

**REMEDIATION SYSTEM EVALUATION**

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**OCONOMOWOC ELECTROPLATING SUPERFUND SITE**  
**ASHIPPUN, WISCONSIN**



Report of the Remediation System Evaluation,  
Site Visit Conducted at the Oconomowoc Site  
14-15 March, 2000

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## NOTICE

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## EXECUTIVE SUMMARY

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The 10.5 acre Oconomowoc Electroplating Company, Inc. located in Ashippun, Wisconsin, encompasses a four-acre electroplating site adjacent to a six and one half-acre wetland. The electroplating facility included a main process building, a wastewater treatment building, wastewater treatment lagoons, and other miscellaneous storage areas. Drinking water wells are in the vicinity of the facility in addition to the wetland area. Davy Creek, a small warm water sport fishery, flows through the wetland area approximately 500 feet south of the site. Untreated wastes containing volatile organic compounds, and heavy metals from degreasing, plating and finishing operations were discharged directly to the Davy Creek Wetlands from 1957 to 1972. From 1972 until the site ceased operations in the 1980's waste was discharged to two waste lagoons. Metals contaminated hazardous wastes and VOC's were found at numerous site locations including the lagoons, storage areas, in and beneath the plating and water treatment buildings.

The remedy identified in the ROD included multiple removal activities to eliminate the source of contamination from the site. These included:

- excavation and disposal of the lagoon sludge and surrounding soils
- excavation and disposal of non-lagoon contaminated soil and debris from the site
- excavation and disposal of metals contaminated sediments from the wetlands area adjacent to Davy Creek.

A groundwater extraction and treatment facility was built to contain and remediate the contaminated groundwater plume. The EPA RPM indicated the extraction system and treatment plant has operated successfully the last two years following some initial start up problems.

The source removal activities were successfully accomplished during the early to mid 1990's. Subsequent to these removal actions, the metals concentrations in the groundwater extraction system influent to the treatment plant are now present below the current preventive action limits (PALs) for all constituents with the exception of nickel (which was not a listed COC in the 1990 ROD).

The RSE suggests many potential modifications to the existing pump-and-treat system at this site. Several key recommendations address effectiveness issues:

- a capture zone analysis is strongly recommended to evaluate the adequacy of the capture zone of the pumping wells, and better understand impacts to the capture zone due to contribution of water from the adjacent wetlands; and
- additional delineation of groundwater contamination west of Eva Street, in a residential area with drinking water wells, is strongly recommended.

Other key recommendations address life-cycle cost reductions:

- potential removal of the cyanide treatment process (potential chemical savings over the operating life-cycle of over \$600,000);
- potential removal of the metals precipitation process (potential sludge disposal savings over the operating life-cycle of over \$500,000); and
- removal of these two processes would save approximately \$117,000 in annual labor costs due to reduced staffing requirements at the treatment plant (savings over the operating life-cycle of over \$2,300,000).

Replacement of the current remedial technology, pump and treat, with a permeable reaction wall would result in a capital cost of approximately \$1.5 million, but could result in a life-cycle cost savings of nearly \$7 million.

More than ten other modifications are recommended to improve technical aspects of the existing pump-and-treat system, and additional recommendations are made to improve the potential for ultimate site closeout.

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## PREFACE

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This report was prepared within the context of a demonstration project conducted by the United States Environmental Protection Agency's (USEPA) Technology Innovation Office (TIO). The objective of the overall project is to demonstrate the application of optimization techniques to Pump-and-Treat (P&T) systems at Superfund sites that are "Fund-lead" (i.e., financed by USEPA). The demonstration project was conducted in USEPA Regions 4 and 5.

The demonstration project has been carried out as a cooperative effort by the following organizations:

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The project team is grateful for the help provided by an EPA Project Liaison in each Region. Kay Wischkaemper in Region 4 and Dion Novak in Region 5 were vital to the successful interaction between the project team and the Regional Project Managers (RPM's) during the course of this project, and both actively participated in one Remediation System Evaluation (RSE) site visit conducted in their Region.

The data collection phase of this project included interviews with many RPM's in EPA Regions 4 and 5. The project could not have been successfully performed without the participation of these individuals.

Finally, for the sites where RSE's were performed, additional participation and substantial support was provided by the RPM's (Ken Mallary and Ralph Howard in Region 4; Steve Padovani and Darryl Owens in Region 5), and their efforts are very much appreciated, as are the efforts of the State regulators and EPA contractors who also participated in the RSE site visits.

