect. Limit)
		9/25/12	72				
		6/13/12	34				
		3/12/12	22				
		9/24/10	65				
		6/00/08	No Well				
	o-Chloroaniline (a.k.a. 2-Chloroaniline)	12/10/12	17	N/A	N/A	N/A	N/A
		9/25/12	30				
		6/13/12	18				
		3/12/12	19				
		9/24/10	51				
		6/00/08	No Well				
	Benzene	12/10/12	0	5	200	1,900	200
		9/25/12	0				
		6/13/12	0				
		3/12/12	0				
		9/24/10	0				
		6/00/08	No Well				
MW-60-10 (10 ft. deep)	3,3'-Dichlorobenzidine	12/10/12	59	7.7	4.5	81	0.3
		9/25/12	73				
		6/13/12	52				
		3/13/12	47				
		3/3/10	14				
		6/16/09	33				
		6/00/08	38				
	Benzidine	12/10/12	49	0.3	2.7	49	0.3 (Detect. Limit)
		9/25/12	46				
		6/13/12	39				
		3/13/12	47				
		3/3/10	28				
		6/16/09	62				
		6/00/08	140				
	o-Chloroaniline (a.k.a. 2-Chloroaniline)	12/10/12	0	N/A	N/A	N/A	N/A
		9/25/12	0				
		6/13/12	0				
		3/13/12	0				
		3/3/10	2.4				
		6/16/09	8.2				
		6/00/08	12				
	Benzene	12/10/12	0	5	200	1,900	200
		9/25/12	0				
		6/13/12	0				

Table 7: LIMITED* Summary of O.U. #1 Groundwater Data Along Big Black Creek: Bofors-Nobel Superfund Site Muskegon, MI

Well Number	Contaminant	Date	Concentration (ug/L or ppb)	Part 201 Industrial Drinking Water Standard (ppb)	Rule 57 Final Chronic Value (ppb)	Rule 57 Final Acute Value (ppb)	Pt 201 Generic GSI Cleanup Criteria (ppb)
MW-60-10 (10 ft. deep) continued.	Benzene	3/13/12	0	5	200	1,900	200
		6/00/09	0				
		6/00/08	0				
MW-60-70 (70 ft. deep)	3,3`-Dichlorobenzidine	12/10/12	Not Sampled	7.7	4.5	81	0.3
		9/25/12	Not Sampled				
		6/13/12	Not Sampled				
		3/12/12	Not Sampled				
		10/5/10	0				
		3/10/09	0				
		6/00/08	< 45				
	Benzidine	12/10/12	Not Sampled	0.3	2.7	49	0.3 (Detect. Limit)
		9/25/12	Not Sampled				
		6/13/12	Not Sampled				
		3/12/12	Not Sampled				
		10/5/10	240				
		3/10/09	1300				
		6/00/08	980				
	o-Chloroaniline (a.k.a. 2-Chloroaniline)	12/10/12	Not Sampled	N/A	N/A	N/A	N/A
		9/25/12	Not Sampled				
		6/13/12	Not Sampled				
		3/12/12	Not Sampled				
		9/24/10	20				
		3/10/09	200				
		6/00/08	< 11				
	Benzene	12/10/12	Not Sampled	5	200	1,900	200
		9/25/12	Not Sampled				
		6/13/12	Not Sampled				
		3/12/12	Not Sampled				
		9/24/10	2				
		6/16/09	27				
		6/00/08	0.15				
WT-1 (Weir/ Sump Structure located inside the Barrier Wall). **	3,3`-Dichlorobenzidine	3/09	17	7.7	4.5	81	0.3
		6/09	19				
		1/10	36				
		7/10	10				
		4/11	31				
		10/11	9.5				
		3/12	27				
		12/12	12				

Table 7: LIMITED* Summary of O.U. #1 Groundwater Data Along Big Black Creek: Bofors-Nobel Superfund Site Muskegon, MI

Well Number	Contaminant	Date	Concentration (ug/L or ppb)	Part 201 Industrial Drinking Water Standard (ppb)	Rule 57 Final Chronic Value (ppb)	Rule 57 Final Acute Value (ppb)	Pt 201 Generic GSI Cleanup Criteria (ppb)
WT-1 (cont'd.) **	Benzidine	3/09	120	0.3	2.7	49	0.3 (Detect. Limit)
		6/09	250				
		1/10	380				
		7/10	74				
		4/11	170				
		10/11	190				
		3/12	160				
		12/12	99				
	o-Chloroaniline (a.k.a. 2-Chloroaniline)	3/09	210	N/A	N/A	N/A	N/A
		6/09	320				
		1/10	460				
		7/10	160				
		4/11	350				
		10/11	450				
		3/12	410				
		12/12	230				
	Benzene	3/09	170	5	200	1,900	200
		6/09	1800				
		1/10	920				
		7/10	430				
		4/11	1500				
		10/11	900				
		3/12	1200				
		12/12	1700				
	cis-1,2-Dichloroethylene	3/09	80	N/A	620	11,000	620
		6/09	220				
		1/10	130				
		7/10	4				
		4/11	160				
		10/11	100				
		3/12	110				
		12/12	48				
	Toluene	3/09	190	790	270	2,600	140
		6/09	1900				
		1/10	1300				
		7/10	480				
		4/11	2600				
		10/11	2300				
		3/12	2700				
		12/12	3300				

Table 7: LIMITED* Summary of O.U. #1 Groundwater Data Along Big Black Creek: Bofors-Nobel Superfund Site Muskegon, MI

Well Number	Contaminant	Date	Concentration (ug/L or ppb)	Part 201 Industrial Drinking Water Standard (ppb)	Rule 57 Final Chronic Value (ppb)	Rule 57 Final Acute Value (ppb)	Pt 201 Generic GSI Cleanup Criteria (ppb)
WT-1 (cont'd.) **	Vinyl Chloride	3/09	23	2	930	17,000	15
		6/09	100				
		1/10	30				
		7/10	2.6				
		4/11	67				
		10/11	28				
		3/12	38				
		12/12	14				

TABLE 7 FOOTNOTES

*** This is a limited summary only for the wells shown. There are numerous other monitoring wells along Big Black Creek for which data has shown contaminants are present in groundwater. See Figure 7.**

**** Samples collected at WT-1 represent groundwater that has reached ground surface level within the treatment wetland contained by the Barrier Wall. The water at the WT-1 location is contained within the Barrier Wall, is collected in a sump, and is pumped to the O.U. #1 Groundwater Treatment Plant.**

TABLE 8 - SUMMARY OF RISK; O.U. #1 ROD AND 1999 SECOND ROD AMENDMENT; BOFORS-NOBEL SITE

EXPOSURE PATHWAY	RESIDENTIAL CARCINOGENIC RISK IDENTIFIED IN 1990 ROD[1]
Groundwater	3.4×10^{-5} to 9.9×10^{-1} [3]
Soil Ingestion	2×10^{-10} to 2×10^{-3} [4]
Soil Direct (Dermal) Contact	7.9×10^{-9} to 1×10^{-5}
Air	7.9×10^{-9} to 1.2×10^{-3} [5]
Surface Water (Computer Modeled)	3.4×10^{-7} to 1×10^{-2} [6]
CUMULATIVE (TOTAL) RISK	3.4×10^{-5} to 1.0×10^{-0}

FOOTNOTES FOR TABLE 8

1 Information from September 1990 Record of Decision and February 1990 Remedial Investigation (RI) Report (repeated in 1999 ROD amendment).

2 Risk uses a basis of a 70 year life time. A 1.0×10^{-6} cancer risk value corresponds to a 1 in 1,000,000 chance that an individual develops cancer as a result of exposure to these concentrations of contaminants over a period of 70 years. Similarly, 1.0×10^{-5} corresponds to a 1 in 100,000 chance, 1.0×10^{-4}, 1 in 10,000, and so on. U.S. EPA may perform a Remedial Action if cancer risks are greater than 1.0×10^{-4}, or a Hazard Index of 1.0 or greater.

3 Calculated in 1990 by computer models ("SeSOIL" and "AT123D") which simulated contaminant release as leachate from soil and sludge.

4 Taken from February 1990 Remedial Investigation (RI) Report, Chapter 6. Original risk calculations based on limited availability of carcinogenic potency information, and computer models noted in Footnote (3). A fundamental requirement for this remedy is a lagoon area cover that must prevent all unacceptable contact with contaminated sludge and/or soil.

5 Calculated in 1990 by a computer model ("ISCLT"), that assumed "worst-case" volatilization of organics from lagoon area sludge.

6 Surface water risks calculated in 1990 by a computer model ("EXAMS-II") that simulated the fate of contaminants in groundwater discharging to a surface water body. State of Michigan Groundwater-Surface Water Interface (GSI) Standards will be the performance criteria for this remedy and will insure protection of Big Black Creek. In addition, the continuation of adequate capture of contaminated groundwater before discharge to the Creek (which has been in operation since the mid-1970s) is a fundamental requirement for this remedy, and thus the surface water exposure pathway will continue to be eliminated.

