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REMEDIATION SYSTEM EVALUATION (RSE)

PEERLESS PLATING SITE
MUSKEGON, MICHIGAN

Report of the Remediation System Evaluation

Site Visit Conducted September, 2005

Final Report

February 2006

Prepared by US Army Corps of Engineers
Hazardous, Toxic, and Radioactive Waste Center of Expertise

Executive Summary

The Peerless Plating Superfund Site is located at 2554 South Getty Street, north of the intersection of South Getty Street and East Sherman Boulevard in Muskegon, Michigan. Copper, nickel, chromium, cadmium, and zinc electroplating operations as well as associated activities such as burnishing, polishing, pickling, oiling, passivating, stress relieving, and dichromate dipping were conducted at Peerless Plating from 1937 to 1983. These processes required the use of toxic, reactive, corrosive, and flammable chemicals that were discharged into seepage lagoons at the rear of the facility throughout Peerless Plating's history. Between 1972 and 1983 several enforcement actions were brought forth by the State of Michigan. In June 1983, Peerless Plating closed, the owner declared bankruptcy with the plant abandoned with plating solution, raw materials, and drummed wastes staged throughout the building.

Between 1983 and 1990, the U.S. EPA carried out various Emergency Response Actions at the site to remove and dispose of hazardous waste and decontaminate the facility. The site was placed on the NPL in August 1990. In June 1992 the RI/FS was completed and in September 1992 the ROD was signed. In 1997 an explanation of significant differences (ESD) was issued which revised the cleanup standards to reflect actual background conditions at the Peerless site. The ESD refined the excavation limits in the areas under adjacent structures and the on site lagoon.

The US EPA through its contractor performed soil remediation at the site in three phases. Phase I which was completed in 1999 removed, stabilized and disposed of approximately 7500 tons of soil, removed an underground storage tank, and installed a soil vapor extraction system. Phase II completed in October 2000 removed an additional 9500 tons of soil after a MDEQ and EPA investigation revealed soil contamination located in a soil layer 4 to 8 feet below ground surface. Phase III soil removal addressed contamination on the adjacent Hardware Distributors and Asphalt Paving properties and was completed in February 2001.

Construction of the groundwater extraction and treatment system began in October 1999 with startup in June 2002. The system consisted of six extraction wells, groundwater treatment for chlorinated volatile organic carbon compounds and metals, followed by discharge to the Little Black Creek.

A second ESD was issued to address the need to implement deed restrictions at the site due to the presence of contaminated soil 3 to 4 feet below the groundwater table and in an area adjacent to the bank of Little Black Creek. A third ESD is planned to allow for the extracted groundwater to be discharged to the Muskegon Regional Wastewater Facility (MRWF) as long as the discharge meets pretreatment standards as defined in the permit issued August 2, 2005. The RSE team endorses implementation of the third ESD.

The current operations include extraction from the existing wells at a rate of approximately 140 gpm, treating the flow to reduce the metals, bypassing the VOC treatment equipment, and discharge to the MRWF.

The present staff has been doing a good job of operating the plant and well field. Many improvements were already under consideration at the time of the RSE site visit. The system is partially automated and the single operator is responsible for doing other tasks such as data entry and investigations. The level of treatment is expected to be further reduced (eliminating metals removal and solids management) when plant influent concentrations from the six groundwater extraction wells verify the metals concentrations are well below the permissible levels identified on the pretreatment permit. Elimination of the metals treatment portion of the water treatment facility should reduce the operations effort to approximately 20 percent of the current levels.

The sampling results have shown large concentration variations between successive sampling events over the past years. The monitoring program is currently in a state of transition from a mix of bailers and peristaltic pumps being used, to the exclusive use of low flow sampling protocols. Use of consistent sampling protocols should reduce the variability in concentrations between sampling rounds which should improve data quality.

The plume boundaries are not well defined, with the extent of the plume north of PZ19 being the primary uncertainty. Additional monitoring locations may be necessary to identify the limits of the contamination. There may need to be additional definition of the plume in the area of EW-06. Sporadic detection of contaminants is

occurring in PZ16 and PZ17. An upgradient background monitoring point should be added to assure no off site sources impact the site.

Based on past sampling results, the ground water concentrations and thus the exposure scenarios are unlikely to change rapidly. The sampling frequency for monitoring wells should not be more than semi-annually. A change to quarterly sampling, as apparently required by site documents, is not necessary for making the necessary site decisions. In fact, some wells, such as WT02A and PZ02B or the PZ06 cluster, could be sampled less frequently, perhaps annually, without a significant loss of information.

The analytical suite should be reduced to metals and cyanide. Based on the very low detections, the analyses for volatile organics could potentially be eliminated or at least reduced to once every two or three years.

The aquifer contaminant plume has not responded to ground water extraction as expected. The presence of concentrations well above the cleanup standards and the lack of a clear downward trend in ground water concentrations suggest the duration of the project will be very long. Additional efforts directed at the removal or stabilization of the metals in the aquifer may be useful for reducing the concentrations closer to the cleanup goals and shortening the time to site closeout. An alternative that could be investigated further would be the in-situ stabilization of metals. Both carbonate and sulfide could bind with the dissolved cadmium and stabilize the metal in low solubility precipitates. Similar reactions may be possible for lead and nickel. The impact of chemical additives on the natural geochemistry of both the aquifer and Little Black Creek is not clear. Present-worth analysis of these avoided future costs will be necessary to fairly conduct the assessment

Though the project team is tracking the plume concentrations and adjusting the system operation, there is not a formal, documented, incremental process to compare site conditions to specific interim goals to quantitatively evaluate progress toward site closure goals. An exit strategy document should be prepared as a means to provide a consistent decision framework for an evolving project team.

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1.0 INTRODUCTION

1.1 PURPOSE

At the request of HQ US EPA, the Army Corps of Engineers (USACE) Hazardous, Toxic, and Radioactive Waste (HTRW) Center of Expertise (CX) performed a Remediation System Evaluation (RSE) of the Peerless Plating Superfund Site ground water corrective action. The RSE process, developed by USACE, is intended to be an independent and holistic evaluation of the remediation for four major purposes:

1) assess the performance and effectiveness of the system to achieve remediation objectives,
2) identify opportunities for reductions in operational costs,
3) verify that a clear and realistic exit strategy exists for the site, and
4) confirm adequate maintenance of Government-owned equipment.

The RSE at Peerless Plating is intended to achieve these four goals. In addition, the RSE was intended to evaluate the format and content of reports on current project operations and monitoring and to recommend changes as appropriate.

1.2 TEAM COMPOSITION

The team conducting the RSE consisted of the following individuals:

Dave Becker, Geologist, USACE HTRW CX
Lindsey Lien, Environmental Engineer, USACE HTRW CX

1.3 DOCUMENTS REVIEWED

The following documents were reviewed as part of the RSE:

Final Remedial Investigation Report, Peerless Plating, Donahue and Associates, September, 1991.

Groundwater Monitoring Reports for November, 2003; May, 2004; and November, 2004, TetraTech EMI.

Form to Submit Site Information for Optimization, Prepared by Linda Martin, 2005.

Daily Operations Logs for July 2005 and August 2005, Prepared by TetraTech.

As Built Drawings Peerless Plating Superfund Site Remedial Action Groundwater Treatment, Muskegon, MI, USEPA Region 5, Conestoga-Rovers & Associates, May 17, 2002

Substantive Requirements Document – No.MU990007, Peerless Plating Superfund Site, 2554 Getty Avenue, Muskegon, MI, Grand Rapids District DEQ, Grand Rapids MI

Wastewater Discharge Permit #PPSS-s01a, Muskegon County Wastewater Management System, Muskegon, MI, August 8, 2005

Groundwater Collection and Treatment System Manual, Peerless Plating Superfund Site, Muskegon, MI, Conestoga-Rovers & Associates, April 2000

First Five-Year Review Report for Peerless Plating Superfund Site, Muskegon Township, Muskegon County, MI, USEPA Region 5, September 25, 2002

Operation and Maintenance Manual, Peerless Plating Superfund Site Remedial Action Groundwater Treatment, Muskegon, MI, Conestoga-Rovers & Associates

Record of Decision, Peerless Plating Site, Muskegon, MI, USEPA Region 5, September 21, 1992

Explanation of Significant Differences (ESD) to the Record of Decision, Peerless Plating Site, Muskegon Township, MI, USEPA Region 5, August 7, 1997.

Explanation of Significant Differences (ESD) to the Record of Decision, Peerless Plating Site, Muskegon Township, MI, USEPA Region 5, April 5, 2001.

Final Basis for Design Report, Design Specifications, and Drawings, Rerouting of Effluent, Peerless Plating Site, Muskegon Township, MI, Tetra Tech EM Inc., March 29, 2005.