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## 1.0 INTRODUCTION

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### 1.1 PURPOSE

The US Environmental Protection Agency's (USEPA) Technology Innovation Office (TIO) and the US Army Corps of Engineers (USACE) Hazardous, Toxic, and Radioactive Waste Center of Expertise (HTRW CX) are cooperating in the demonstration of the USACE Remediation System Evaluation process at Superfund sites. The demonstration of the RSE's is part of a larger effort by TIO to provide USEPA Regions with various means for optimization, including screening tools for identifying sites likely to benefit from optimization and computer modeling optimization tools for pump and treat systems, such as the MODMAN code.

The Oconomowoc Electroplating Company Superfund site was chosen based on initial screening of pump and treat systems managed by USEPA Region 5 and represented a site with relatively high operation cost and a long projected operating life. One or two sites in Regions 4 and 5 will be evaluated with RSE's in the first phase of this demonstration project. A report on the overall results from these demonstration sites will also be prepared and will identify lessons learned, typical costs savings, and a process for screening sites in the USEPA regions for potential optimization savings.

The RSE process is meant to identify cost savings through changes in operation and technology, to evaluate performance and effectiveness (as required under the NCP, i.e., and "five-year" review), assure clear and realistic remediation goals and exit strategy, and verify adequate maintenance of Government owned equipment. This report provides a brief background on the site and current operations, a summary of the observations made during a site visit, and recommendations for changes and additional studies. The cost impacts of the recommendations are also discussed.

### 1.2 TEAM COMPOSITION

The team conducting the RSE included:

Lindsey K. Lien, Environmental Engineer, USACE HTRW CX  
Dave Becker, Geologist, USACE HTRW CX  
Kathy Yager, HQ EPA TIO  
Rob Greenwald, HSI GeoTrans (EPA TIO's contractor)

### 1.3 DOCUMENTS REVIEWED

Author	Date	Title/Description
US EPA	9/20/90	Record of Decision, Oconomowoc Electroplating Company Superfund Site, Ashippun, WI, September 20, 1990 (and two non-applicable ESDs)
Dames and Moore	9/28/92	Predesign Engineering Report, Oconomowoc Electroplating Company Superfund Site, Ashippun, WI
B & V Waste Science and Technology Group	??	Final Plans and Specifications, and Design Analysis, Oconomowoc Electroplating Company Superfund Site, Ashippun, WI,
St. Paul District Corps of Engineers, and Analytical Process Laboratories	12/22/98	Purchase Order DACW37-99-M-0057
Ebasco Services Incorporated	6/1/90	Draft Feasibility Study, Oconomowoc Electroplating Company Superfund Site, Ashippun, WI
APL Environmental	2/15/90	Monthly Operation and Maintenance Report for January, 2000
APL Environmental	2/15/00	Monthly Monitoring Report for January, 2000
APL Environmental	9/96-6/97, 7/98-12/99	Tabulated Sampling Results

### 1.4 PERSONS CONTACTED

Craig Evans, Project Manager, USACE St. Paul District  
 Steve Brossart, USACE St. Paul District, Winona Area Office  
 James Chang, Program Manager, APL Environmental  
 Dean Groleau, Plant Superintendent, APL Environmental  
 Tony Goodman, Plant Operator, APL Environmental  
 Paul Kozol, Wisconsin Department of Natural Resources  
 Steve Padovani, RPM, EPA Region V  
 Dion Novak, RPM, EPA Region V

### 1.5 SITE LOCATION, HISTORY, AND CHARACTERISTICS

#### 1.5.1 LOCATION

The site is located at 2572 Oak Street, Ashippun, Wisconsin, an unincorporated town approximately 7 miles north of the city Oconomowoc and 40 miles west-northwest of Milwaukee. The site occupies 4 acres between Oak and Elm Streets and is bounded on the northwest by Eva Street and on the southeast by the maintenance yard for the Town of Ashippun. Davy Creek and associated wetlands lie southwest of the site across Elm Street and approximately 6.5 acres of these wetlands were originally impacted by site operations. The site is now relatively flat except for linear berms on the

northwest, northeast and southeast sides of the site, and slopes gradually toward Davy Creek. The original and current site layouts are shown on Figures 1-1 and 1-2.