TABLE 9 - CONTAMINANTS IN GROUNDWATER[1] AND GROUNDWATER CLEANUP CRITERIA (PERFORMANCE STANDARDS); 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE

CONTAMINANT	PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb)	PART 201 RESIDENTIAL DRINKING WATER CRITERIA [3] (ppb)	PART 201 GENERIC GSI CLEANUP CRITERIA [4] (ppb)	PART 201 GROUNDWATER CONTACT CRITERIA [5] (ppb)	BACKGROUND[6] (ppb)	MAX. CONTAMINANT CONCENTRATION (ppb) IN 1990 ROD OR REMEDIAL DESIGN (month/yr) [1]
Acenapthene	3,800	1,300	19	4200 S [7]	ND[9]	20
Acenapthylene [17]	75	26	ID[12]	3900 S [7]	ND	21
Acetone	2,100	730	1,700	31,000,000	ND	5,100; 81;000 E
Aniline (cc)	610	150	IP [14]	370,000	ND	10,000
Anthracene	43 S [7]	43 S [7]	ID [12]	43 S [7]	ND	14 J
Azobenzene (cc)	32	7.7	NA [5]	410	ND	420 @ PW-40 (7/93)
Benzene (cc)	5 A [8]	5 A [8]	200 X[13]	9,400	8,000	65,000
Benzeneacetic acid [17]	N/L [11]	NOT LISTED			ND	140 J
Benzidine (cc)	0.3 M [10]	0.3 M [10]	ID [12]	6.8	ND	12,000 @ MW-106 (6/92)
Benzo(a)anthracene	5 M [10]	5 M [10]	NA [5]	5 M [10]	ND	19 J
Benzo(a)pyrene [17]	5 M [10]	5 M [10]	ID[12]	5 M [10]	ND	230
1,2,3-Benzothiadiazole [17]	N/L [11]	NOT LISTED			ND	1,300 J
Benzyl Alcohol	29,000	10,000	NA [5]	44,000,000 S[7]	ND	310 @ PW-39 (6/92)
Bis(2-ethylhexyl)phthalate	6 A [8]	6 A [8]	32	47	ND	4,000 J
Carbon Disulfide	2,300	800	ID [12]	1,100,000	ND	1,000
2-Chloroaniline	N/L [11]	NOT LISTED			ND	63,000
4-Chloroaniline	N/L [11]	NOT LISTED			ND	62 @ MW-62 (7/93)
Chlorobenzene	100 A [8]	100 A [8]	47	68,000	ND	920
Chloroform	100 A,W [8,15]	100 A,W [8,15]	170 X[13]	96,000	ND	4.8 @ MW-60 (6/94)

TABLE 9 - CONTAMINANTS IN GROUNDWATER[1] AND GROUNDWATER CLEANUP CRITERIA (PERFORMANCE STANDARDS); 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE

CONTAMINANT	PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb)	PART 201 RESIDENTIAL DRINKING WATER CRITERIA[3] (ppb)	PART 201 GENERIC GSI CLEANUP CRITERIA[4] (ppb)	PART 201 GROUNDWATER CONTACT CRITERIA[5] (ppb)	BACKGROUND[6] (ppb)	MAX. CONTAMINANT CONCENTRATION (ppb) IN 1990 ROD OR REMEDIAL DESIGN (month/yr)[1]
(3-chlorophenyl)(4-chlorophenyl) - methanone	N/L[11]	NOT LISTED			ND	700 J
Chrysene	5 M[10]	5 M[10]	ID[12]	5 M[10]	ND	19 J
Dibenzofuran[17]	ID[12]	ID[12]	4	ID[12]	ND	18 J
3,3'-Dichlorobenzidine (and isomers) (cc)	7.7	1.9	0.3 M,X[10,13]	270	ND	2,600
1,2-Dichlorobenzene	600 A[8]	600 A[8]	16	160,000 S[7]	ND	400
1,2-Dichloroethane	5 A[8]	5 A[8]	360 X[13]	11,000	ND	110
1,1-Dichloroethylene (ethene)	7 A[8]	7 A[8]	65 X[13]	9000	ND	34 J @ PW-33 (6/94)
1,2-Dichloroethylene (ethene)	70 A[8]	70 A[8]	ID[12]	170,000	ND	2,400 @ PW-33 (6/94)
N,N - Dimethylformamide	2,000	700	NA[5]	130,000,000	ND	450 J
Dimethyl phthalate	210,000	73,000	NA[5]	4,200,000 S[7]	ND	120 J
Dimethylbenzenamine[17]	N/L[11]	NOT LISTED			ND	780 J
Dimethylnapthalene[17]	N/L[11]	NOT LISTED			ND	52 J
Di-n-Butylphthalate	2,500	880	9.7	11,000 S[7]	ND	180 @ PW-40 (11/93)
Di-n-Octylphthalate	380	130	ID[12]	250	ND	459 @ PW-40 (6/92)
1,1'-Diphenyl- 2,2-Diamine	N/L[11]	NOT LISTED			ND	3,200 J
2,3-Dihydrodimethyl-1H-Indene	N/L[11]	NOT LISTED			ND	42 J
Ethylbenzene	74 E[14]	74 E[14]	18	170,000 S[7]	ND	340 @ PW-41 (9/92)

TABLE 9 - CONTAMINANTS IN GROUNDWATER[1] AND GROUNDWATER CLEANUP CRITERIA (PERFORMANCE STANDARDS); 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE

CONTAMINANT	PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb)	PART 201 RESIDENTIAL DRINKING WATER CRITERIA [3] (ppb)	PART 201 GENERIC GSI CLEANUP CRITERIA [4] (ppb)	PART 201 GROUNDWATER CONTACT CRITERIA [5] (ppb)	BACKGROUND[6] (ppb)	MAX. CONTAMINANT CONCENTRATION (ppb) IN 1990 ROD OR REMEDIAL DESIGN (month/yr) [1]
Fluoranthene	210 S [7]	210 S[7]	1.6	210 S [7]	ND	16 J
Fluorine [17]	2,000 A E [8]	2,000 A E [8]	NA [5]	13,000,000	ND	16 J
2-Hydroxybenzonitrile [17]	N/L [11]	NOT LISTED			ND	44 J
4-hydroxy-4-methyl-2-pentanone[17]	N/L [11]	NOT LISTED			ND	190 J
Isophorone	3,700	900	570 X [13]	1,100,000	ND	1,400
2-Methylnapthalane	750	260	ID [12]	32,000	ND	480
2-Methylphenol	1,000	370	82	710,000	ND	470
4-Methylphenol	100	37	ID [12]	75,000	ND	170
1-Methoxynitrobenzene [17]	N/L [11]	NOT LISTED			ND	22,000 J
1-Methylnaphthalene [17]	N/L [11]	NOT LISTED			ND	490 J
Methoxybenzeneamine [17]	N/L [11]	NOT LISTED			ND	21,000 J
Methylene Chloride	5 A [8]	5 A [8]	940 X[13]	110,000	ND	5,820 @ PW-38 (6/92)
N-nitroso-Di-n-Propylamine	5 M [10]	5 M [10]	NA [5]	220	ND	30 @ PW-34 (12/92)
Naphthalene	750	260	13	31,000 S [7]	ND	650
Nitrobenzene	9.6	5 M [10]	180 X [13]	9,600	ND	6,600
Phenanthrene	75	26	5 M [10]	1,000 S [7]	ND	19 J
Phenol	13,000	4,400	210	28,000,000	ND	140; 170 J
Pyrene	140 S [7]	140 S [7]	ID [12]	140 S [7]	ND	27
Sulfur [17]	N/L [11]	NOT LISTED			ND	1,800 J

TABLE 9 - CONTAMINANTS IN GROUNDWATER[1] AND GROUNDWATER CLEANUP CRITERIA (PERFORMANCE STANDARDS); 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE

CONTAMINANT	PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb)	PART 201 RESIDENTIAL DRINKING WATER CRITERIA[3] (ppb)	PART 201 GENERIC GSI CLEANUP CRITERIA[4] (ppb)	PART 201 GROUNDWATER CONTACT CRITERIA[5] (ppb)	BACKGROUND[6] (ppb)	MAX. CONTAMINANT CONCENTRATION (ppb) IN 1990 ROD OR REMEDIAL DESIGN (month/yr)[1]
Tetrachloroethylene	5 A[8]	5 A[8]	45 X[13]	5,100	ND	18,000
Toluene	790 E[8]	790 E[8]	140	530,000 S[7]	3,000 J	280,000
1,2,4-Trichlorobenzene	70 A[8]	70 A[8]	30	15,000	ND	56 J
Trichloro-1-propene isomer[17]	N/L[11]	NOT LISTED			ND	36 J
Trichloroethylene	5 A[8]	5 A[8]	200 X[13]	11,000	ND	2,100 @ PW-33 (6/94)
3,3,5-Trimethylcyclohexanone	N/L[11]	NOT LISTED			ND	31,000 J
Trimp (trimethylphenols)	N/L[11]	NOT LISTED			ND	2,000 J
1,2,4-Trithiolane[17]	N/L[11]	NOT LISTED			ND	420 J
1,3,5-Trithlane[17]	N/L[11]	NOT LISTED			ND	100 J
Unknowns ****	N/L[11]	NOT LISTED			ND	100,500
Vinyl chloride	2 A[8]	2 A[8]	15	290	ND	1,000
Xylenes (total)	280 E[8]	280 E[8]	35	190,000 S[7]	8,000	580 @ PW-41 (5/91)
Aluminum	50	50	NA[5]	70,000,000	192	23,200
Antimony[17]	6 A[8]	6 A[8]	ID[12]	75,000	61.3	61
Arsenic	50 A[8]	50 A[8]	150 X[13]	4,700	4.8 J	74
Barium	2,000 A[8]	2,000 A[8]	190	15,000,000	23.2 J	174 J
Beryllium	4 A[8]	4 A[8]	G[18]	1,100,000	ND	14 @ MW-72 (12/92)
Cadmium	5 A[8]	5 A[8]	G[18], X[13]	210,000	5.3	120,000 @ IL-01 (3/93)