Letter from Environmental Drilling and Contracting to Mr. Tim Fish, TetraTech, Subject: Well Cleaning at Peerless Plating Site, dated June 17, 2004.

1.4 PERSONS CONTACTED

Linda Martin, USEPA Region V RPM
Lee Christenson, Project Manager, Tetra Tech
Andy Suminski, Construction Engineer, Tetra Tech
Sunny Krajkovic, Michigan Department of Environmental Quality RPM
Carol Nisson, Project Engineer, Tetra Tech
Tim Fish, Plant Operator, Tetra Tech

1.5 SITE LOCATION, HISTORY, AND CHARACTERISTICS

1.5.1 SITE LOCATION

The Peerless Plating Site (“Site”) is an abandoned electroplating facility located at 2554 Getty Avenue, Muskegon Township, Muskegon, Michigan. The property covers approximately 1 acre in the southwest 1/4 of Section 33, T.10 N., and R.16 W., Muskegon Township. The land use in the vicinity of the Site is urban, light industrial and residential. The site is located northwest of Little Black Creek and one mile north of Mona Lake. The Site was placed on the National Priorities List (“NPL”) for site cleanup in August 1990.

1.5.2 SITE HISTORY

Electroplating operations were conducted at Peerless Plating from 1937 to 1983. Electroplating operations and processes conducted at Peerless Plating included copper, nickel, chromium, cadmium, and zinc plating, as well as associated activities such as burnishing, polishing, pickling, oiling, passivating, stress relieving, and dichromate dipping. These processes required the use of toxic, reactive, corrosive, and flammable chemicals. Throughout Peerless Plating's history, process wastes with pH extremes and high heavy metal concentrations were discharged into seepage lagoons at the rear of the facility.

Between 1972 and 1983 several enforcement actions were brought forth by the State of Michigan. In 1972 the state issued a Stipulation that required Peerless Plating monitor its discharge and install a water treatment plant. In 1975 the owner was issued a "Notice of Noncompliance and Order to Comply," indicating violation of all aspects of the 1972 Stipulation. Suits were filed against Peerless Plating by the Michigan Attorney General’s office for environmental contamination in 1975, 1976, and 1978.

The seepage lagoons were removed in 1980 following a hydrogeologic study which identified the lagoons as an ongoing source of contamination to the groundwater, and eventual discharge to the Little Black Creek adjacent to the site. In 1983, the MDNR conducted an investigation into the operating practices at Peerless Plating and sampled materials in and around the plant. The MDNR found that treatment facilities still had not been upgraded adequately, and discharge limitations were still being exceeded for chromium, cyanide, cadmium, and zinc. The MDNR determined that manholes inside the building did not connect to the sanitary sewer or plant treatment system, so wastes were discharged directly to the ground. MDNR files indicated that drummed wastes had not been removed from the building since 1980, and that materials on the ground outside the building or ground surface material contained high levels of heavy metals.
In 1983, the MDNR and the Michigan Attorney General again filed joint suit against Peerless Plating. The County of Muskegon Waste Water Management System blocked Peerless Plating's discharge due to failure to meet County Ordinance discharge limitations.

In June 1983, Peerless Plating closed, the owner declared bankruptcy with the plant abandoned with plating solution, raw materials, and drummed wastes staged throughout the building. The building was not well maintained, and access was generally unrestricted. Subsequently, personnel from Muskegon County Civil Defense and Michigan Department of Public Health, Division of Occupational Health detected hydrocyanic acid gas in the facility atmosphere. Additional site investigations by the Muskegon County Health Department and the MDNR verified the presence of cyanide gas.

From September 6 until October 7, 1983, the U.S. EPA carried out an Emergency Response Action at the site. Objectives of the emergency response action included the removal and disposal of hazardous waste and decontamination of the facility. This action resulted in the removal of 37,000 gallons of hazardous liquids including: sulfuric acid, nitric acid, hydrochloric acid, chromic acid, cyanide plating solution, chromium plating solution, and trichloroethylene (TCE). Lagoons were drained; soil was removed from lagoon areas; soils and sludges were removed from the building interior; vats, lines, tanks, sumps, debris, floorboards, and walls were decontaminated; sewer lines were sealed; virgin and proprietary chemicals were removed; and on-site neutralization of cyanides and nitric acid occurred.

1985, a hydrogeologic study was conducted under the direction of USEPA Region 5 Field Investigation Team (FIT) personnel. This involved the installation of 7 monitoring wells and soil borings on the Peerless Plating property and testing the hydraulic parameters of the aquifer. Sampling results indicated contamination of groundwater by cadmium, chromium, copper, nickel, cyanide, TCE, and trans-1, 2-dichloroethylene (trans-1, 2-DCE). Metals were found in all wells including upgradient wells. Benzene, ethylbenzene, xylenes, cyanide and naphthalene were found in wells around the center of the site. The distribution of the data with respect to the hydraulic gradient was concluded to confirm groundwater contamination as a direct result of methods and processes employed at Peerless Plating.

The U.S. EPA conducted another emergency removal action beginning March 13, 1990 to remove and dispose of the 2,500 gallons of liquids with elevated levels of heavy metals and cyanide liquids and sludges contained in an enclosed above-ground tank on the site. A portion of this removal action was performed by a Potentially Responsible Party (PRP) and involved encapsulation of an asbestos oven in the Peerless Plating building and installation of a fence for site security. A second removal action was accomplished in 1993 to demolish and dispose of the Peerless building.

The site was placed on the NPL in August 1990. In June 1992 the RI/FS was completed and in September 1992 the ROD was signed. In 1993 and 1996 pre-design data collected revealed contamination had spread off the Peerless property boundary. In 1997 an explanation of significant differences (ESD) was issued which revised the cleanup standards to reflect actual background conditions at the Peerless site. Previous cleanup standards identified in the 1992 ROD were based on background samples from the Bofors site located elsewhere in Muskegon. The revised cleanup standards reduced the volume of soil requiring excavation from 6600 cubic yards to 1200 cubic yards. Excavation limits in the areas under adjacent structures and on site lagoon were defined.

The US EPA through its contractor removed, stabilized and disposed of approximately 7500 tons of soil in 1997. An additional 9500 tons of soil was removed in November 1999 after a MDEQ and EPA investigation revealed soil contamination located in a soil layer 4 to 8 feet below ground surface. Construction of the groundwater extraction and treatment system began in October 1999 with startup in July 2002.

A second ESD was issued to address the need to implement deed restrictions at the site due to the presence of contaminated soil 3 to 4 feet below the groundwater table and in an area adjacent to the bank of Little Black Creek.

1.5.3 SITE CHARACTERISTICS

1.5.3.1 HYDROSTRATIGRAPHY

The groundwater occurs between approximately 5 and 13 feet beneath the site within lacustrine sands. The lacustrine sands comprise the primary aquifer beneath the site. This unconfined aquifer is separated from the underlying Marshall Sandstone Aquifer System by a fine-grained deep water lacustrine clay aquitard and presumably the underlying silty clay glacial till aquitard. Shallow groundwater flow is primarily horizontal to the southeast, toward Little Black Creek. The groundwater appears to discharge to Little Black Creek. There is a slight downward gradient at most locations away from the Creek.

1.5.3.2 SITE CONTAMINATION

Site contamination had impacted soils, ground water, and sediment. The site contaminants are predominantly metals including cadmium, nickel, aluminum, chromium, and lead. Previous investigations had also identified several volatile organic compounds (VOC's) including trichloroethylene, 1,1,1 trichloroethane, vinyl chloride, and chloroform. With the exception of some soil contamination under a portion of an adjacent building, most soil contamination above the water table has been excavated for offsite disposal.

Recent monitoring has shown cadmium at concentrations over 10 mg/L and TCE is present in ground water at fluctuating levels between 1.0 µg/L and 26 µg/L in monitoring well M14013. Vinyl chloride and 1,1,1 trichloroethane are present at maximum concentrations of 5.1 µg/L and 1.0 µg/L, respectively. Cyanide is also detected at concentrations above the cleanup goals (to hundreds of ppb) in ground water from a number of monitoring wells at the site. Ground water contamination extends at least from the location of the former plating works southeastward to Little Black Creek and southward to areas south of Sherman Boulevard. Concentrations of some of the metals, particularly aluminum, are somewhat variable, but cadmium is consistently high in many wells.

Past sampling of sediments in Little Black Creek indicated the presence of elevated concentrations of metals. Other potential sources of contamination exist in the Little Black Creek basin in addition to the Peerless Plating site. The impacts of contaminated discharges from Little Black Creek into Mona Lake, located approximately 8000 feet southwest of the Peerless site, are the subject of public concern.