### **1.5.2 POTENTIAL SOURCES**

The Oconomowoc Electroplating Company operated at the site from 1957 to 1991. The company performed metal cleaning and plating operations involving the use of solvents, cyanide, chromium, cadmium, nickel, tin, zinc, and copper. Process wastes were discharged at various locations around the plant, into low areas between the plant and the town's Maintenance Yard, through wastewater lagoons in the western part of the site, and into the wetlands southwest of the plant. As a result of the waste disposal activities, contaminated soil, sediment, and ground water were widely detected around the site and in the neighboring wetlands. Between 1991 and 1994, various removal actions were conducted to remove the plant buildings, lagoon contents (including supernatant and sludge), contaminated soils, and contaminated sediments from the wetlands.

### **1.5.3 HYDROGEOLOGIC SETTING**

Ground water occurs in glacial till composed of unconsolidated sands and silty sands with occasional sandy silts and silty clay layers. Bedrock is encountered between 25 - 50 feet below grade and is comprised of shale or dolomite of the Maquoketa Shale Group. Hydraulic conductivities of the unconsolidated materials based on slug tests ranged from 2E-4 to 7E-3 cm/sec and transmissivity based on the pump test conducted during the Pre-Design Investigation was 1.7 sq. cm/sec. The hydraulic conductivity based on the pump test, assuming an aquifer thickness of 20 feet was 2.8E-3 cm/sec. Depths to water range from approximately 8 to 0.5 feet below the surface. Ground water flow varied from south to west prior to extraction system operation. Flow directions under pumping conditions have not been documented, but are expected to be somewhat radial to the extraction wells based on the relatively flat background hydraulic gradient. Gradients under non-pumping conditions range from 0.001 to 0.006. Ultimately, ground water discharges to the wetlands of the Davy Creek floodplain.

### **1.5.4 DESCRIPTION OF GROUND WATER PLUME**

The ground water plume was defined during the Remedial Investigation and in the Pre-Design Investigation and consisted primarily of various chlorinated organics, including trichloroethene (TCE), perchloroethene (PCE), 1,1,1 trichloroethane (1,1,1 TCA), and breakdown products of those solvents. Maximum levels of TCE at that time exceeded 10,000 ug/L along the southeast boundary of the site and southwest of the site near the wetlands. Nickel, cadmium, and cyanide were also present at significant levels at the time the RI was completed. The plume extended from the northeast side of the site southwest into the wetlands and from the Town of Ashippun Maintenance Yard west toward the residences along Elm Street northwest of Eva Street. Currently, maximum concentrations typically range between 2,000 and 3,000 ug/L total VOCs. TCE, 1,1,1 TCA, and their breakdown products predominate and the highest levels are found in the central part of the former Oconomowoc Electroplating site near EW-4 and EW-5. Following extensive excavation of site soils and impacted sediments in the wetlands in the mid-1990s, concentrations of metals in ground water have declined. Sporadic occurrences of nickel, copper, and lead above standards are noted in various wells (see section 5.2), though it should be noted that samples are not filtered.

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## 2.0 SYSTEM DESCRIPTION

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### 2.1 SYSTEM OVERVIEW

The remediation system consists of:

- 5 extraction wells
- extraction pumps
- transfer piping to the treatment facility
- 20,000 gallon equalization tank
- a cyanide removal system consisting of a two stage alkaline chlorination system
- metals precipitation consisting of a 350 gallon rapid mix tank, 1050 gallon flocculation tank, followed by an inclined plate clarifier with 288 square feet of settling area
- a pH adjustment tank
- a continuous backwash, 4 feet diameter, 12 feet high tertiary sand filter and 525 gallon storage tank
- a six tray stacked air stripper
- 2-1000 pound granular activated carbon adsorbers operated in series
- a 3000 gallon effluent storage tank
- an NPDES composite sampler monitoring station
- a 30 cubic feet center feed recessed plate filter press, and 10,000 gallon sludge holding tank, and 6000 gallon press filtrate holding tank
- discharge to an infiltration gallery in the wetland area located in the floodplain of Davy Creek

The system was designed to treat a flow rate of 35 gpm from the five extraction wells including 5 gpm from the plant processes such as filter backwash and filter press filtrate. The actual flow rate from the well field ranges from 20 to 30 gpm, and with recycle flows, generally averaging approximately 30 gpm. Iron bacteria fouling problems in the extraction well network has intermittently reduced flow to the plant. Excessive scale formation in the alkaline chlorination cyanide destruction process has also resulted in treatment downtime due to the need to clean the scale formed on the tank walls approximately every two weeks.