TABLE 9 - CONTAMINANTS IN GROUNDWATER[1] AND GROUNDWATER CLEANUP CRITERIA (PERFORMANCE STANDARDS); 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE

CONTAMINANT	PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb)	PART 201 RESIDENTIAL DRINKING WATER CRITERIA[3] (ppb)	PART 201 GENERIC GSI CLEANUP CRITERIA[4] (ppb)	PART 201 GROUNDWATER CONTACT CRITERIA[5] (ppb)	BACKGROUND[6] (ppb)	MAX. CONTAMINANT CONCENTRATION (ppb) IN 1990 ROD OR REMEDIAL DESIGN (month/yr)[1]
Calcium[17]	(no threat to human health and the environment)				43,700	345,800 @ PW-41 (10/91)
Chromium (VI)	100 A[8]	100 A[8]	11	1,000,000	28.2	74 @ MW-72 (12/92)
Cobalt	100	50 M[10]	100	1,100,000	10	38 @ MW-72 (12/92)
Copper	1,000 E[8]	1,000 E[8]	G[18]	8,100,000	64.7	120 @ MW-72 (12/92)
Iron[17]	300 E[8]	300 E[8]	NA[5]	ID[12]	768	35,400
Lead	4 L[19]	4 L[19]	G,X[13,18]	ID[12]	7.3	8,800 @ MW-110 (9/92)
Magnesium[17]	1,200,000	420,000	NA[5]	1,000,000,000 D[20]	13,200	85,000 @ MW-106 (9/92)
Manganese	50 E[8]	50 E[8]	G,X[13,18]	10,000,000	34	5,390
Mercury	2 A[8]	2 A[8]	0.2 M[15]	56 S[7]	0.2	1.3
Nickel[17]	100 A[8]	100 A[8]	G[18]	16,000,000	22.9 J	810 @ MW-110 (9/92)
Potassium[17]	(no threat to human health and the environment)				1930 J	16,500
Selenium	50 A[8]	50 A[8]	5	1,100,000	3.6 J	14.7
Silver	98	34	0.2 M[15]	1,000,000	12.9	16,000 @ MW-72 (12/92)
Sodium[17]	450,000	160,000	NA[5]	1,000,000,000 D[20]	1430	1,610,000
Thallium	2 A[8]	2 A[8]	3.7 X[13]	14,000	ND	30 @ MW-110 (9/92)
Vanadium	180	64	12	1,900,000	12.7 J	412
Zinc	5,000 E[8]	2,400	G[18]	70,000,000	88.7	210,000 @ MW-72 (12/92)

FOOTNOTES AND LEGEND FOR TABLE 9

(cc) Baseline risk assessment identified this contaminant as presenting a major Site risk. Baseline risk assessment did not identify any inorganic contaminants as contaminants of concern.

1 Data taken from Record of Decision and Landfill Remedy Remedial Design. Maximums represent either the maximum shown in the ROD, or the maximum concentration discovered during RD quarterly groundwater monitoring from mid-1992 to mid-1994. Maximum concentrations that have been noted with location and (month/year) are 1991-94 RD data. All other maximums are 1990 ROD and RI data.

2 Industrial Drinking Water Standard is the cleanup criteria that are applicable to groundwater unless appropriate deed restrictions can not be obtained for future industrial land use, in which case criteria for future residential land use would apply for groundwater.

3 Residential Drinking Water Standard is the cleanup criteria that are applicable to groundwater for future residential land use.

4 Groundwater - Surface Water Interface (GSI) Criteria are contaminant concentrations in groundwater which, if not exceeded, are protective of a surface water body that receives such contaminated groundwater discharge. These GSI limits must be maintained to insure protection of Big Black Creek.

5 Groundwater Contact Criteria are contaminant concentrations in groundwater which, if not exceeded, are protective of human health in the event of inadvertent human direct contact with such contaminated groundwater.

6 BACKGROUND - Background concentration taken from sample in relatively "clean" Site area as shown in the February 1990 Remedial Investigation (RI) report. For cleanup standards noted by a 'B', background concentrations may be used instead of the value shown.

7 S - Criterion is based on the chemical specific water solubility limit.

8 A - State of Michigan Drinking Water Criterion established pursuant to Section 5 of the Safe Drinking Water Act, Act No. 399 of the Public Acts of 1976;
E - Criterion is the aesthetic drinking water value, as required by Sec. 20120(1)(5).

9 ND - Compound Not Detected in laboratory analysis.

10 M - Criterion is below the Method Detection Limit, therefore, the criterion defaults to the MDL. The Method Detection Limit is the lowest value accepted by the State of Michigan that laboratory equipment can measure. If the Part 201 cleanup criterion is lower than what the laboratory can detect, then the MDL becomes the cleanup criterion.

11 N/L - Not Listed in Michigan Part 201 Generic Industrial and Commercial Cleanup Criteria.

12 ID - Inadequate Data. The State of Michigan does not have enough health risk data to develop criterion for this contaminant.

13 X - The GSI criterion shown is not protective for surface water that is used as a drinking water source.

14 IP - Development of generic GSI value in process but not yet complete.

15 W - Concentrations of trihalomethanes in groundwater must be added together to determine compliance with the Drinking Water Standard of 100 ppb.

16 NA - Not Available.

17 Contaminant discovered at the time of the 1990 ROD, but subsequently shown (by subsequent sampling and analysis) as not present, naturally occurring, or well below soil, air, groundwater, or surface water cleanup standard after appropriate U.S. EPA and MDEQ review and approval.

18 H - Standard is dependent on "hardness" of groundwater; G - GSI cleanup criterion is dependent upon water hardness in the area.

19 L - For Lead, higher concentrations may be acceptable and criteria may be modified based on an acceptable site-specific demonstration subject to U.S. EPA/MDEQ review and approval.

20 D - Calculated groundwater criterion exceeds 100 % and is reduced to 100 %. Site - specific evaluation of contaminant status and adverse impacts subject to U.S. EPA/MDEQ review and approval may be required.

DATA QUALIFIER LEGEND

When chemical analysis data is submitted to U.S. EPA, limitations of analytical equipment must be noted with results so an accurate scrutiny can be performed. These limitations are shown as qualifiers, noted as letters next to numerical values. Explanations of these qualifiers are as follows:

**** Compound is noted as "unknown" because there were detections of organic chemicals, but specific identification of specific compound or isomer detected is unknown.

J - Signifies a value that was estimated. This means that the compound was detected by the analytical equipment but the value shown may not be able to be reproduced exactly if the analysis were repeated.

B - Signifies a compound that was also detected in a blank. A blank is a 'clean' sample prepared in the laboratory, carried with field samples, transported, and stored. If contamination is found in a blank, there is a possibility that contamination may be from a source other than what was sampled (such as through faulty sampling, storage, transportation, or laboratory procedures).

D - Signifies that the sample shown had to be diluted for the lab equipment to show results that are reproducible.

E - Estimated value due to deviations discovered in lab quality control (QC) procedure.