1.5.3.3 SITE AND NEARBY LAND USE

The region around the Peerless Plating Superfund Site is predominantly used for commercial and residential purposes. Approximately 12,000 persons permanently reside in Muskegon Heights based on 2000 census data. The Superfund Site is bounded on the east and south by Little Black Creek, on the west by Getty Street and on the north by other commercial properties. The site is generally surrounded by a mixture of commercial and residential areas.

The treated water effluent is discharged to the nearby creek located on the southeast side of the site. The EPA was in the process of installing a connection from the treatment plant to the Muskegon Country Municipal WWTP during the site visit in September 2005.

2.0 SYSTEM DESCRIPTION

2.1 SYSTEM OVERVIEW

The original remedy for the Peerless Site includes the following items:

- Groundwater extraction and treatment by air stripping and metals precipitation
- Contaminated soil excavation to the water table with off-site disposal
- Vapor extraction of VOC-contaminated soils above the water table

The vapor extraction and excavation and disposal of contaminated soil have been completed. The groundwater extraction and treatment system was commissioned and began operations in July 2002. Operations have continued since that time.

2.2 EXTRACTION AND INJECTION SYSTEM

Contaminated ground water is recovered from six extraction wells. These wells are all approximately 66 to 73 feet deep and screened over 55 feet, though the pump is set in a five-foot long blank with five of the 55 feet of screen below the blank. The wells are six-inch diameter and constructed of stainless steel screen and riser. Each well is provided with Grundfos submersible pumps. Wells EW-1 through -4 and EW-6 are equipped with 0.5 HP pumps, EW-5 is equipped with a 1 HP pump. The wells are completed with pitless adapters. Extraction pipelines are 2-inch diameter high-density polyethylene and run separately from each well to the treatment plant where the flow is combined into a header. Each well is provided (in the treatment plant) a control valve, sample port, and flow meter. The extraction wells are generally installed in a line parallel to Little Black Creek.

2.3 TREATMENT SYSTEMS

The groundwater treatment system was designed to operate at 165 gallons per minute (gpm) with maximum design influent concentrations for cadmium, chromium, cyanide, lead, nickel and zinc of 1460 µg/L, 26 µg/L, 0 µg/L, 1 µg/L, 201 µg/L, and 1080 µg/L respectively. In addition, the VOC design influent concentrations for benzene, dichloroethene, trichloroethene, and vinyl chloride are 23 µg/L, 75 µg/L, 240 µg/L and 10 µg/L respectively. The treatment system consists of the following elements:

- tray type air stripper
- vapor phase granular activated carbon (GAC) trains (2 units operating in series)
- equalization tank
- reaction tank (air sparging, chemical addition and mixing)
- flash mix tank
- flocculation tank
- clarifier
- cartridge filters (operating in parallel)
- treated effluent tank (with pH adjustment)
- sludge dewatering system
- acid, lime, ferrous sulfate and polymer feed systems.

During the RSE site visit, the EPA was in the process of installing a sewer line that would direct the treated effluent to the Muskegon County Wastewater Treatment Facility. The discharge was previously directed to the Little Black Creek.

2.4 MONITORING SYSTEM

There are approximately 27 monitoring wells currently sampled as part of the semi-annual monitoring program. These include wells of varying depth, but do not include two shallow wells that are typically dry (PZ-18 and -19) or one that was damaged (M14014). The six extraction wells are also typically sampled. No residential or other private wells wells are sampled. Wells are sampled in May and November. Table 1 shows the wells that are currently sampled as part of the semi-annual monitoring program. These wells are shown on Figure 1.

Table 1. Monitoring Wells Sampled as Part of Monitoring Program

Well ID	Depth Interval	Diameter	Material of Construction
M14013	Shallow	Unknown	Unknown
M14014	Damaged	Unknown	Unknown
M14015A	Middle	Unknown	Unknown
PZ2B	Deep	2 inch	PVC
PZ5C	Deep	2 inch	PVC
PZ6A	Intermediate	2 inch	PVC
PZ6B	Deep	2 inch	PVC
PZ6C	Deep	2 inch	PVC
PZ11A	Shallow	2 inch	PVC
PZ11B	Intermediate	2 inch	PVC
PZ11C	Deep	2 inch	PVC
PZ12A	Shallow	2 inch	PVC
PZ12B	Intermediate	2 inch	PVC
PZ12C	Deep	2 inch	PVC
PZ13A	Shallow	2 inch	PVC
PZ13B	Intermediate	2 inch	PVC
PZ13C	Deep	2 inch	PVC
PZ14A	Shallow	2 inch	PVC
PZ14B	Intermediate	2 inch	PVC
PZ14C	Deep	2 inch	PVC
PZ15A	Shallow	2 inch	PVC
PZ15B	Intermediate	2 inch	PVC
PZ15C	Deep	2 inch	PVC
PZ16	Shallow	2 inch	PVC
PZ17	Shallow	2 inch	PVC
PZ18	Shallow	2 inch	PVC
PZ19	Shallow	2 inch	PVC
PZ20	Shallow	2 inch	PVC
PZ21	Shallow	2 inch	PVC
WT02A	Shallow	2 inch	PVC

3.0 SYSTEM OBJECTIVES, PERFORMANCE AND CLOSURE CRITERIA

3.1 CURRENT SYSTEM OBJECTIVES AND CLOSURE CRITERIA

The remedial actions were conducted as prescribed in the ROD and ESD. The following are goals for the remedy:

- Control risks posed by ingestion of or dermal contact with groundwater and soils.
- Capture and treat the contaminated ground water.
- Treat the principal threat (soils) in accordance with risk based requirements as promulgated in the 1994 Natural Resource and Environmental Protection Act, PA 451 Michigan Department of Environmental Quality (MDEQ) Part 201.
- Prevent or minimize further migration of contaminants from soil source materials to the groundwater (source control).
- Prevent exposure to contaminated groundwater above acceptable risk levels by preventing consumption of groundwater on the site and preventing the contaminant plume from reaching drinking water wells.
- Prevent or minimize further migration of the contaminant plume by removing the affected water for treatment.
- Implement institutional controls

The duration of the final remedy was estimated to require 10 years to meet cleanup standards detailed in the ROD.

3.2 TREATMENT PLANT OPERATION GOALS

The treatment plant goals are generally consistent with the final cleanup criteria specified in the ROD and have been consistently met. These include:

- Meet permit equivalent discharge standards to Little Black Creek as identified in the ROD.
- Operate the extraction and treatment system safely and effectively with minimal down time.

The average VOC plant influent concentration identified over the operating period from plant startup in July 2002 to the present has been at or below discharge standards. The system was originally designed to remove a VOC concentration of nearly 400 µg/L. A permit equivalent was issued for the plant water effluent which included the metals standards as well as VOC's. Since startup VOC levels have been below discharge criteria making the corresponding VOC treatment units unnecessary. Even though the concentrations of VOC's are below discharge standards, best available technology (BAT) requirements for the minor concentrations of VOC's in the influent must be complied with, according to the MDEQ Grand Rapids District. The concentrations of metals continue to be well above discharge standards. In order to eliminate the need to operate the VOC removal processes, the RPM investigated and approved connection to the Muskegon County Wastewater Treatment Facility. Connecting to the Muskegon Regional Treatment Facility (MRTF) will reclassify the treatment facility from a point discharge permitted facility to a pretreatment facility. Due to this reclassification the VOC treatment components can, and were shut down in August 2005. A review of the MRTF pretreatment standards reveals the groundwater extracted from the well field could be discharged directly to the MRTF without pretreatment.

3.3 ACTION LEVELS

The action levels for the primary contaminants of concern are the cleanup criteria specified in the Proposed Plan and ROD. The soil cleanup criteria as amended by the August 1997 ESD are as identified in Table 2. Applicable Federal and State groundwater cleanup levels and principal contaminants are also identified in Table 2.