### 2.2 EXTRACTION SYSTEM

The extraction system includes five wells, four of which were installed during construction of the treatment plant. These four wells are 6-inch diameter and have approximately 30 feet of screen, extending from approximately seven feet below the surface to a five-foot-long sump set into bedrock. The other well was installed for a pump test conducted during the Pre-Design Investigation. This well is significantly shallower - only 15 feet deep. The wells are connected to the treatment plant by a common header of 1 to 1.5-inch pipe inside 4-inch containment pipe. Each well is supplied with a Grundfos submersible pump. The well head is completed above grade inside a hinged, locked, and insulated fiberglass housing. The connections to the extraction piping, flow-control valve, flow meter, and sample port are all contained inside the housing. Power and control lines are run in below-grade conduits parallel to the collection piping.

## 2.3 TREATMENT SYSTEM

Groundwater is extracted from a series of five wells and discharged to a 20,000-gallon equalization storage tank. This tank also functions as a sump discharge tank where the recycle stream from the treatment facility sump, as well as granular activated carbon (GAC), filter press filtrate, and sand filter backwash water. Flow is then pumped via diaphragm pumps to the first stage of the alkaline cyanide oxidation process. In the first stage of the process (CRT 201), sodium hydroxide is added to adjust the pH to approximately 9 concurrently with the addition of sodium hypochlorite. Following a retention time in CRT 201 of approximately 30 minutes at a flow rate near 30 gallons per minute, the overflow is directed to a second tank (CRT 211) with a detention time of approximately 70 minutes where additional sodium hypochlorite is added and the pH is further adjusted to approximately 10.5 using sodium hydroxide. The final step of the cyanide removal takes place in a third basin with a detention time of 35 minutes at 30 gpm, where additional sodium hydroxide is added to complete the pH adjustment to  $\geq 11$ . This allows the noncomplex cyanide to escape from the solution while providing a favorable environment to precipitate metal hydroxides from solution. Cyanide gas is removed from the covered basins via a small induced draft fan, and discharged to the atmosphere. Polymer is added to the water in a flash mix step and then allowed to slow mix for 30 minutes prior to settling in a 288 square foot inclined plate clarifier. Sludges produced are transferred to a sludge-settling tank and allowed to consolidate in the bottom of the unit prior to being pumped to a 30 cubic foot plate and frame filter press. The sludge cake was analyzed and found to be below TCLP concentrations for metals and the organics listed in Table 3-1. The State of Wisconsin considers the sludge to be a listed F006 waste (due to the historical use of the site as an electroplating facility), which requires disposal at a RCRA Subtitle C landfill. Following pH adjustment with sulfuric acid, the water is filtered through a 4-foot diameter continuous backwash sand filter, before being processed through a 6-tray low profile air stripper (AS) for volatile organics removal. The AS effluent is treated through 2 GAC units in series, each containing 1000 pounds of GAC. The effluent is then discharged via a 3-inch force main to a percolation bed located below the surface water level in the wetland area in the floodplain of Davy Creek.

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## **3.0 SYSTEM OBJECTIVES, PERFORMANCE AND CLOSURE CRITERIA**

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### **3.1 CURRENT SYSTEM OBJECTIVES AND CLOSURE CRITERIA**

The goal of the treatment system, as documented in the ROD, is to both contain and remediate the ground water to preventive action limits (PALs). The plant is required to meet discharge standards set in Wisconsin Department of Natural Resources wastewater discharge permit DOCb 44976. The treated water is discharged via a subsurface infiltration gallery. It is not clear what the bases are for the values set in the permit, since the required levels for a few parameters are lower than the PALs (e.g., cadmium, lead) If the limits are based on the potential aquatic (surface water) impacts in the wetlands, it should be noted that the levels currently observed in the ground water under the wetlands, in some cases, greatly exceed these values. The current limits for operations requires CN concentrations be reduced to less than 40 ug/L in treated water, however it was stated during the site visit that the state regulator was requiring a more stringent discharge level for CN in the plant discharge of 10 ug/L. Metals concentrations are consistently below the PALs with the exception of nickel, which generally occurs at an influent concentration of 40 ug/L, well above the 20 ug/L PAL but well below the current state enforcement standard of 100 ug/l. No points of compliance have been identified for the groundwater. There are potential users of ground water in the immediate vicinity of the plume, across Eva Street. The ultimate future receptor of the contaminated water, if not removed by pumping, is Davy Creek and the associated wetlands.