TABLE 10- CONTAMINANTS IN SLUDGE AND SOIL AND SOIL CLEANUP CRITERIA (PERFORMANCE STANDARDS) ; 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE

CONTAMINANT	PART 201 RPGW [2] (ppb)	PART 201 IPGW [2] (ppb)	PART 201 GSIPGW [2] (ppb)	PART 201 IND. DCV [2] (ppb)	LAGOON NUMBER (Approximate Location); Contaminant Concentration in ppb										
					BACKGD [3]	1	2	3	4	5	6	7	8	9	10
Acetone	15000	42000	34000	7.40e+07	ND [4]	70								91	11
Alkyl benzene isomers [12]	N/L [5]			N/L [5]	ND [4]			148000 J			123000 J		147000	148000000 J	4400
Aniline (cc)	3000	12000	IP [9]	4.50e+06 C [14]	ND [4]	860		9200					1700	3900000	3400
Azobenzene (cc)	1400	5900	N/A [5]	1.40e+06	ND [4]	93 J		12000000		170000	680000	22000 J	33000 J	8200000	230000
Azoxybenzene	N/L [5]			N/L [5]	ND [4]			690000 J						36000	85000
Benzene (cc)	100	100	4000 X [13]	400,000 C [14]	ND [4]			980000		23			2800	120000	8 J
Benzidine (cc)	1000 M [11]	1000 M [11]	ID [7]	1,000 M [11]	ND [4]			3400000		2100 J	70000 J		13000	1300000	13000
2-Butanone (MEK)	260000	760000	44000	2.70e+07 C [14]	ND [4]									25 J	
2-Chloroaniline	N/L [5]			N/L [5]	ND [4]	260000		270000		540	22000 J; 21000	240	12000 J	2300000	24000 J
(3-Chlorophenyl) (4-Chlorophenyl) Methanone	N/L [5]			N/L [5]	ND [4]	300000 J		6100000 J		330000 J	1,300,000	520000 J	34000 J	6200000	190000 J
3,3'-Dichlorobenzidine (and isomers) (cc)	2000 M [11]	2000 M [11]	2000 M [11], X [13]	55000	ND [4]	65000 J		2700000		930000; 950000 J	390000; 1000000 J	260000; 100000 J	1500000; 1700000 J	11,000,000	2900000; 3500000 J
Ethylbenzene	1500	1500	360	140,000 C [14]	ND [4]	51					9,200	1			
Methylene Chloride (cc)	100	100	19000 X [13]	2.30e+06 C [14]	ND [4]					4 J ***	2200 J **	18 ***	1200 J		
Sulfur - NP [10]	N/L [5]			N/L [5]	ND [4]	5100 J						8300 J		1500	
1,1' - Sulfonyl - bis (2-	N/L [5]			N/L [5]	ND [4]										82000 J

TABLE 10- CONTAMINANTS IN SLUDGE AND SOIL AND SOIL CLEANUP CRITERIA (PERFORMANCE STANDARDS) ; 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE

CONTAMINANT	PART 201 RPGW [2] (ppb)	PART 201 IPGW [2] (ppb)	PART 201 GSIPGW [2] (ppb)	PART 201 IND. DCV [2] (ppb)	LAGOON NUMBER (Approximate Location); Contaminant Concentration in ppb										
					BACKGD [3]	1	2	3	4	5	6	7	8	9	10
Methyl) Benzene															
Tetrachloroethylene	100	100	900 X [13]	88000 C [14]	ND [4]							82	680		
Toluene	16000	16000	2800	250000 C [14]	ND [4]	8,900		1,100,000		17	130,000		80,000	1600000	210
1,2,4 - Trichlorobenzene	4200	4200	1800	1.1e+06 C [14]	ND [4]			350		150	150		7,100	250000	
Unknowns **** [10]				NP [10]	26 J		1400 J			5700 J	503000 J	19000 J			14400 J
Xylenes (total)	5600	5600	700	150,000 C [14]	ND [4]	120				14	58,000				
Aluminum	1000	1000	N/A [5]	3.00e+08	3770000	250000	1110000	1740000	781000	7920000	4070000	1900000	6220000	1930000	3830000
Antimony [10]	4300	4300	ID [7]	1.60e+06	ND [4]	25200									
Arsenic	23000	23000	70000 X [13]	100000	ND [4]	43800 E	630 J	6100	600 J	3600	5100	780 J	3700 J	2700 J	3300 J
Barium	1.30e+06	1.30e+06	130000	3.20e+08	12600 J	9800 J	5700 J	40300 J	3400 J	48000 J	43400 J	18300 J	85000	18300 J	44700 J
Beryllium	51000	51000	G [13]	2.30e+07	ND [4]			670 J		540 J	2100	320			2400
Cadmium	6000	6000	G,X [13]	2.30e+06	ND [4]	424000		21900						15100	
Calcium - NO [10]			G,X [13]	4.5 e+06	109000 J	83000 J	242000 J	64600000	676000J	194000000	265000000	7350000	253000000	25900000	271000000
Chromium	30000	30000	3300	2.20e+07	2200	916000	2400	79500		22100	12100	17000	68000	45700	21200
Cobalt	1000	2000	2000	2.30e+07	2200 J	36700				3500 J	7700 J				3400 J
Copper	1.60e+08	1.60e+08	G [13]	1.70e+08	ND [4]	1640000	41200	226000		19100	14300	6400	2800	36700	27100
Iron - NO [10]	6000	6000	N/A [5]	ID [7]	2650000	5460000	2660000	11000000	1420000	3780000	2550000	3870000	2920000	13000000	1430000
Lead	1000 M [11]	1000 M [11]	G,X [13]	900,000 L [8]	3200	6040000	6200	887000	700 J	34700	20800	37400	29700 R	362000	12500 E

TABLE 10- CONTAMINANTS IN SLUDGE AND SOIL AND SOIL CLEANUP CRITERIA (PERFORMANCE STANDARDS) ; 1999 ROD AMENDMENT; O.U. #1 AREA; BOFORS-NOBEL SITE

CONTAMINANT	PART 201 RPGW [2] (ppb)	PART 201 IPGW [2] (ppb)	PART 201 GSIPGW [2] (ppb)	PART 201 IND. DCV [2] (ppb)	LAGOON NUMBER (Approximate Location); Contaminant Concentration in ppb										
					BACKGD [3]	1	2	3	4	5	6	7	8	9	10
			M [11]			E									
Magnesium - NO [10]	8.40e+06	2.40e+07	N/A [5]	1.0e+09 D [6]	342000 J	95000 J	368000 J	1840000	459000J	2870000	2350000	721000 J	3400000	3050000	2470000
Manganese	2000 M [11]	2000 M [11]	G,X [13]	2.10e+08	17300	2680000	41200	85200	23900	52000	46400	58600	71600	164000	32800 E
Mercury	1700	1700	170	1.40e+06	ND [4]	150 E	100	710						330	
Nickel	100000	100000	G [13]	3.40e+08	ND [4]	460000	2100 J	21000		17500	10300 J	9300	3600 J	15100	4800 J
Potassium - NO [10]				NO [10]	86400		71800 J	189000 J	106000 J	412000 J	245000 J	79300 J	394000 J R	104000 J	132000 J
Selenium	4000	4000	400	2.30e+07	ND [4]		680 J	3300							2400 J
Silver	4500	13000	500 M [11]	2.10e+07	ND [4]	15600				4600				1800 J	1200
Sodium [10]	3.20e+06	9.00e+06	N/A [5]	1.0e+09 D [6]	ND [4]		26100 J	5920000	44000 J	191000 J	169000 J	49900 J	366000 J	3500000	318000 J
Thallium	2300	2300	4200 X [13]	300000	ND [4]										
Vanadium	1.00e+06	2.90e+06	240	3.90e+07	4800	28,600	3000 J	4200 J	940 J	17700	10800 J	4600 J	9300 J	5400 J	6200 J
Zinc	2.40e+06	5.00e+06	G [13]	1.0e+09 D [6]	1240000	59,400	15,900	91,200,000	18,500	1,240,000	1,280,000	8,370,000	2,510,000	61,800,000	1,270,000

FOOTNOTES AND LEGEND FOR TABLE 10

(cc) Baseline risk assessment identified this contaminant as presenting a major Site risk. Baseline risk assessment did not identify any inorganic contaminants as contaminants of concern.

1 Data taken from Record of Decision and February 1990 Remedial Investigation (RI) Report. Data represents maximum concentrations found in soils or sludge samples taken in lagoon area at an average depth of 10 feet deep. (Soil samples - 2 to 6 ft.; Sludge 10 to 12 ft.). No PCBS or pesticides (other than those shown) were detected. Blank spaces in Table 4 signify that compound was not detected in laboratory analysis. Values shown in format "1.0e+09" are scientific notation (i.e.,1.0e+09 = 1,000,000,000; 1.0e+06=1,000,000; 1.0e-03=0.001; 1.0 e-06=0.000001).

2 **IPGW** - Industrial Soil Cleanup Criteria Protective of Groundwater as of June 1999. This is the contaminant concentration in soil which, if not exceeded, insures that groundwater is protective for human consumption under a future industrial land use scenario. **RPGW** - Residential Soil Cleanup Criteria Protective of Groundwater as of June 1999. This is the contaminant concentration in soil which, if not exceeded, insures that groundwater is protective for human consumption under a future residential land use scenario. **GSIPGW** - Soil Cleanup Criteria Protective of GSI Criteria for Groundwater as of June 1999. This is the contaminant concentration in soil which, if not exceeded, insures that groundwater is protective for Big Black Creek. **DCV** - Direct Contact Value - Part 201 Industrial Direct Contact Value as of June 1999. This is the contaminant concentration in soil which, if exceeded, presents an unacceptable human risk by contact with the soil within a typical industrial scenario. Any exposure to lagoon area soil would be to an individual working on the Site within a controlled work environment. The DCV criterion is the basis for the O.U. #1 lagoon area cover component of the TIC remedy.

3 BACKGRD - Background concentration taken from sample in relatively "clean" site area.

4 ND - Compound Not Detected in laboratory analysis.

5 N/L - Not Listed in Michigan Part 201 Generic Industrial and Commercial Cleanup Criteria as of June 1999.
N/A - Not Available or Not Applicable, but contaminant has been listed as of June 1999.