Table 2: Site Groundwater Cleanup and Discharge Criteria									
Parameter	Groundwater Cleanup Criteria µg/L[1]	Influent Concentration GWTP µg/L Design [2]	Actual [3]	Discharge Criteria To Creek[4] µg/L	To POTW[5] Monthly Ave µg/L	Ecotoxicity Chronic Screening Levels[6] EPA Reg 4 (µg/L)	RBC's/PRG Levels [7] (µg/L) EPA Reg 3 (tap water)	EPA Reg 9 (tap water)	Soil Cleanup Criteria mg/kg[8]
INORGANIC									
Aluminum	50		43			87	NV	36,000	
Antimony	3		<4			160	15	NV	150
Arsenic	0.2		<2			NV	0.045c	0.045 c	10.7
Barium	2,000		55			NV	7300	2,600	30,000
Cadmium	4	1460	241	12	2,840	0.66	18	18	210
Chromium III	7,000	26	9		(total) 7,870	117.32	55,000	5,500	69,000
Chromium VI	2		12	15		11	110	110	180
Lead	5	1	<2	160	466	1.32	NV	NV	400
Mercury	2		<0.5			0.012	NV	11	130
Nickel	57	201	25	300	3,440	87.71	730	730	960
Silver	0.1		<3		572	0.012	180	180	350
Thallium	0.5		<2			4	2.6	2.4	28
Zinc	--	1080	99	720	9,050	58.91	11,000	11,000	
Cyanide	4	0	35	7	245	5.2	730	730	9300
Phosphorus	--	198	NA	0.5	17,300	NV	NV	NV	

Table 2: Site Groundwater Cleanup and Discharge Criteria

Parameter	Groundwater Cleanup Criteria µg/L[1]	Influent Concentration GWTP µg/L Design[2]	Influent Concentration GWTP µg/L Actual[3]	Discharge Criteria To Creek[4] µg/L	Discharge Criteria To POTW[5] Monthly Ave µg/L	Ecotoxicity Chronic Screening Levels[6] EPA Reg 4 (µg/L)	RBC's/PRG Levels[7] (µg/L) EPA Reg 3 (tap water)	RBC's/PRG Levels[7] (µg/L) EPA Reg 9 (tap water)	Soil Cleanup Criteria mg/kg[8]
ORGANICs									
Benzene	1	23	ND	5		53	0.34 c	0.35 c	78
Chloroform	6		ND			289	0.15 c	0.17 c	270
1, 1 Dichloroethane	700	75	ND			NV	900	810	13,000
1, 2 Dichloroethane	0.4		ND			2000	0.12 c	0.12 c	25
1, 2 Dichloroethene			NA	5		NV	55	(cis) 61	
Ethyl Benzene	30		ND			453	1,300	1,300	6,700
Toluene	100		ND			175	2300	720	11,000
1, 1, 1 TCA	117		ND			528	1700	3,200	3,100
TCE	3	240	ND	5		NV	0.026c	1.40 c	160
Vinyl Chloride	0.2	10	ND	3		NV	0.015c	0.020 c	1.2
Xylene	59		NA			NV	210	NV	130,000
TSS			NA		500,000	NV	NV	NV	
BOD			NA		300,000	NV	NV	NV	
pH			NA	6.5		NV	NV	NV	
Dissolved Oxygen			NA	4,000		NV	NV	NV	
BTEX			NA	20		NV	NV	NV	

Notes: All values are micrograms per liter (µg/L).

[1]Table 7 ROD Peerless Plating Superfund Site, Muskegon, MI, September 21, 1992

[2] O&M manual CRA April 2000

[3] Calculated from Quarterly Data for a flow rate =120 gpm

[4]Final Design Report Rerouting Effluent Discharge to the Sanitary Sewer March 29, 2005 Inorganics (Monthly Ave) Organics (Daily Max)

[5] Issuance of Wastewater Discharge Permit to Peerless Plating Superfund Site by the County of Muskegon August 2, 2005 Max Flow Rate 185 gpm, minimum pH = 5.0

[6] Region 4 Screening Values, November 30, 2001

[7] Region 9 PRG's, October 2004; Region 3 RBC's, October 2005 both reflect HI = 0.1 or 10^{-6} Increased Cancer Risk

[8] ESD 1 to ROD Peerless Plating Superfund Site, Muskegon County, MI, August 7, 1997

MCL = Maximum Contaminant Level NA = Not analyzed NC = Not calculated NV = No value given AL = Action Level

c = carcinogenic risk

4.0 FINDINGS AND OBSERVATIONS FROM THE RSE SITE VISIT

4.1 GROUND WATER EXTRACTION AND INJECTION SYSTEM

4.1.1 WELL CONDITION

The extraction wells appear to be operating satisfactorily, with the possible exception of EW-2. Table 3 presents the typical flow rates for the wells and the concentrations of select metals measured from each well. Note that influent concentrations for these metals have not fluctuated significantly over the past several years.

Table 3. Recent Extraction Well Flow Rates and Concentrations

Well	Ave. Flow Rate, gpm 8/05[1]	Ave. Flow Rate, gpm 11/04[2]	Conc (ug/L), November 04		
			Cadmium	Nickel	Zinc
EW-1	26	27	123	10	41
EW-2	16	26	298	16	85
EW-3	23	24	275	32	181
EW-4	17	14	308	29	132
EW-5	39	33	301	33	59
EW-6	15	16	24	13	21

[1]From daily log sheets prepared by the operator.
[2]From Nov 2004 Groundwater Monitoring Report

Wells EW-3, 4, 5 were throttled at the time of the site visit, but EW-3 and -4 were soon to be fully opened as they were recently cleaned. EW-5 is normally throttled and is consistently the best producer. The piping from EW-4 was 50% occluded before recent cleaning using acid recirculation. Fouling materials have also been found in flow meters for the wells. Well EW-2 was showing a decline in pumping rate and will need rehabilitation. The wells are rehabilitated when a drop in production rate is noted. Rehabilitation is conducted about once a year for some wells. Samples of the material fouling EW-1 and –2 were black. The material fouling in EW-3 and -4 is more of a reddish brown color. EW-5 has not yet needed rehabilitation. Rehabilitation consists of pulling the pump from the pitless adapter, cleaning the pump, pressure washing the discharge lines, applying a mixture of "special acid" and dispersants, and brushing and surging. The well contractor that conducts the cleaning has done this at the Bofors Nobel Superfund site. There are no level monitors in the extraction wells, so dynamic water levels can not be determined. Measurements of the dynamic level would assist in assessing well performance through calculation of well specific capacity.

4.1.2 PLUME CAPTURE AND REMEDIATION

Total flow from the extraction system is approximately 140 gpm. Individual well flow rates as of August 2005 are shown in section 4.1.1 above.

Based on the available information, the hydraulic conductivity of the aquifer is on the order of 0.026 cm/sec (75 ft/day) and the hydraulic gradient is 0.013 (November 2003 Monitoring Report). Based on an average extraction rates, a range of capture zone widths of 50 to 125 feet is calculated (see Appendix [DJB1]A) for the various extraction wells. The plume is over 400 feet wide, measured along the line of the extraction wells. The full width of the plume is not completely defined and the plume likely turns southward near the stream. In most cases, it is likely the current extraction flow rates are adequate to capture most of the known plume, with the possible exception of an area between EW-2 and EW-3 near PZ21. In this area, the predicted capture zones would not overlap. Flow rates of 25 gpm or more from EW-2 are likely required to assure capture (recent flow rates are less than 20 gpm). The capture zones for the extraction wells may extend back to Little Black Creek, though the calculated distances to the down gradient stagnation points for the wells are less than the distance between the wells and the creek. Any contribution from the creek to the extraction flow would diminish the capture zone widths.

Contours of the water level data generally support the capture zone analysis described above. Apparent composite cones of depression are evident around EW-1 and -2, as well as EW-3 and -4. The water levels around PZ21 suggest a potential gap in the composite capture zones for the surrounding wells. The impacts of the high extraction rate from EW-5 are not apparent in the piezometric contours due to a lack of nearby piezometers; however, plume capture would probably be achieved without the use of EW-4 due to the large extraction at EW-5.

Note again that the leading edge of the plume south of EW-6 may not yet be defined, nor is the extent north of PZ18. Concentrations in these outlying areas are probably low, but above the cleanup goals. It is likely these outlying areas are not captured by the existing extraction system.

4.2 TREATMENT EQUIPMENT

4.2.1 AIR STRIPPER AND CARBON OFF GAS TREATMENT

Water from the six 2-inch diameter extraction well lines is combined into a 4-inch diameter header that discharges directly into the top of the tray air stripper. The flow from the extraction wells is measured in each of the force mains prior to discharging into the header. Well pumps are not controlled automatically. Flow and draw down levels are controlled manually.

The air stripper is a Carbonaire Stat 180 tray type stripper with 6 trays designed to operate a water flow rate of up to 165 gpm and an air flow rate of 650 cfm. The primary contaminants designed to be removed by the stripper included benzene, 1, 1 DCA, and TCE at expected concentrations of 23, 75, and 240 µg/L. The system draws ambient air through the stripper by the blower. The organic laden air then exits the top of the stripper and passes through 2 vapor phase granular activated carbon units designed to remove the organics prior to final discharge to the environment via a stack through the roof. The concentration of organic constituents has been below discharge standards since the plant began operations in 2002. The MDEQ requires the treatment facility comply with the best available technology (BAT) requirements since the permit equivalent requires organics treatment. The air stripper and GAC off gas treatment systems were taken out of service when the plant discharge was routed to the Muskegon Regional Treatment Facility in August 2005.

Water exiting the stripper flows by gravity to a wet well that pumps the water to subsequent units. The wet well also receives water from the building sump, filter press filtrate, and the filter press area wash down sump.