### **3.2 TREATMENT PLANT OPERATION GOALS**

The current contract for operations calls for the plant to operate 24 hours per day, seven days a week while treating water from all designated active extraction wells. Two personnel attend the facility for one shift Monday through Friday, and one individual is present during a single shift on Saturday and Sunday.

### **3.3 ACTION LEVELS**

Discharge/Clean-up standards as identified in the ROD are as shown in Table 3-1:

**Table 3-1. Action Levels**

	<b>Permit Standards (ug/L)</b>	<b>PALs (1990 ROD) (ug/L)</b>	<b>Latest PALs Effective 1-1-1999 (ug/L)</b>	<b>Enforcement Standard (1990 ROD) (ug/L)</b>	<b>Enforcement Standard 1-1-1999 (ug/L)</b>
pH	monitor				
TSS	monitor				
Arsenic	5.0	5	5	50	50
Barium	400		400		2,000
Cadmium	0.5	1	0.5	10	5
Lead	1.5	5	1.5	50	15
Mercury	0.2	0.2	0.2	2	2
Iron	monitor		150		300
Manganese	monitor	25	50	50	25
Nickel	20.0		20		100
Selenium	10		10		50
Silver	10		10		50
Thallium	0.4		0.4		10
Copper	monitor	500	130	1,000	1,300
Cyanide	40	40	40	200	200
Cyanide Free	monitor				
Chromium Total	10.0	5	10	50	100
Zinc	monitor	2500	2500	5,000	5,000
1,1-Dichloroethane	85	85	85	850	850
1,1-Dichloroethene	0.7	.024	0.7	.24	7
1,2-Dichloroethane	0.5	.05	0.5	.5	5
1,2-Dichloroethene		10		100	
1,2-Dichloroethene Cis	7		7		70
1,2-Dichloroethene Trans	20		20		100
Ethylbenzene	140		140		700
Methylene Chloride	0.5		0.5		5
Tetrachloroethene	0.5	0.1	0.5	1	5
1,1,1-Trichloroethane	40	40	40	200	200
1,1,2-Trichloroethane	0.5	0.06	0.5	0.6	5
Trichloroethene	0.5	0.18	0.5	1.8	5
Toluene	68		200		1,000
Xylenes Total	124 ug/L		1,000		10,000
Vinyl Chloride	0.2 ug/L	0.0015	0.02	0.015	0.2
Ammonia Nitrogen	monitor				
COD	monitor				
Phosphorus Total	monitor				
Nitrate + Nitrite	monitor		2,000		10,000

MW12B in December 1999 far exceeds any other value and should be verified.



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## **4.0 FINDINGS AND OBSERVATIONS FROM THE RSE SITE VISIT**

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### **4.1 FINDINGS**

In general, the RSE team found the system to be well operated and maintained. 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 and the public. These recommendations obviously have the benefit of the operational data unavailable to the original designers.

### **4.2 SUBSURFACE PERFORMANCE AND RESPONSE**

Currently, analytical and water level data are received on paper from the lab of field and the data is manually entered to tables on the computer at the treatment plant. The time necessary for this tedious effort is significant. In using the compiled analytical data, it became apparent that there may be data quality issues, transcription errors, and transposition of results in the tables. Some results may also simply be outliers. For example, September 1998 monitoring well data included results for recoverable hexavalent chromium. Several of the concentrations were extremely high (>20 ppm) although total chromium was low. In the December 1998 sampling results, the values for MW14D and MW15D may have been switched. Switching the reported concentrations back would result in levels in both wells that are more consistent with the historical levels of contaminants. Finally, the 13-ppm value for nickel in

#### **4.2.1 WATER LEVELS**

Wells included in the late 1999 monitoring round were MW02D, MW05D, MW12B, MW12D, MW13S, MW14D, MW15D, and MW-16S. Several other wells have been checked but found to be dry. In March 2000, water levels were high enough to yield measurements from MW03S, MW05S, MW06S as well as the those listed above. The water levels taken from monitoring wells have not clearly indicated a capture of the contaminant plume. In particular, there are significant questions regarding the capture of the chlorinated organic plume west of the site near MW15. In both the May 1999 and December 1999 water level measurements, there seems to be inadequate evidence of capture in this area. Water levels in MW15 are lower than in MW06, which suggests a flow component away from EW-2.