6 D - Concentration constituting cleanup criteria exceeds 100 % in soil hence it is reduced to 100 %.

7 ID - Inadequate Data. There is not enough health risk data to develop criterion for this contaminant.

8 L - Criteria developed using the U.S. EPA integrated uptake Biokinetic Model for children. Higher level may be acceptable subject to U.S. EPA and State of Michigan review and approval procedure.

9 IP - Development of generic GSI value in process but not yet complete.

10 NP, NO - Contaminant discovered at the time of the 1990 ROD but subsequently shown (by subsequent sampling and analysis) as Not Present, Naturally Occurring, or well below soil, air, groundwater, or surface water cleanup criteria.

11 M - Method Detection Limit is cleanup criterion. The Method Detection Limit is the lowest value accepted by the State of Michigan that laboratory equipment can measure. If the Part 201 cleanup criterion is lower than what the laboratory can detect then the MDL becomes the cleanup standard.

12 Alkylbenzene isomers are compounds related to Toluene, Ethylbenzene, and Isopropylbenzene (all are "Alkyl benzenes").

13 G - Soil criteria for GSI protection is dependent on hardness of water in the area. X - The GSI criterion shown is not protective for surface water that is used as a drinking water source.

14 C - Soil criteria is based on contaminant-specific generic soil saturation concentration to insure a more protective cleanup goal. Soil criterion may be modified based on an acceptable site-specific demonstration subject to U.S. EPA/MDEQ review and approval.

DATA QUALIFIER LEGEND

When chemical analysis data is submitted to U.S. EPA limitations of analytical equipment must be noted with results so an accurate scrutiny can be performed. These limitations are shown as qualifiers noted as letters next to numerical values. Explanations of these qualifiers are as follows:

** Not found in duplicate analysis; *** Less than 10 times the concentration found in lab field or background blanks; **** Compound is unknown in the sense that there were detections of organic chemicals but specific identification of a certain compound or isomer detected is unknown.

J - Signifies a value that was estimated. This means that the compound was detected by the analytical equipment but the value shown may not be able to be reproduced exactly if the analysis were repeated.

B - Signifies a compound that was also detected in a blank. A blank is a 'clean' sample prepared in the laboratory carried with field samples transported and stored. If contamination is found in a blank there is a possibility that contamination may be from a source other than what was sampled (such as through faulty sampling storage transportation or laboratory procedures).

D - Signifies that the sample shown had to be diluted for the lab equipment to show results that are reproducible.

E - Estimated value due to deviations discovered in lab quality control (QC) procedure.

TABLE 11
Site Inspection Checklist

I. SITE INFORMATION	
Site name: BOFORS-NOBEL	**Date of inspection(s):** THURSDAY, MAY 16, 2013
Location and Region: EGELSTON TOWNSHIP, MUSKEGON COUNTY, MI. U.S. EPA REGION 5	**EPA ID:** MID006030373
Agency leading the five-year review: U.S. EPA * * Collaborative inspection with Performing Settling Defendants (PSDs) and Michigan Dept. of Environmental Quality (MDEQ).	**Weather/temperature:** NO PRECIPITATION, MODERATE WIND, 70^{O} F, SUNNY, CLEAR.

Inspection Team:
a. John V. Fagiolo, U.S. EPA Remedial Project Manager
b. Tim Fischer, U.S. EPA Remedial Project Manager
c. Wally Wagaw, State Project Manager, MDEQ
d. Tom Berdinski, Water Resources Division, MDEQ
e. Chuck Graff, Geologist, Superfund Section, MDEQ
f. James Campbell, Engineering Management Inc., PSDs' Project Coordinator

Others: D. Houston, Envirocorp (GWTP contractor).

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other_____
- ☐ Monitored natural attenuation
- ☒ Groundwater containment
- ☒ Vertical barrier walls

Attachments: ☐ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **Site Manager ***

a. James Campbell — PSDs' Project Coordinator , Engineering Management, Inc.
Name — Title

5/16/2013
Date

Interviewed ** ☒ at site ☒ at office ☒ by phone ☒ e-mail ☐ Report attached
Phone no.: 412-244-0917; email: jrc@e-emi.com

Problems, suggestions, other:

* Performing Settling Defendants' Project Coordinator. ** Dates of "interviews" vary from January 2013 to present and consisted of an exchange of information between PSDs' representatives and U.S. EPA.

2. **Site staff:** Don Houston (Name) — Environ/Camus, GWTP Site Manager (Title)

Date: 5/16/2013

Interviewed ☒ at site ☐ at office ☐ by phone ☒ other* Phone: 231-788-4934; email: dhouston@environcorp.com
☐ Report attached

Problems, suggestions, other; * Information has been provided in the form of Site Monthly Progress Reports, and various maintenance updates (as needed), via email messages.

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

a. Agency: Michigan Department of Environmental Quality (MDEQ)
Contact: Walelign Wagaw (Name) — Senior Project Manager MDEQ Remediation/Redevelopment Div. (Title)
5/16/2013 (Date) — 517-373-9896 (Phone no.)
Problems; suggestions; ☐ Report attached

Other: COMMENTS PROVIDED BY MDEQ AS SEPARATE CORRESPONDENCE, NOT INCLUDED WITH THIS SITE INSPECTION FORM.

4. **Other interviews** (optional). ☐ Report attached.

NONE.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents ***

☒ O&M manual	☒ Readily available	☒ Up to date	☐ N/A
☒ As-built drawings	☒ Readily available	☒ Up to date	☐ N/A
☒ Maintenance logs	☒ Readily available	☒ Up to date	☐ N/A

Remarks: OPERATION AND MAINTENANCE DOCUMENTS ARE APPLICABLE FOR THE GROUNDWATER TREATMENT PLANT (GWTP) ONLY. ALL APPLICABLE GWTP O&M DOCUMENTS REMAIN IN PLACE, ARE AVAILABLE AND UP TO DATE. NO ALTERATIONS TO THE GWTP HAVE OCCURRED SINCE THE LAST FIVE-YEAR REVIEW IN 2008, AND ALL O&M DOCUMENTS REMAIN CURRENT.

2. **Site-Specific Health and Safety Plan** ☒ Readily available ☒ Up to date ☐ N/A
☒ Contingency plan/emergency response plan ☒ Readily available ☒ Up to date ☐ N/A

Remarks: ALL SITE DOCUMENTS ARE UP TO DATE AND AVAILABLE ONSITE IN THE GWTP OPERATIONS OFFICE. ON-SITE DOCUMENTS INCLUDE A SITE SAFETY PLAN AND O&M MANUAL.

3. **O&M and OSHA Training Records** ☒ Readily available ☒ Up to date ☐ N/A

Remarks: O&M AND OSHA TRAINING RECORDS ARE UP TO DATE AND AVAILABLE AT BOTH THE GWTP AND CAMUS/ ENVIRON OFFICES.

4. **Permits and Service Agreements**

☐ Air discharge permit	☐ Readily available	☐ Up to date	☒ N/A
☒ Effluent discharge	☐ Readily available	☒ Up to date	☒ N/A
☒ Waste disposal, POTW	☒ Readily available	☒ Up to date	☐ N/A
☐ Other permits_____			

Remarks: **THE GWTP NO LONGER DISCHARGES TO BIG BLACK CREEK AND THEREFORE IS NOT REQUIRED TO MAINTAIN ANY EFFLUENT DISCHARGE PERMIT. COPIES OF ANY DISCHARGE PERMITS REQUIRED FOR ANY DISCHARGE TO THE MUSKEGON COUNTY SYSTEM IS ON FILE ATTHE PSDS' PROJECT COORDINATOR'S OFFICE (ENGINEERING MANAGEMENT).**

5. **Gas Generation Records** ☐ Readily available ☐ Up to date ☒ N/A

Remarks:_____

6. **Settlement Monument Records** ☐ Readily available ☐ Up to date ☒ N/A

Remarks:_____

7. **Groundwater Monitoring Records** ☒ Readily available ☒ Up to date ☐ N/A

Remarks: **GROUNDWATER MONITORING REPORTS ARE UP TO DATE AND READILY AVAILABLE AT THE PSDS' PROJECT COORDINATOR'S OFFICE (ENGINEERING MANAGEMENT), WITH COPIES AT THE U.S. EPA AND MDEQ OFFICES.**

8. **Leachate Extraction Records** ☐ Readily available ☐ Up to date ☒ N/A

Remarks:_____

9. **Discharge Compliance Records**

☐ Air	☐ Readily available	☐ Up to date	☒ N/A
☒ Water (effluent) *	☒ Readily available	☒ Up to date	☐ N/A

Remarks: **THE GWTP NO LONGER DISCHARGES TO BIG BLACK CREEK AND THEREFORE IS NOT REQUIRED TO MAINTAIN ANY EFFLUENT DISCHARGE PERMIT. A COPY OF THE DISCHARGE PERMIT REQUIRED FOR ANY GROUNDWATER DISCHARGE TO THE MUSKEGON COUNTY SYSTEM IS ON FILE AT THE PSDS' PROJECT COORDINATOR'S OFFICE (ENGINEERING MANAGEMENT).**