4.2.2 REACTOR TANK

Water from the wet well is pumped via a variable speed pump to the 5000 gallon fiberglass reinforced plastic (FRP) reactor tank R1, where the metals containing groundwater is subjected to aeration and chemical additives to enhance precipitation of target metals. Pumping rate is based on the level within the wet well. The metals that require removal include cadmium, chromium, nickel and zinc. The reactor tank has a 30 minute residence time. Chemicals added to the reactor tank include lime and ferric sulfate. Sludge from the clarifier is also recycled to the reactor tank to enhance sludge characteristics. Aeration is intended to enhance the conversion of the ferrous sulfate to ferric hydroxide which serves to co precipitate and adsorb heavy metals present in the groundwater. Aeration flow rate is manually adjusted. Lime is added to adjust the pH to a level which optimizes the removal of cadmium. Based on the operators' experience, the optimum pH is manually adjusted to approximately 10.3.

4.2.3 RAPID MIX, FLOCCULATION TANK AND CLARIFIER

Water from the reactor tank flows by gravity to the clarifier. The clarifier consists of 3 compartments, a rapid mix tank with a detention time of 1.5 minutes, a flocculation compartment with a detention time of 9.7 minutes, and the clarifier tank. Polymer is added to reactor tank effluent in the rapid mix tank, and the precipitated particle formation enhanced through gentle mixing causing antiparticle collisions which result in larger particles that are more readily settled in the clarifier. The clarifier provides a detention time of approximately 30 minutes. Sludge is recycled to the wet well prior to the reaction tank to enhance floc formation in the processes upstream of the clarifier. The operator indicated the clarifier is the size limiting component within the treatment facility. Excess sludge is wasted to either of 2 sludge thickening tanks where solids content is increased as liquid is decanted back to the wet well along with the filtrate from the filter press. Controls are adjusted manually for mixer speeds, sludge cycle pumping and diverter valves along with the rake drive. Detention time in the flash mixer is appears to be adequate, generally 30 seconds to 2 minutes of detention time is common for this type of application. The flocculation tank provides slightly less than 10 minutes of detention time for the floc particles to agglomerate prior to clarification at the plant design flow rate. Generally 30 minutes is considered to be adequate time for flocculation to occur prior to discharge to the clarifiers. The limited detention time and potential for short-circuiting in the mixing/equalization tank might compromise floc formation in the unit. The mixer design within the mix tank is not optimum for flocculation to occur. The gravity settler has an overflow rate of 0.25 gpm/sf at the design flow of 165 gpm which is generally recommended for these types of applications. The overflow rate should be designed to assure the small floc particles have ample settling time in the units, generally recommended near 0.25 gpm/sf. Flow from the clarifiers is directed by gravity to the effluent holding tank T-2.

4.2.4 BAG FILTERS AND CLEAR WELL

Following discharge from the clarifier into tank T-2, the effluent is pumped through 2 vessels in series each containing 8 filter bags. The 50 micron bags are designed to remove solids that could carry over the clarifier exceeding the NPDES total suspended solids (TSS) limit to the Little Black Creek. Pressure loss over the filters ranges from 13 psi when clean, to 25 psi when they require change out. Filtered water is discharged to the 1500 gallon clear well after being metered. The clear well is a mixed tank where the final pH is adjusted to approximately 8.0 using sulfuric acid. The tank is provided with an overflow that allows the treated water to gravity flow to the Little Black Creek. The effluent line is equipped with a composite sampler. If the pH in the clear well rises to 8.9, the control system is programmed to shut the plant down.

4.2.5 SOLIDS HANDLING, FILTER PRESS

The solids handling system consists of two cone-bottom, 7500 gallon sludge thickening tanks, a 15 cubic foot recessed plate and frame filter press, 1500 gallon filtrate tank, and associated equipment such as compressed air supply, pumps, and sludge roll off. Sludge from the clarifier is pumped either to the thickening tanks, or recycled to the wet well upstream of the reactor tank. The sludge pump is programmed to waste sludge to the thickening tanks approximately 20% of the time and recycle sludge to tank T-1 approximately 80% of the time. An average of one press cycle per day results in approximately 9 tons of (F006 Plating) waste that requires disposal every 2 weeks. The thickening tanks were designed to have adequate capacity to hold sludge for three days allowing the system to operate over a weekend without pressing sludge. Filtrate from the press cycle, as well as process water decanted from the sludge thickening tanks are routed to the filtrate tank (T-4) and recycled back to tank T-1. Estimated sludge solids of 4% is extracted from the clarifier, and a final cake containing 25 – 30% solids is produced by the press operating at a maximum feed pressure of 100 psi.

4.3 MONITORING SYSTEM AND PROGRAM

4.3.1 GROUND WATER MONITORING

The sampling program consists of semi-annual events in May and November. Each sampling event includes a comprehensive round of water level measurements. The results for May 2005 had been received but the report was still being prepared as the time of the site visit. Apparently, the Substantive Requirements Document (SRD) for the site has a requirement for quarterly sampling after three years of system operation, anticipating that the system would be close to shut down. The project team does not see a need for this given that the metals concentrations remain high. It is not clear if the permit requires all monitoring points and extraction wells to be sampled quarterly. The analytical results are provided to Tetra Tech in Adobe Acrobat and Excel format, but Tetra Tech manually enters the data into the tables in the reports.

The state had recently installed 17 additional monitoring points, primarily down gradient and side gradient of extraction wells EW-1 through –4. Additional points were added near EW-6 to assess adequacy of capture. Three new piezometers near EW-6 did not yet have protective casings, but were locked.

Sampling at the site has been done by Tetra Tech staff. In the past, both standard “bail and sample” and “low-flow” methods have been used by different crew members during the same round. One crew member would use the peristaltic pump for low-flow sampling while another person purged another well by bailing. The methods used for a specific well were not consistent from round to round and are only documented on field forms now residing in Tetra Tech files. Even the low-flow purge volume was based on a goal of removing three well volumes (casing and screen, not including filter pack) rather than geochemical parameter stability. The field crew monitors pH, temperature, conductivity, turbidity, and dissolved oxygen and will continue purging beyond three volumes if the parameters have not stabilized. “Stability” is determined qualitatively.

Turbidity values are highly variable (due to the various sampling methods) and there is some apparent correlation between turbidity and metals concentrations. The field crews have not observed a tendency for the monitoring points to silt in, though they sound the bottom of the well before sampling. The bottles used for the samples are pre-preserved with acid. The acid would likely leach metals from the suspended clays and increase observed metals concentrations.

In the May 2005 sampling round, they rented two peristaltic pumps and did not use a bailer. The Tetra Tech staff said this slowed them down since the peristaltic pump takes longer than bailing to remove 3 well volumes.

4.3.2 PROCESS MONITORING

Process monitoring to assess the performance of individual treatment components is not routinely done at the plant. Monthly influent and effluent sampling required by the permit as well as parameters such as pH, pressure, flow and temperature are monitored as necessary for automatic system component control.

4.4 COMPONENTS OR PROCESSES THAT ACCOUNT FOR MAJORITY OF MONTHLY COSTS

Based on information provided by the remedial project manager, the contractor bid for operating and maintaining the system is approximately $440,000/year. This includes labor, utilities, materials, sampling and analysis, repair, and fees. Approximately 28% of the annual cost is routine operator labor. The one operator is employed full time (40+ hours/week) on this system. This labor includes routine plant operation and maintenance and data entry. Project management costs are approximately $7,300/year. Consumable reagents cost approximately $27,000 per year or about 6% of the annual costs. Disposal costs are about $2,400/year. Ground water sampling is reported to cost approximately $7,500 in labor (though this seems low given that the sampling is done with a crew of three people over five days twice a year). Analytical costs (including sampling equipment) for ground water, vapor, and treatment plant process samples are approximately $10,000/year. Costs for utilities include approximately $16,000/year for electricity, and an additional $14,000 for water, gas, and phone service. This is about 7% of the total site costs. Subcontracted services, shipping, parts, and repair are almost $239,000/year. No breakdown is provided for these services and materials. Significant savings can be realized by cost reductions in labor, materials, repair, and utilities.

To summarize recent annual costs:

Labor	$135,000
Expendable Materials	$27,000
Chemical Analyses	$10,000
Utilities	$29,000
Disposal	$2,400
Repairs and Other Services	$238,000
Total	$440,000

4.5 RECURRING PROBLEMS OR ISSUES

4.5.1 WELL ISSUES

Biofouling appears to be the only consistent issue with the extraction wells. The problem appears to be adequately addressed through the use of preventative maintenance and good rehabilitation techniques.

4.5.2 EFFLUENT EXCURSIONS

Since plant start up there have been two situations that have occurred resulting in the effluent discharges that exceed the NPDES permit equivalent limits. In both circumstances, the polymer feed system failed causing carryover of metals precipitated floc, too fine to settle properly, discharging to the Creek. The polymer system was modified following the second failure and has functioned without incident ever since.