#### **4.2.2 CAPTURE ZONES**

The capture zone of a well pumping 6 gpm in a 25-foot-thick aquifer with a hydraulic conductivity of  $2.8E-3$  cm/sec (based on the pre-design pump test) and a natural gradient of 0.001-0.006 should be 1000-6000 feet wide (assuming no impacts from hydrogeologic barriers). In that case, the stagnation point would range from 160 to 950 feet downgradient of the extraction well. Calculations are attached as Appendix A. Given the great distance to the stagnation point projected for the aquifer relative to the short distance from the extraction wells to the adjoining wetlands, it is almost certain

that the extraction wells are drawing significant amounts of water from the adjacent wetlands. This, coupled with any contribution to the extraction wells from the bedrock and infiltration, would limit the capture zone width to values much less than the 1000-6000 feet per well projected by the simple analysis. To address this, an analysis was performed using an equation from Bear (1979) to determine the proportion of water contributed from an injection image well an equal (but opposite) distance from the edge of the wetland. This analysis indicated that, assuming a distance of 30 feet from well to the wetland, between 63% to 81% of the extracted water may be derived from the wetland. This would reduce the capture zone width to between 360 and 1100 feet per well. This is still large relative to the plume size.

### **4.2.3 CONTAMINANT LEVELS**

Ground water samples are currently obtained from monitoring wells MW02D, MW05D, MW06S, MW12B, MW12D, MW14D, MW15D, and MW16D. If not dry, samples are also obtained from MW03S and MW05S. Although hydropunch sampling done during the pre-design investigation indicated the limits of the plume, the plume is not well defined by the current monitoring system. The primary concern appears to be chlorinated organics in ground water. The extent of the organics plume is not clearly defined east of EW-3, MW05D, and EW-5, and is also not clearly defined west of MW15D (within a residential neighborhood where wells are used for water supply). Levels of TCE in MW15D, which is screened within the shallow aquifer, have consistently measured near 30 ug/L in this residential area. Residential wells are screened in the deeper bedrock aquifer, and detections of TCE of approximately 0.5 ug/l at these residential wells were mentioned during the site visit. Monitoring well MW05D has consistently shown levels of a number of organics, particularly TCE, above the PALs. Although concentrations in MW15D have been quite stable, there is evidence for decreasing concentrations of TCE and 1,1 dichloroethane in MW05D as shown in Figure 4-1.

Monitoring results from monitoring wells in the wetlands, including wells MW16S and MW12D, indicate that chlorinated organics (including 1,1,1 trichloroethane, 1,1 dichloroethane, 1,1 dichloroethene, trichloroethene, 1,2 dichloroethene, and vinyl chloride) exist under the wetlands at levels significantly above the PALs. The concentrations have had a modest increasing trend, as illustrated on Figure 4-2. These contaminants likely discharge to the surface water of the wetlands or Davy Creek. The levels of vinyl chloride, dichloroethene, and 1,1 dichloroethane (degradation products of TCE and/or 1,1,1 TCA) strongly suggest that the chlorinated organics are being actively degraded in this (wetland) environment. Degradation and volatilization of chloroethane and vinyl chloride may be rapid once the contaminants reach the surface water. This contamination is very unlikely to be captured by the extraction system. The extraction system is, however, limiting the amount of additional chlorinated organics reaching the wetlands. Metals do not appear to be a significant problem at the site with a few exceptions. These include elevated copper in monitoring well MW12D (>1 ppm) and levels of nickel in monitoring wells MW12D, plus MW-13S and MW16S (in the wetland). Sporadic concentrations of nickel and selenium above PALs are observed from other wells at the site, but other than the three monitoring wells cited above, there is no consistent trend or pattern to their occurrence. Iron and manganese are usually present at levels above other metals, especially in the wetland. The samples are not filtered and low-flow sampling methods are not used at the site.

## **4.3 COMPONENT PERFORMANCE**

### **4.3.1 TREATMENT SYSTEM PERFORMANCE (I.E., DOWN-TIME)**

The system does not have a contractual requirement for the plant to continuously treat water from all active extraction wells for some minimum time percentage. The system has been up and running about 85-90% of the time. Most of the downtime has been due to unscheduled maintenance events such as cleaning biofouled wells, cleaning the scale from the cyanide removal system, and excess filter backwashes caused by chemical feed problems.