10. **Daily Access/Security Logs** ☐ Readily available ☐ Up to date ☒ N/A

Remarks: **THERE IS NO PUBLIC ACCESS TO SITE. SITE IS COMPLETELY FENCED AND LOCKED, AND REQUIRES CAMUS PERMISSION FOR ACCESS. SITE KEYS ARE ONLY AVAILABLE TO CAMUS STAFF, PSDS' REPRESENTATIVES AND THEIR ASSOCIATED CONTRACTOR PERSONNEL. SITE SIGN-IN LOGS ARE MAINTAINED AT THE GWTP. THE EAST GATE IS KEPT LOCKED.**

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house ☐ Contractor for State
☐ PRP in-house ☒ Contractor for PRP: **ENGINEERING MANAGEMENT**
☐ Federal Facility in-house ☐ Contractor for Federal Facility
☒ Other: **GWTP O&M CONTRACTOR IS ENVIRON, AS PARTNERED WITH CAMUS LLC (SUN/LOMAC LIMITED LIABILITY PARTNERSHIP)**

2. **O&M Cost Records**

☒ Readily available ☒ Up to date
☒ Funding mechanism/agreement in place:
A. GWTP: DEC. 2, 1999 PROSPECTIVE OPERATORS' AGREEMENT
B. O.U. #1 REMEDY: 1999 CONSENT DECREE, WHICH INCLUDES USE OF A SPECIAL ACCOUNT.

Original O&M cost estimate:
1999 AMENDED RECORD OF DECISION: APPROX. $604,800 ANNUALLY
(SEE TABLE 6 IN 1999 ROD AMENDMENT, COMBINED ITEMS G,H, AND I)

Total annual cost by year for review period if available

AN APPROXIMATE AVERAGE OF $700,000 HAS BEEN EXPENDED ANNUALLY SINCE THE LAST FIVE YEAR REVIEW OF 2008 FOR CONTINUED OPERATION OF THE GWTP, COSTS FOR OPERATION, REPAIR, AND MAINTENANCE OF GROUNDWATER EXTRACTION WELLS, AND SITE MONITORING (INCLUDING LABORATORY ANALYSES).

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: **NONE.**

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☒ N/A

Remarks: **GATES AND FENCING ARE IN EXCELLENT CONDITION THROUGHOUT THE SITE.**

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A

Remarks: _____

C. Institutional Controls (ICs)

1. **Implementation and enforcement ***

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A

Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

*** ON MAY 4, 2012, THE MUSKEGON COUNTY REGISTER OF DEEDS RECORDED THE SIGNED DOCUMENT "DECLARATION OF RESTRICTIVE COVENANT AND GRANT OF ENVIRONMENTAL PROTECTION EASEMENT" FOR THE PROPERTY WITHIN WHICH O.U. #1 IS LOCATED.**

Type of monitoring (*e.g.*, self-reporting, drive by): **SITE INSPECTION**

Frequency: **QUARTERLY, SIMULTANEOUSLY WITH GROUNDWATER SAMPLING**

Responsible party/agency **PERFORMING SETTLING DEFENDANTS.**

Contact: **James Campbell** (Name) **PSDs' Project Coordinator, Engineering Management, inc.** (Title) **412-244-0917** (Telephone)

Reporting is up-to-date	☐ Yes	☐ No	☒ N/A
Reports are verified by the lead agency	☐ Yes	☐ No	☒ N/A
Specific requirements in deed or decision documents have been met	☒ Yes	☐ No	☐ N/A
Violations have been reported	☐ Yes	☒ No	☐ N/A

Other problems or suggestions: **NONE.** ☐ Report attached

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A

Remarks_____

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident

Remarks_____

2. **Land use changes on site** ☐ Yes ☒ No ☐ N/A

Remarks_____

3. **Land use changes off site** ☐ Yes ☒ No ☐ N/A

Remarks: **ADJACENT PROPERTIES ON EITHER SIDE OF THE SITE ARE BOTH OWNED BY SUN CHEMICAL, WHO MAINTAINS ADEQUATE SITE SECURITY AND ACCESS CONTROL. THERE IS NO UNACCEPTABLE USE OF LAND OR GROUNDWATER AT OR NEAR THE SITE.**

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A

Remarks_____

B. Other Site Conditions

Remarks_____

VII. LANDFILL COVERS ☒ Applicable ☐ N/A (NOTE: SOIL COVER OVER LAGOON AREA)

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident
   Areal extent_____ Depth_____
   Remarks: _____

2. **Cracks** ☐ Location shown on site map ☒ Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks _____

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
   Areal extent_____ Depth_____
   Remarks _____

4. **Holes** ☐ Location shown on site map ☒ Holes not evident
   Areal extent_____ Depth_____
   Remarks _____

5. **Vegetative Cover** ☒ Grass ☐ Cover properly established ☒ No signs of stress
   ☐ Trees/Shrubs (indicate size and locations on a diagram)

   Remarks: **NOT ALL INSTALLED TREES/ SHRUBS HAVE SURVIVED SINCE THE LAST FIVE-YEAR REVIEW IN 2008. THE CAUSE OF THIS FAILURE IS UNKNOWN AND MAY BE DUE TO CONTAMINANTS, ADVERSE WEATHER, OR LACK OF MAINTENANCE. THE PROTECTIVE SOIL COVER EXHIBITS NO SIGNS OF BREACHING, AND GRASS IS ESTABLISHED AND PRESENT.**

6. **Alternative Cover (armored rock, concrete, etc.)** ☒ N/A
   Remarks_____

7. **Bulges** ☐ Location shown on site map ☒ Bulges not evident
   Areal extent_____ Height_____
   Remarks_____

8. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident
   ☐ Wet areas ☐ Location shown on site map Areal extent_____
   ☐ Ponding ☐ Location shown on site map Areal extent_____
   ☐ Seeps ☐ Location shown on site map Areal extent_____
   ☐ Soft subgrade ☐ Location shown on site map Areal extent_____
   Remarks_____

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability
   Areal extent_____
   Remarks_____

B. Benches ☐ Applicable ☒ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☒ N/A or okay
   Remarks_____

2. **Bench Breached** ☐ Location shown on site map ☒ N/A or okay
   Remarks_____

3. **Bench Overtopped** ☐ Location shown on site map ☒ N/A or okay
Remarks_____

C. Letdown Channels ☒ Applicable ☐ N/A
(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** ☐ Location shown on site map ☒ No evidence of settlement
Areal extent_____ Depth_____
Remarks_____

2. **Material Degradation** ☐ Location shown on site map ☒ No evidence of degradation
Material type_____ Areal extent_____
Remarks_____

3. **Erosion** ☐ Location shown on site map ☒ No evidence of erosion
Areal extent_____ Depth_____
Remarks_____

4. **Undercutting** ☐ Location shown on site map ☒ No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ ☒ No obstructions ☐ Location shown on site map
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
☐ No evidence of excessive growth
☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent_____
Remarks: **INSTALLED VEGETATION ON SITE DOES NOT OBSTRUCT STORM RUN-OFF CONTROLS.**

D. Cover Penetrations ☒ Applicable ☐ N/A

1. **Gas Vents** ☐ Active ☐ Passive
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☒ N/A
Remarks: **NO GAS VENTS ARE PRESENT AT THE SITE**

2. **Gas Monitoring Probes**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☒ N/A
Remarks: **NO PROBES ARE PRESENT AT THE SITE.**

3. **Monitoring Wells** (within surface area of landfill): **WITHIN LAGOON AREA COVER**
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks_____

4. **Leachate Extraction Wells**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☒ N/A
Remarks_____

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☒ N/A
Remarks

6 **Other:**

VEGETATION WAS INSTALLED THROUGHOUT THE (FORMER) LAGOON AREA, INCLUDING DECIDUOUS TREES, SHRUB, WILLOW TREES, POPLAR TREES, AND PRAIRIE PLANTS. SOME OF THIS VEGETATION HAS FAILED SINCE THE LAST FIVE YEAR REVIEW IN 2008, BUT IT IS UNKNOWN WHETHER THIS IS DUE TO CONTAMINANTS, ADVERSE WEATHER, OR LACK OF MAINTENANCE. PRECIPITATION THAT INFILTRATES THE O.U. #1 AREA IS CAPTURED BY THE GROUNDWATER CONTAINMENT SYSTEMS.