4.6 REGULATORY COMPLIANCE

As stated previously, the plant operating under its current configuration has consistently met the permit equivalent discharge standards except as noted in paragraph 4.5.2. A series of whole effluent toxicity (WET) tests were required by the DEQ to ensure the plant discharge was not harmful to stream biota. The treatment plant was not allowed to discharge following two unsuccessful tests which resulted in long periods of down time in 2004. Multiple WET tests were performed in 2005 prior to being successful, but the DEQ allowed the plant to continue operating following the first unsuccessful test. Connection to the MRTF will eliminate this problem from reoccurring.

4.7 ACCIDENTAL CONTAMINANT RELEASES

There have not been any unscheduled releases of extracted ground water.

4.8 SAFETY RECORD

The facility has a commendable safety record with no lost-time accidents reported during the operation of the remediation system. According to a plant records, there has not been a lost-time accident since plant startup in December 2002.

5.0 EFFECTIVENESS OF THE SYSTEM TO PROTECT HUMAN HEALTH AND THE ENVIRONMENT

5.1 GROUND WATER

Based on the sampling of monitoring and extraction wells since system start-up, it appears that the extent of the full ground water plume is undefined and, therefore, the ground water extraction system is likely not currently containing the plume as defined by the cleanup goals (e.g. 4 ug/L for cadmium). The plume extent north of PZ19 is the primary uncertainty. Though the system is largely containing the on-site portion of the plume, there is a potential gap in the containment between EW-2 and EW-3 in the vicinity of PZ21. There are no users of ground water in the vicinity of the site, but ground water likely discharges to Little Black Creek.

The rate of improvement in ground water contaminant concentrations has not been as expected. Concentrations of metals in ground water are generally stable. The ground water contaminant plume will persist for significantly longer than several years under current conditions. The potential risk posed by the plume will remain for the foreseeable future.

5.2 SURFACE WATER

The plant formerly discharged into Little Black Creek which in turn empties into Mona Lake. There are concerns that heavy metals, especially cadmium, may be impacting water quality in the lake. Although discharge standards were very low, eliminating the discharge to the stream will eliminate the perception that the treated ground water discharge is contributing to metals contamination in the creek and Mona Lake. There is a possibility of contaminated ground water discharging to Little Black Creek, especially north of EW-1. Concentrations and volumes of contaminated ground water discharging to the creek are likely to be small, so the impact is not highly significant, but may be of concern to ecological receptors.

The effluent does not contain metal or VOC compounds at levels that pose a health risk. Based on the EPA Region IV ecological screening levels listed in Table 2 and the effluent concentrations, cadmium may exceed chronic ecotoxicity levels if treatment is not successful in reducing the concentration to very low levels, less than 1 µ/L. Zinc could potentially be of concern if the treatment effectiveness was less than 50%, which has not been the case. Rerouting the discharge from the creek to the MRTF will eliminate concerns that cadmium and zinc present in the treated water discharge will result in creek contaminant concentrations above chronic ecotoxicity screening levels.

5.3 AIR

There are currently no unacceptable impacts on air quality due to the operation of the plant. Vapors are treated via vapor-phase carbon. An analysis of the groundwater since the plant startup reveals that the VOC concentrations in the influent are below discharge standards. The local Michigan Department of Environmental Quality (MDEQ) District requires compliance with the BAT as part of their permit. Following connection to the MRWF the VOC treatment components were shut down.

5.4 WETLANDS AND SEDIMENTS

There are no wetlands downstream of the facility, or sediments in the downstream creek area that are further impacted by remediation activities. By eliminating the groundwater discharge and direct discharges from the plating facilities, the metals concentrations in the creek downstream of the site have decreased. The site remediation did not address contaminated sediments within Little Black Creek. Concern has been expressed pertaining to the sediments and water quality in Little Black Creek and Mona Lake located down stream of the site. A number of potential sources of contamination exist within the drainage basin. Contaminants similar to those present at the Peerless site, though from undefined sources, have been found historically in creek sediments up gradient of the site. Since the RSE site visit, the Michigan DNR has taken sediment samples from Little Black Creek upstream, downstream and in the reach adjacent to the Peerless site. EPA and the Michigan DNR are at the time of this writing, in the process of evaluating that data to determine the appropriate actions to take if any, in the Little Black Creek sediments.

6.0 RECOMMENDATIONS

6.1 RECOMMENDATIONS TO ENSURE EFFECTIVENESS

6.1.1 GROUND WATER EXTRACTION AND INJECTION WELL PERFORMANCE

The extent of the plume may not be currently fully defined, particularly to the north. In addition, northernmost monitoring point PZ18 appears to have a modest increasing trend in concentrations of Cd, Ni, and cyanide. Additional monitoring points located north of the existing monitoring well are necessary to define the northerly extent of the plume. Assuming the extent of the plume is confirmed to extend beyond the capture zone of extraction EW-1 and that the agencies desire to capture the full extent of the plume above the cleanup goals, either an additional extraction well north of EW-1 or increased pumping from EW-1 will be needed to assure capture of the full plume in that area. The increase in extraction could be somewhat offset by a reduction in the pumping rate of EW-5 or EW-4. The design of any new extraction well(s) would best be conducted following additional delineation of the plume extent. A case could be made to allow the plume in this area to continue to migrate without certain capture, given the relatively low concentrations and lack of human receptors.

The capture zone near extraction wells EW-2 and -3 is potentially inadequate. The feasibility of increasing pumping from EW-2 and EW-3 should be investigated. If the rates from these wells could be increased by approximately 25%, more certain capture could be achieved in this area,

The capture zone of EW-5 largely overlaps that of EW-4. Though this increases confidence in the capture of the plume in this part of the site, this may unnecessarily raise costs for extracted water treatment and/or disposal. A reduction in the total pumping from extraction wells EW-4 and -5 should be considered. If EW-5 were used without pumping EW-4, there would be a portion of the plume between EW-5 and the creek that would not be captured (the capture zone would only extend down gradient a portion of the distance between the well and the creek). As such, it is recommended that both wells be pumped, but at reduced rates to offset other increases in pumping discussed above.

There may need to be additional definition of the plume south of extraction well EW-6. Sporadic detection of contaminants (particularly cadmium and lead) above remediation goals have been identified in monitoring points PZ16 and PZ17. The concentrations observed in those wells are low, they are within the capture zone of EW-6, and access is difficult immediately southwest of these wells. The relationship between the plume edge and the EW-6 capture zone should be further investigated unless the agencies determine the very low concentrations that potentially exist outside the capture zone are not of concern or are related to turbidity of the samples. Increased pumpage from EW-6 may be adequate to address the concern once the plume is fully defined.

6.1.2 MODIFICATIONS TO MONITORING PROGRAM

The primary concern about the monitoring program is the lack of plume definition north of PZ18 and possibly south of extraction well EW-6, as discussed in section 6.1.1. In addition, there is no real up gradient monitoring point as all up gradient points (WT-02A and PZ02B) are impacted by low concentrations of metals. Given the potential for other sources in the vicinity, a true background point would be beneficial. Additional permanent monitoring points are recommended west of well WT02, north of well PZ18 and southwest of well PZ16. Another piezometer cluster would be useful near EW-5. The estimated costs for these new wells are estimated to be approximately $48,000.

In addition, dissolved metals concentrations may be affected by inconsistent sampling methods. If not already implemented, the sampling procedures must be converted to strictly low-flow sampling in accordance with the EPA fact sheet on low-flow sampling (EPA/540/S-95/504, April 1996), if this change has not already been made. Every effort should be made to reduce sample turbidity to more truly represent the mobile metals concentrations.

6.2 RECOMMENDATIONS TO REDUCE COSTS

6.2.1 BYPASS REMAINING GROUNDWATER TREATMENT PLANT PROCESSES

Given the low concentrations of many contaminants of concern, in particular VOC's, the discharge from the plant was rerouted to discharge to the MRTF, which allowed for elimination of the air stripper and vapor phase carbon treatment system. Given the concentration of the metals undergoing treatment in the plant are below the pretreatment requirements stipulated in the MRTF permit, bypassing the remaining components (reaction tank, metals precipitation system, sludge processing equipment) would be a logical next step. The remediation team has already taken several steps to initiate component shutdown. The RPM has started a third ESD that identifies a revision in the plant discharge point, and proposes changes in the treatment requirements within the plant. The RSE team agrees with the RPM that direct discharge to the regional treatment facility is efficient and cost effective to eliminate the remaining treatment components within the plant. The RSE team also endorses modifications the operations staff has initiated within the plant in an effort to reduce costs without impacting BAT requirements imposed by the DEQ. The high capacity 50 micron cartridge filters each costing about $97 each have been replaced with 100 micron bag filters at a cost of $1 each. The cost difference between a change out every 4 days has been reduced from $776 to $8, resulting in an annual cost savings of over $70,000 (365/4 x. $768 = $70,080). The operations staff is also slowly reducing the amount of lime, polymer and ferrous sulfate fed to the system to further reduce costs. Filter press cycle frequency has remained constant at 1 per day, so disposal costs will remain nearly the same as before. The unused components could be bypassed by rerouting the existing air stripper feed line to the clear well in the vicinity of the bag filter housings using new bypass piping, 2 valves, and control wiring for a flow meter, and critical shut down procedures for the well field and other components as necessary. Cost for these revisions would cost in the range of $8,000. Control modifications would require approximately $1,000 for programming since the control system is in place, and no new control components will be added.