### **4.3.2 WELLS**

The extraction and injection wells have generally performed acceptably, although periodic rehabilitation is necessary to maintain performance. The extraction wells have experienced fouling due to biological growth. The extraction wells are periodically (every 3-6 months) rehabilitated when total extraction flow rates drop significantly from the expected 25-30 gpm. The flows from individual extraction wells are evaluated to determine which well(s) have lost the most capacity. Extraction well 2 has recently been most plagued with fouling problems, but other wells have shown problems. Rehabilitation has consisted of pump removal and cleaning, well swabbing, and disinfection with hypochlorite. Rehabilitation is conducted by treatment plant staff. Electrical outlets have been installed at each extraction wellhead to facilitate the process. Wellhead vaults appear in excellent shape. A limited number of monitoring wells are included in the sampling and water level measurement program. In part, this is due to some monitoring wells (MW03S, MW05S, and MW06) being dry. In inspecting the monitoring wells, it was noted that several wells have protective casings that have been bent (MW05S, MW01S, MW02D). It is not clear that the well integrity has been compromised. Two wells (MW08, MW07) have evidence for frost "jacking" which has lifted the concrete pad out of the ground. Plant personnel indicated that well MW04D has a bailer stuck in the screen.

### **4.3.3 CARBON UNITS**

Carbon run times have been shorter than expected. The reasons are not clear. Since the GAC is regenerated, it may have been through numerous cycles and subsequent losses per regeneration cycle may have reduced the capacity, or unexpected non-hazardous organic compounds (TOCs) may be using up the GAC adsorption sites. Without expending significant effort, the cause is difficult to ascertain. A value engineering proposal to add a second air stripper was recently submitted to which would allow removal of the GAC component from the treatment process.

### **4.3.4 ALKALINE OXIDATION CYANIDE REMOVAL SYSTEM**

The cyanide removal system has been an ongoing source of problems for the plant operations staff since plant start up. The cyanide reaction tanks CRT 201/211 require isolation, draining and cleaning due to CaCO<sub>3</sub> scale buildup on the reaction vessel walls, floors and mixing equipment. The scaling is so severe the units have to be taken out of service approximately every two weeks for cleaning. The cleaning process involves draining the tanks, pressure cleaning the walls, floors and mixers, then doing a confined space entry to physically scrape the scale from the walls, floors and

other components in the vessels. Flow is diverted around the cyanide treatment equipment for a minimum of one full shift during the semiweekly cleaning exercise. Cyanide effluent standards have not been exceeded during these outages.

#### **4.3.5 METALS PRECIPITATION SYSTEM**

In general, the metals precipitation unit has been operating well with proper scheduled maintenance, and has experienced few upsets. The primary problems associated with its operation have been related to the chemical feed system probes fouling and low solids content in the sludge. The influent contaminant concentrations have been very low, generally below the PALs, with the exception of nickel which has consistently been 40 ug/L, or approximately twice the 20 ug/L PAL (but well below the enforcement standard of 100 ug/l). The levels identified are suspect since the samples are generally not filtered prior to analysis, and therefore may be related to sample turbidity. The sludge handling system was designed for sludge with a much greater density than is currently produced by the metals precipitation unit. Since the solids content is so low, management of the sludge blanket has proven difficult. The existing sludge pumps and control system used to transfer settled sludge from the parallel plate clarifier makes it difficult for the operators to maintain the fragile sludge blanket using the existing pumps. The operators generally manually pump the sludge for a period of time at the beginning of each occupied shift to reduce the potential for upsets. The sludge thickener tank was sized for a higher solids sludge, which results in the need for the operators to decant the liquid from above the sludge in the tank to the sump, which discharges to the influent tank EQT-100. This allows the operators to accumulate approximately 4 feet of sludge depth in the thickener over a two-week period allowing the operators to maximize the solids captured in the filter press. Prior to this operational change the thickener had sludge capacity for one-half the filter press capacity. Decanting a large volume of water through the sump and eventually back to the EQT-100 tank has resulted in a sludge build-up within it that requires periodic removal via equipment designed with the plant.

#### **4.3.6 NEUTRALIZATION**

Following the metals precipitation step, the pH is adjusted to  $\leq 9$  to neutralize the polymer previously added, reduce the potential for scaling, redissolve any residual hydroxide precipitates, and reduce the volume of acid needed for the final pH adjustment prior to discharge.