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

1. **Gas Treatment Facilities**
☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
☐ Good condition ☐ Needs Maintenance ☐ Other
Remarks:

2. **Gas Collection Wells, Manifolds and Piping**
☐ Good condition ☐ Needs Maintenance
Remarks

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
☐ Good condition ☐ Needs Maintenance ☒ N/A
Remarks

F. Cover Drainage Layer ☐ Applicable ☒ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☒ N/A
Remarks

2. **Outlet Rock Inspected** ☐ Functioning ☒ N/A
Remarks

G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A

1. **Siltation** Areal extent_____ Depth_____ ☒ N/A
☐ Siltation not evident
Remarks

2. **Erosion** Areal extent_____ Depth_____ ☒ N/A
☐ Erosion not evident
Remarks

3. **Outlet Works** ☐ Functioning ☒ N/A
Remarks

4. **Dam** ☐ Functioning ☒ N/A
Remarks

H. Retaining Walls ☐ Applicable ☒ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident
Horizontal displacement_____ Vertical displacement_____
Rotational displacement_____
Remarks

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
Remarks_____

I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☒ N/A

1. **Siltation** ☐ Location shown on site map ☒ Siltation not evident
Areal extent_____ Depth_____
Remarks_____

2. **Vegetative Growth** ☐ Location shown on site map ☒ Vegetation does not impede flow
Areal extent_____ Type_____
Remarks_____

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
Areal extent_____ Depth_____
Remarks_____

4. **Discharge Structure** ☒ Functioning ☐ N/A

Remarks: **SITE DISCHARGE IS FROM A PIPELINE TO MCES MAN-HOLE / STRUCTURE, TO THE MCES SEWER SYSTEM.**

VIII. VERTICAL BARRIER WALLS ☒ Applicable ☐ N/A

1. **Settlement** ☐ Location shown on site map ☒ Settlement not evident
Areal extent_____ Depth_____
Remarks_____

2. **Performance Monitoring**
☒ Performance not monitored ☐ Evidence of breaching ☐ N/A *
Type of monitoring: **GROUNDWATER CHEMISTRY AND GROUND WATER ELEVATIONS.**
Frequency: **QUARTERLY**

Head differential: **UNKNOWN; INTERNAL WELLS ARE NOT MEASURED QUARTERLY.**

Remarks: *** 2009 GROUNDWATER ELEVATION DATA COLLECTED SHOWED A GENERAL HEAD DIFFERENTIAL VARYING FROM APPROXIMATELY 1 TO 3 FEET, WITH THE HIGHER GROUNDWATER ELEVATION INSIDE THE BARRIER WALL.**

IX. GROUNDWATER / SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps. and Pipelines ☒ Applicable ☐ N/A

1. Pumps, Wellhead Plumbing. and Electrical
☒ Good condition ☒ All required wells properly operating
☐ Needs Maintenance ☐ N/A
Remarks: **WELLS ARE PROPERLY OPERATING, HOWEVER THE OPERATING FLOW RATES MAY BE INADEQUATE.**

2. Extraction System Pipelines. Valves, Valve Boxes, and Other Appurtenances
☒ Good condition ☒ All process equipment is properly operating
☐ Needs Maintenance ☐ N/A
Remarks: _____

3. Spare Parts and Equipment
☒ Readily available ☒ Good condition
☐ Requires upgrade ☐ Needs to be provided
Remarks: **WELL FIELD AND GWTP CONTRACTORS HAVE LOCAL PARTS SUPPLIERS READILY AVAILABLE.**

B. Surface Water Collection Structures, Pumps. and Pipelines ☐ **Applicable** ☒ **N/A**

1. Collection Structures, Pumps, and Electrical
☐ Good condition ☐ Needs Maintenance
Remarks:

2. Surface Water Collection System Pipelines, Valves, Valve Bolts, and Other Appurtenances
☐ Good condition ☐ Needs Maintenance
Remarks:

3. Spare Parts and Equipment
☐ Readily available ☐ Good condition
☐ Requires upgrade ☐ Needs to be provided
Remarks:

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☒ Metals removal ☐ Oil/water separation ☐ Bioremediation
☒ Air stripping+ ☒ Carbon adsorbers
☒ Filters: **SAND FILTERS**

☒ Additive: **SULFURIC ACID, FLOC POLYMER, SODIUM HYDROXIDE, HYDROGEN PEROXIDE.**

☒ Others: **OZONE GENERATORS AND ULTRAVIOLET/OXIDATION TANKS.**

☒ Good condition ☐ Needs Maintenance
☒ Sampling ports properly marked and functional
☒ Sampling/maintenance log displayed and up to date
☒ Equipment properly identified
☒ Quantity of groundwater treated annually: **APPROX. 131,400,000 GALLONS (250 GPM)**
☐ Quantity of surface water treated annually

Remarks: *** SAMPLING AND MAINTENANCE DOCUMENTATION IS READILY AVAILABLE AT THE GWTP OFFICE.**

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks **INTERVIEW WITH GWTP SITE MANAGER DON HOUSTON (ENVIRON)**

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance
Remarks: **INTERVIEW WITH GWTP SITE MANAGER DON HOUSTON (ENVIRON)**

4. **Discharge Structure and Appurtenances**
☒ N/A ☐ Good condition ☐ Needs Maintenance
Remarks: **GWTP NO LONGER DISCHARGES TO BIG BLACK CREEK - DISCHARGE STRUCTURE NO LONGER IN USE.**

5. **Treatment Building(s)**
☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
☒ Chemicals and equipment properly stored
Remarks: **VISUAL OBSERVATION BY U.S. EPA DURING MAY 2013 SITE INSPECTION.**

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ All required wells located * ☐ Needs Maintenance ☐ N/A

Remarks: *** AS PER THE PSDS, SOME WELLS IDENTIFIED BY U.S. EPA WERE NOT LOCATED OR WERE OTHERWISE INACCESSIBLE OR UN-OPENABLE. SINCE THE LAST FIVE-YEAR REVIEW IN 2008, THE STATUS OF THESE QUESTIONABLE WELLS WAS DETERMINED AND DOCUMENTED.**

D. Monitoring Data

1. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring data suggests:
☒ Groundwater plume is effectively contained* ☐ Contaminant concentrations are declining

Remarks: *** ADDITIONAL MONITORING DATA IS REQUIRED TO DETERMINE THE EFFECTIVENESS OF BARRIER WALL CONTAINMENT AND THAT OF THE GROUNDWATER CAPTURE OF THE THREE EXTERIOR EXTRACTION WELLS.**

E. Monitored Natural Attenuation ☐ Applicable ☒ N/A

1. **Monitoring Wells** (natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks _____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

THE GOAL OF THE O.U. #1 REMEDY IMPLEMENTED AT THE BOFORS-NOBEL SITE IS RESTORATION OF THE AQUIFER TO STANDARDS REQUIRED BY PART 201 OF THE NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION ACT (ENVIRONMENTAL REMEDIATION), PA 451 OF 1994, AS AMENDED ("PART 201"). THE DESIGN BASIS FOR THE TIC REMEDY IS REDUCTION OF THE ON-SITE CONTAMINANTS TO CLEANUP CRITERIA ASSOCIATED WITH A FUTURE INDUSTRIAL LAND USE SCENARIO. PHYSICAL CONSTRUCTION OF THE BARRIER WALL WAS COMPLETED IN LATE 2005 AND INSTALLATION OF THE OTHER ELEMENTS OF THE TIC REMEDY WAS COMPLETED IN LATE 2007. THE REMEDIAL ACTION OBJECTIVES (CLEANUP GOALS) SHOWN IN THE 1999 ROD AMENDMENT AND CONSENT DECREE ARE: CONTAINMENT OF LAGOON SLUDGE AND SOILS TO PREVENT ON-SITE EXPOSURE TO HAZARDOUS SUBSTANCES AT CONCENTRATIONS THAT POSE AN UNACCEPTABLE RISK TO HUMAN

RECEPTORS UNDER INDUSTRIAL LAND USE SCENARIOS; CONTAINMENT OF LAGOON SLUDGE AND SOILS TO PREVENT ON-SITE EXPOSURE TO HAZARDOUS SUBSTANCES AT CONCENTRATIONS THAT POSE AN UNACCEPTABLE RISK TO ENVIRONMENTAL RECEPTORS; CONTAINMENT OF LAGOON SLUDGE AND SOILS TO PREVENT OFF-SITE MIGRATION OF CONTAMINANTS TO AIR, SOIL OR GROUNDWATER AT CONCENTRATIONS THAT WOULD POSE AN UNACCEPTABLE RISK TO HUMAN AND/OR ENVIRONMENTAL RECEPTORS; CONTAINMENT OF GROUNDWATER TO PREVENT MIGRATION OF CONTAMINANTS AT CONCENTRATIONS THAT WOULD POSE AN UNACCEPTABLE RISK TO HUMAN AND/OR ENVIRONMENTAL RECEPTORS OFF-SITE INCLUDING TO BIG BLACK CREEK AND TO THE ON-SITE WETLANDS BETWEEN BIG BLACK CREEK AND THE BARRIER WALL.