Heat tracing and insulating the components left in service should be investigated to allow for a reduced temperature, perhaps 40 degrees F, within the facility itself. Added annual cost savings of bypassing the remaining plant components would include*:

Labor	80% $130K	$100K
Chemicals	100% $33K	$ 33K
Sludge Disposal	100% $ 30K	$ 33K
Lift Rental	100% $ 9K	$ 9K
Electric	75% $ 48K	$ 36K
Other Costs	60% $ 27K	$ 16K
Total		**$227,000**

*Costs based on First Five Year Review, Attachment 5, September 25, 2002
Savings do not include cartridge filters which were replaced with bags at an annual savings of >$70K

6.2.2 MODIFICATION OF MONITORING FREQUENCY AND ANALYTICAL SUITE

The monitoring program reflects three primary purposes: 1) to define the limits of the plume for capture assessment, 2) to track changes in concentrations at the sources and along the axis of the plume to assess progress toward cleanup, and 3) to assess exposures at Little Black Creek. Results of the monitoring are assessed to determine if other actions (e.g., changes in extraction well flow rates, locations, additional investigations, etc.) are necessary. The ground water concentrations and thus the exposure scenarios are unlikely to change rapidly. The sampling frequency for monitoring wells should, therefore, not be more than semi-annually and could be reduced further. A change to quarterly sampling, as apparently required, is not warranted and is not necessary for making the necessary site decisions. In fact, some wells could be sampled annually (or less frequently) without a significant loss of information. Sampling of WT02A and PZ02B or the PZ06 cluster could be done annually (or less frequently) and would still provide adequate and timely information about upgradient conditions or monitor for underflow of contaminant past Little Black Creek, respectively. Such a change may reduce sampling costs by approximately 10%, discounting the additional monitoring points recommended in section 6.1.2. Plans, including the definition of the time and circumstances, should be made to reduce the entire sampling program to annual sampling of the monitoring wells at some point in the future. This would reduce the sampling costs by approximately 50%.

Note that water level monitoring should continue to be made on at least a semi-annual basis and the results should be assessed to verify the adequacy of the capture of the plume by the extraction system. The water levels should be presented in tabular and graphical form in the site reports.

The analytical suite should be reduced to metals and cyanide. Based on the very low detections, the analyses for volatile organics could potentially be eliminated or at least reduced to once every two or three years. Further use should be made of electronic data deliverables from the analytical laboratory in preparing the report tables and figures. This would avoid the potential for errors in transcription and reduce labor costs for report preparation.

Overall, the recommended changes, including the addition of 7-10 wells discussed in section 6.1, result in a 9-42% decrease in the number of samples per year. If the above changes were implemented the total annual savings for long-term monitoring of the existing network would be approximately $1,500 to $7,300/year.

6.2.3 REPORTING REQUIREMENTS

Currently, the treatment plant contractor does not prepare any type of operations report regarding the current state of the treatment plant operations, current and upcoming maintenance issues, changes proposed, process sampling accomplished, repairs accomplished over the last period, repairs required in the next reporting period, and so forth. Given the expected /proposed scenario to bypass most of the remaining treatment units, these items should be incorporated into the groundwater monitoring reports.

6.2.4 LEVEL OF OPERATOR SUPPORT

The operational requirements of the extraction and treatment systems will decrease significantly when the remaining process units are bypassed. The remaining level of support should be reduced by nearly 80% (1 day per week rather than 5) as reflected in paragraph 6.2.1.

6.3 RECOMMENDATIONS FOR TECHNICAL IMPROVEMENT

6.3.1 INSTALL A DUST COLLECTOR OVER THE $FeSO_4$ HOPPER

The operator adds $FeSO_4$ at a rate of 150 – 200 lbs per day using bagged $FeSO_4$. There is no dust collector present over the hopper where the bags are broken resulting in a layer of red dust throughout the plant. This recommendation is contingent on the plant not being shut down as is currently planned. Estimated cost for this improvement is approximately $4,500.

6.3.2 INSTALL AN ENCLOSURE AROUND THE AIR COMPRESSOR

The air compressor is quite loud and generates a good deal of heat, a benefit in the winter, but problematic in the warm summer months. The unit should be enclosed within a properly insulated space provided with an external air supply and exhaust to reduce the heat load within the treatment building in the warm season. Cost for this type of enclosure would be approximately $20,000.

6.3.3 Initiate a Formal Operation and Maintenance Program

The site does not have a formal preventative maintenance plan in place. The operations contractor proposes initiating a formal preventative maintenance, record keeping, spare parts inventory, and process monitoring program for the plant and well field. The operations staff has many standard procedures that should be formalized. The RSE team endorses the need for this program, but would recommend the final scope of the effort be based on results of negotiations with the regulators concerning bypassing remaining processes in the plant. Costs should be minimal since the number and complexity of procedures will likely diminish greatly following the anticipated shut down and bypass of most of the treatment equipment in the plant.

6.3.4 Place Used Equipment on the USACE/EPA Web Site for Reuse

Equipment taken out of service should be made available for use at other sites by posting the pertinent information on the Used Equipment Web site managed by the Corps of Engineers.

6.4 Modifications Intended to Gain Site Closeout

6.4.1 Assessment of the Need for Additional Treatment of Source Areas

Clearly, the aquifer contaminant plume has not responded to ground water extraction as expected. The presence of concentrations well above the cleanup standards and the lack of a clear downward trend in ground water concentrations suggest the duration of the project will be very long. Additional efforts directed at the removal or stabilization of the metals in the aquifer may be useful for reducing the concentrations closer to the cleanup goals and shortening the time to site closeout. Additional excavation of contaminated soil from below the water table, though likely beneficial, would be disruptive to site facilities, as well as technically difficult and very costly to implement.

An alternative that could be investigated further would be the in-situ stabilization of metals. Both carbonate and sulfide could bind with the dissolved cadmium and stabilize the metal in low solubility precipitates. Similar reactions may be possible for lead and nickel. The impact of chemical additives on the natural geochemistry of both the aquifer and Little Black Creek is not clear. There would likely be impacts on the aquifer pH and oxidation/reduction potential, depending on the nature of the additives. Additional evaluation of the appropriate geochemical approach would be necessary and is beyond the scope of the RSE. The focus of the studies would include the permanence of the stabilization in light of natural ground water chemistry and the presumably transient impacts to aquifer pH and redox conditions. The evaluation should also assess the cost implications. The costs for applying the technology should be offset by avoided operating costs in the future. Present-worth analysis of these avoided future costs will be necessary to fairly conduct the assessment

The addition of the appropriate reagents could be performed within the footprint of the highest concentrations in the contaminant plume. Conceptually, the process would include coupled injection of amended water near the up gradient extent of the high concentrations (west of EW-2 and EW-3) and extraction of contaminated water at the existing extraction wells for some period of time. Though the coupled injection and extraction would create a circulation cell that would divert natural flux around the cell, it would be prudent to maintain higher extraction rates than injection rates to assure capture of the injected water. Extraction would continue at EW-1, EW-4, EW-5, and EW-6. The costs of three new injection wells with associated piping were estimated to be approximately $70,000. It was assumed that chemical feed systems already in place in the existing treatment plant could be modified for addition of the necessary reagents. This would require the cessation of metals treatment at the plant, as discussed in section 6.2.1. The feasibility of this would require further assessment.

6.4.2 Permeable Barrier Alternative to Ground Water Extraction.

The RSE team considered use of an alternative technology to ground water extraction to reduce the required effort and cost to achieve closure. The placement of a permeable treatment barrier filled with organic matter parallel to Little Black Creek was considered as a potential alternative for treatment of metals in ground water prior to natural discharge to the stream. We considered a 230-foot-long trench excavated to 25 feet below grade (approximately 15 feet below water) and filled with peat or comparable organic materials. The trench alignment is shown in Figure 2. This would result in a significant reduction of the flux of metals, particularly cadmium. Bench- and/or pilot-scale testing would be advisable prior to implementation of such a remedy change. An amendment to the ROD would likely be necessary for such a change.