THE PERFORMANCE STANDARDS ARE, AS DEFINED IN THE CONSENT DECREE, MEASURES OF ACHIEVEMENT OF THE REMEDIAL ACTION OBJECTIVES, AND INCLUDE CLEANUP STANDARDS, STANDARDS OF CONTROL, QUALITY CRITERIA AND OTHER SUBSTANTIVE REQUIREMENTS, CRITERIA OR LIMITATIONS, INCLUDING ALL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS ("ARARS") SET FORTH IN THE SECOND AMENDED ROD, SOW AND/OR CONSENT DECREE. THE PERFORMANCE STANDARDS FOR MEASURING THE ACHIEVEMENT OF THE REMEDIAL ACTION OBJECTIVES ARE: FOR CONTAINMENT OF LAGOON SLUDGE AND SOILS TO PREVENT ON-SITE EXPOSURE TO HAZARDOUS SUBSTANCES AT CONCENTRATIONS THAT POSE AN UNACCEPTABLE RISK TO HUMAN RECEPTORS UNDER INDUSTRIAL LAND USE SCENARIOS; FOR CONTAINMENT OF LAGOON SLUDGE AND SOILS TO PREVENT ON-SITE EXPOSURE TO AND MIGRATION PATHWAYS FROM HAZARDOUS SUBSTANCES AT CONCENTRATIONS THAT POSE AN UNACCEPTABLE RISK TO ENVIRONMENTAL RECEPTORS, THE PERFORMANCE STANDARDS TO BE APPLIED TO ENVIRONMENTAL ASSESSMENT ENDPOINTS ARE: (A) PREVENTION OF UNACCEPTABLE ACUTE TOXIC EFFECTS; (B) PREVENTION OF UNACCEPTABLE OBSERVABLE CHRONIC EFFECTS; AND (C) PREVENTION OF OTHER UNACCEPTABLE CHRONIC EFFECTS IF DOCUMENTED THROUGH FIELD MEASUREMENT; FOR CONTAINMENT OF LAGOON SLUDGE AND SOILS TO PREVENT MIGRATION OF CONTAMINANTS OFF-SITE TO GROUNDWATER AND SOILS, THE PERFORMANCE STANDARDS TO BE MET AT THE OFF-SITE BOUNDARY ARE THE RESIDENTIAL CRITERIA FOR GROUNDWATER AND SOILS SET FORTH IN PART 201 OF NREPA; FOR AMBIENT AIR OFF-SITE, THE PERFORMANCE STANDARDS WILL BE ESTABLISHED PURSUANT TO PART 55 OF NREPA; FOR CONTAINMENT OF GROUNDWATER TO PREVENT MIGRATION OF CONTAMINANTS AT CONCENTRATIONS THAT WOULD POSE AN UNACCEPTABLE RISK TO HUMAN AND/OR ENVIRONMENTAL RECEPTORS OFF-SITE INCLUDING TO BIG BLACK CREEK AND TO THE ON-SITE WETLANDS BETWEEN BIG BLACK CREEK AND THE BARRIER WALL THE PERFORMANCE STANDARDS TO BE MET AT THE GROUNDWATER-SURFACE WATER INTERFACE ("GSI") ARE THE GENERIC GSI STANDARDS FOR BIG BLACK CREEK AS ESTABLISHED BY MDEQ, OR STANDARDS OTHERWISE DEVELOPED PURSUANT TO PART 31 OF NREPA AND ITS ADMINISTRATIVE RULES.

THE RESULTS OF THE SITE INSPECTION, INFORMATION COLLECTION, AND DOCUMENT REVIEW TO DATE SUGGESTS THE REMEDY MAY BE EFFECTIVE AND FUNCTIONING AS DESIGNED. HOWEVER, ALTHOUGH PRELIMINARY DATA SUGGESTS THAT SOURCE CONTROL SYSTEMS MAY BE EFFECTIVE IN RETARDING GROUNDWATER FLOW TOWARD BIG BLACK CREEK, ADDITIONAL MONITORING DATA IS REQUIRED TO DETERMINE THE EFFECTIVENESS OF BARRIER WALL CONTAINMENT AND THAT OF THE GROUNDWATER CAPTURE OF THE THREE EXTERIOR EXTRACTION WELLS.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

THE RESULTS OF SITE INSPECTIONS, INFORMATION COLLECTION, AND DOCUMENT REVIEW TO DATE SHOWS NO ISSUES OR PROBLEMS WITH THE IMPLEMENTATION AND SCOPE OF O&M PROCEDURES FOR THE GROUNDWATER TREATMENT PLANT PORTION OF THE O.U. #1 REMEDY.

BECAUSE MONITORING DATA HAS NOT DEMONSTRATED SATISFACTORY CONTAINMENT OF CONTAMINATED GROUNDWATER BETWEEN THE BARRIER WALL AND BIG BLACK CREEK, IT HAS NOT BEEN POSSIBLE TO CERTIFY THAT THE LAGOON AREA AND GROUNDWATER CONTAINMENT ASPECTS OF THE O.U. #1 REMEDY ARE OPERATIONAL AND FUNCTIONAL (O&F). THEREFORE THE LAGOON AND GROUNDWATER CONTAINMENT PORTION OF THE O.U. #1 TIC REMEDY IS NOT IN THE O&M STAGE.

U.S. EPA HAS NOT YET ISSUED AN O.U. #2 RECORD OF DECISION, THEREFORE O.U. #2 IS NOT YET IN THE O&M STAGE.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

FOR THE GWTP, THE SITE INSPECTION, INFORMATION COLLECTION, AND DOCUMENT REVIEW TO DATE DID NOT SUGGEST UNEXPECTED CHANGES IN THE COST OR SCOPE OF O&M OR A HIGH FREQUENCY OF UNSCHEDULED REPAIRS.

BECAUSE MONITORING DATA HAS NOT DEMONSTRATED SATISFACTORY CONTAINMENT OF CONTAMINATED GROUNDWATER BETWEEN THE BARRIER WALL AND BIG BLACK CREEK, IT HAS NOT BEEN POSSIBLE TO CERTIFY THAT THE LAGOON AREA AND GROUNDWATER CONTAINMENT ASPECTS OF THE O.U. #1 REMEDY ARE OPERATIONAL AND FUNCTIONAL (O&F). THEREFORE THE O.U. #1 REMEDY IS NOT IN THE O&M STAGE.

REGARDLESS OF THE O&F STATUS OF THIS O.U. #1 REMEDY, THE PSDS ROUTINELY PERFORM THE FOLLOWING FOR THE TIC REMEDY: UPKEEP, MONITORING, AND ROUTINE INSPECTION OF THE VEGETATIVE PORTION OF THE TIC REMEDY, INCLUDING INTRODUCTION OF NUTRIENTS AND IRRIGATION, IF NEEDED; REGULAR INSPECTIONS OF THE O.U. #1 LAGOON AREA COVER TO ASSURE THE PROTECTIVENESS OF THE COVER, TO PREVENT DISTURBANCE AND EXPOSURE TO CONTAMINATED SOILS REMAINING UNDERNEATH THE COVER, AND TO ASSESS WHETHER ADVERSE ECOLOGICAL EFFECTS ARE OCCURRING AT THE SITE; REMOVAL OF VEGETATION IF NEEDED, AND; UPKEEP OF ANY ADDITIONAL EXTRACTION SYSTEM COMPONENTS INSTALLED TO AUGMENT GROUNDWATER CONTAINMENT PROVIDED BY THE BARRIER WALL.

FOR THE (FORMER) LAGOON AREA OF O.U. #1, ADDITIONAL INDIVIDUAL O&M EVENTS SINCE THE LAST FIVE-YEAR REVIEW IN 2008 INCLUDED: DRAINAGE REPAIRS IN AUGUST 2010 TO CERTAIN PORTIONS OF SPECIFIC (FORMER) LAGOON AND ACCESS ROAD AREAS TO ADDRESS EXCESS SURFACE WATER FLOW AND UNACCEPTABLE EROSION ISSUES; AND A SUMMER 2012 ACTION TO ELIMINATE PHRAGMITES FROM THE O.U. #1 AREA. PHRAGMITES IS AN AGGRESSIVE, NON-NATIVE PLANT KNOWN TO OVERRUN WETLANDS. WITH THE EXCEPTION OF POTENTIAL ISSUES FOR THE GROUNDWATER EXTRACTION WELLS, O&M PROCEDURES WILL MAINTAIN THE EFFECTIVENESS OF THE REMEDY. THERE HAVE BEEN NO INORDINATE VARIANCES IN O&M COSTS SINCE THE 2008 FIVE-YEAR REVIEW, AND THUS NO INDICATION OF A POTENTIAL REMEDY PROBLEM.

U.S. EPA HAS NOT YET ISSUED AN O.U. #2 RECORD OF DECISION, THEREFORE O.U. #2 IS NOT YET IN THE O&M STAGE.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

ANNUAL GWTP OPERATIONS COSTS HAVE BEEN REDUCED WITH THE CHANGE-OVER OF THE EFFLUENT DISCHARGE TO SUN CHEMICAL. SINCE THEIR TAKE-OVER OF THE BOFORS-NOBEL SITE IN 2000, THE PSDS HAVE CONTINUALLY IDENTIFIED OPTIMIZATION OPPORTUNITIES AND IMPLEMENTED PERFORMANCE IMPROVEMENTS AND COST REDUCTIONS. AS SUCH, THERE ARE FEW ADDITIONAL OPTIMIZATION OPPORTUNITIES UNTIL CONTINGENT REMEDIAL ACTIONS ARE IMPLEMENTED.