There would be a significant reduction in costs for operations for such a barrier system. Though there would be a slight rise in monitoring required for assessing barrier performance, the treatment costs (or charges for discharge of treated or untreated water), would be avoided. The capital costs for the barrier were estimated to be approximately $650,000, including construction of the trench, monitoring points, design, and oversight. This includes off-site disposal of the displaced soil (some clean excavated soil is assumed to be replaced in the trench above the peat). This investment would be recouped in a few years by savings in the treatment costs if the treatment plant operations continue. If treatment ceases and the water is discharged to the sewer system, the pay-back period for the investment in the trench would be longer.

6.5 Suggested Approach to Implementation of Recommendations

The additional characterization of the plume should be conducted irrespective of other actions at the site. Similarly, changes to extraction rates of EW-2 and EW-3 to assure capture should also be conducted soon. The changes to the ground water sampling methods should be done for the next sampling round, if not already implemented at the site. The proposed change in the monitoring frequency from semi-annually to quarterly should be critically examined prior to any change in sampling frequency. The reason for the increase of sampling frequency required by the site documentation is not valid at this time (the site is not approaching cleanup). The recommended changes to the management of the electronic analytical data from the lab could also be implemented immediately for easier and potentially more accurate report generation.

The RSE team fully supports the change of discharge point to the sanitary sewer. The recommendation in section 6.2.1 to bypass metals treatment, as the influent metals concentrations are below the pretreatment standards for the sewer authority, should be pursued soon in light of all stakeholders concerns. The potential savings would be significant. The development of a formal operations and maintenance program recommended in section 6.3.3 should wait until this issue is resolved. If the interim period until shut down of the metals removal system is expected to be in excess of one year, the recommendations for the dust collector over the $FeSO_4$ hopper and the enclosure for the air compressor should be pursued. If the metals treatment is discontinued unneeded equipment can be offered for reuse on the web site listed in section 6.3.4 following decommissioning. Given the unlikely future need for the air stripper, this piece of equipment could be offered for reuse now.

The changes to the monitoring frequency at selected wells as described in section 6.2.2 should be considered in the next year. The decrease in sampling frequency at selected existing wells could be initiated even if the monitoring network is expanded as recommended since the existing wells have a long sampling history. New wells would require at least semi-annual sampling to assess seasonality and to establish a good baseline concentration history.

The replacement of the ground water extraction system with a permeable barrier at some point in the future should probably only be considered if the on-site metals treatment is continued indefinitely. This is a long-range future change that would require amendment to the ROD, stakeholder acceptance, and verification of effectiveness.

The use of in-situ chemical stabilization of metals could be considered as part of a long-term strategy to shorten time to site cleanup. There is no urgency, but the additional assessment of the potential application of this approach could begin soon.

6.6 SUGGESTED EXIT STRATEGY

Though the project team is tracking the plume concentrations and adjusting the system operation, there is not a formal, documented process to compare site conditions to specific interim goals to quantitatively evaluate progress toward site closure goals. An exit strategy document should be prepared as a means to provide a consistent decision framework for an evolving project team.

This exit strategy document should describe the basis and considerations for shut-down or restart of an extraction well or treatment process, set targets for future plume reductions, and identify contingent actions should capture not be maintained or target reductions go unmet. Extraction wells should be turned off when the extracted concentrations are below MCLs or when the extracted water does not contribute substantially to the capture of the plume (other nearby wells may be adequate to capture the plume). Those responsible for proposing and accepting these changes should be clearly stated. The exit strategy should consider the impact of various source reduction/treatment options on the longevity of the ground water remediation and recommend cost-effective actions to treat or contain the source areas (see section 6.4.1).

Periodic assessments of performance by the project team should be outlined in the strategy (e.g., done on an annual basis and documented in an annual report) and the responsibility for conducting these should be clearly assigned. The exit strategy should also plan for periodic independent reviews (such as RSEs and/or five-year reviews) of system performance.

Furthermore, the exit strategy would identify (in the exit strategy document or site sampling and analysis plan) decision logic for modification of the monitoring program as the plume (hopefully) shrinks. This would include a clear definition of the monitoring objectives and the basis for adding or excluding monitoring points, or increasing or decreasing sampling frequency. For the Peerless Plating site the exit strategy should consider the need to fully characterize the extent of the plume and note the potential need for additional extraction wells should the extent of the plume requiring capture exceed the reach of the existing extraction wells.

The strategy should also plan for the tailoring of the treatment processes to the actual extracted concentrations. For example, if the metals concentrations in the combined influent are similar to current levels the metals precipitation and filtration processes could be bypassed. The plant may be maintained in a stand-by mode in the event that metals concentrations spike or if additional source area treatment is proposed and accepted.

Finally, the exit strategy should identify what constitutes a basis for closure, including monitoring for concentration rebound. For example, the strategy may indicate delisting would be proposed when all monitoring wells reach the cleanup goals in two sampling rounds at least six months apart.

These are only suggestions offered as a starting point for the project team. The actual exit strategy must be determined through consensus building and may require modeling or other studies to actually develop trigger or target concentrations for the strategy.

7.0 SUMMARY

The observations and recommendations given below are not intended to imply a deficiency in the work of either the designers or operators, but are offered as constructive suggestions in the best interest of the EPA USACE, and the public. These recommendations obviously have the benefit of the operational data unavailable to the original designers.

The RSE process is designed to help site operators and managers improve effectiveness, reduce operation costs, improve technical operation, and gain site closeout. In this report several recommendations are made with respect to system effectiveness, cost reduction, and technical improvement. The report addresses potential ways to enhance remediation, reduce costs, improve reporting and data management.

The ground water extraction system is generally operating in a way that achieves containment of the contaminant plume with the exception of the area near extraction wells EW-2 and EW-3. Pumping rates from these wells should be investigated to ensure capture is achieved. Conversely the capture zone in the vicinity of EW-4 and EW-5 overlaps and may be reduced and still obtain capture. Further characterization of the northern, southern, and western boundaries of the plume is required. Additional extraction may be needed.

The current treatment plant discharge has been revised from a surface discharge to the Little Black Creek to the Muskegon County Regional Treatment Facility (MRTF). Potential savings in labor resources and consumables is significant. Initial charges levied against the EPA by the local sewer board appear to be well in excess of what is reasonable. The RSE team recommends the EPA RPM and state RPM, along with the operations contractor meet with the local sewer district and clarify their fee structure. The RSE team concurs with the revision to discharge to the MRTF and recommends the team continue to pursue the shut down of the metals removal components within the treatment facility and discharge directly to the MRTF without pretreatment at significant cost savings.

These and other recommendations are summarized in Table 4 below.

Table 4. Cost Summary Table for Individual Recommendations

Recommendation	Reason	Estimated Change in Capital Costs	Estimated Change in Annual Costs	Estimated Change in Life-cycle Costs*
6.1.1 Evaluation of GW capture	Effectiveness	Not estimated: depends on model, plume definition	$0 Dependent upon 6.2.1	Not estimated, but there will be savings due to reduced duration of remedy
6.1.2 Modification to Monitoring Program	Effectiveness	($48,000)	Included in 6.2.2	Included in 6.2.2
6.2.1 Eliminate Several GW Treatment Processes	Cost Reduction	($9,000)	$218,000 (year 1) $227,000 (year 2 and beyond)	$4,531,000**
6.2.2 Modifications to the Monitoring Program	Cost Reduction	$0	$1,500 (min)	$30,000 (min)
6.2.3. Revise Reporting Reqm'ts	Cost Reduction	Not estimated	Not estimated	Not estimated
6.2.4. Level of Operator Support	Cost Reduction	Reflected in 6.2.1	Reflected in 6.2.1	Reflected in 6.2.1
6.3.1. Install Dust Collection System over $FeSO_4$ Hopper	Technical Improvement	($4,500)	$0	$0
6.3.2 Install Enclosure Around Air Compressor to Reduce Noise	Technical Improvement	($20,000)	$0	$0
6.3.3 Initiate a Formal O&M Program	Technical Improvement	Not estimated depends on 6.2.1	Not estimated depends on 6.2.1	Not estimated depends on 6.2.1
6.3.4 Place Used Equipment on USACE/EPA Web Page	Technical Improvement	$0	Not estimated	Not estimated
6.4.1. Assess Source Area Treatment Alternatives	Site Closeout	($70,000)	Not estimated	Not estimated
6.4.2. Permeable Barrier	Site Closeout (Cost Reduction)	($650,000)	Not estimated, could be substantial	Not estimated

Costs in parentheses imply cost increases.
* assumes 20 years of operation at a discount rate of 0% (i.e., no discount).
** computed costs do not reflect discharge fees to the MRTF