#### **4.3.7 TERTIARY FILTRATION**

The continuous backwash filters were designed to remove precipitate carryover from the metals precipitation step, which will prevent plugging of down stream units. Unfortunately, short filter cycles have plagued the tertiary filters. Sodium hydroxide crystallization in the NaOH pump suction lines has resulted in low pH levels in the metals precipitation unit. The low pH results in poor metals precipitation and consequently, poor solids removal in the sedimentation unit. The unsettled solids, as well as high concentrations of polymer added to aid in the sedimentation, carry over into the tertiary filter which causes binding within the filter, and eventually plugging. Due to the high concentration of unused polymer binding the filter media, additional high flow rate back wash cycles are needed. These backwash cycles are not normally required and generate excessive additional volumes of backwash water that must be processed through the plant. The filter backwash flow is discharged directly to the building sump that discharges to equalization tank EQT-100. During

periods of excessive backwash frequency, equalization tank EQT-100 fills to the high level and shuts down the extraction system and building sump pumps. Unfortunately the remaining equipment including treatment facility feed pumps TFP 110/111, the tertiary filters and backwash pumps continue operating and discharging to the sump, eventually causing an overflow onto the plant floor.

#### **4.3.8 AIR STRIPPERS**

The existing air stripper is functioning well with few unexpected problems. The unit is a Carbonair model STAT 80, six tray air stripper which consistently reduces volatile organic contaminant concentrations to below effluent limits, with the exception of TCE. TCE is reduced to below 2 ug/L prior to polishing in the GAC units, which consistently reduce the concentration to below the 0.5 ug/L effluent standard. The strippers were designed to reduce TCE levels from approximately 1300 ug/L to  $\leq 2.0$  ug/L while operating at a flow rate of 35 gpm, and an air to water ratio of 75:1. Currently the TCE concentration into the unit is approximately 600 ug/L. The only unscheduled maintenance is the need to inspect, and remove scale and precipitates from the trays every six months which takes approximately 8 total hours of labor. Sulfuric acid is being fed upstream from the stripper to reduce the pH <8, which prevents precipitation in the piping, stripper and GAC. Scaling or fouling within the stripper has not been a problem.

#### **4.3.9 PIPING**

Piping within the plant subjected to acidic pH water was recently replaced with polyvinyl chloride piping. The iron process water piping failed because the acidic pH leached the iron out of the piping. No further problems within the plant have been experienced since the pipe replacement. The well discharge collection piping has experienced numerous plugging problems caused by iron bacteria accumulation within the lines. The lines are systematically cleaned when head loss in them exceeds a predetermined value. The cleaning method consists primarily of high velocity flushing.

#### **4.3.10 CHEMICAL FEED SYSTEMS**

The chemical feed systems for the most part are operating properly with occasional unscheduled maintenance required to maintain optimum operation. There are four primary chemical feed systems in use at the Oconomowoc plant; acid, caustic, sodium hypochlorite, and polymer feed. Occasionally the 20 percent sodium hydroxide solution forms crystals in the NaOH pump suction lines and strainers. When this occurs, inadequate caustic is fed to the CN removal, and metals removal processes. The metals precipitation unit does not form a hydroxide floc, and consequently when polymer is added, no interparticle binding occurs. The excess polymer is discharged to the tertiary filters where the polymer attaches to the sand media, which binds together, resulting in the formation of "mud balls", that eventually plug the filter. Generally when sand filters are subjected to high polymer dosages, the media must be replaced. Following some improvements to the polymer feed system and polymer dilution system by the operating contractor, the system has worked well.

#### **4.3.11 SLUDGE HANDLING AND TREATMENT**

The sludge handling systems primary purpose is to dewater the sludge generated by the metals precipitation system. The metals precipitation process is discussed in paragraph 4.3.5. The primary components in the system are the 30 cubic foot plate and frame filter press, a 10,000 gallon sludge

holding tank (ST-820), a 6,000 gallon press filtrate holding tank (PFT-820). The concentration of solids in the sludge is lower than expected which requires the staff to periodically decant a portion of the supernatant from above the sludge accumulation. After the sludge depth reaches approximately four feet, an adequate volume of sludge is available for one filter pressing cycle. Enough sludge is generated from the metals precipitation process to facilitate a press cycle once every other week. The cake is dropped into a roll off dumpster located below the press. Cake is accumulated on site for 90 days, which is in accordance with RCRA regulations, prior to disposal at a Subtitle C approved facility in Illinois for \$350 per ton. The disposal of this material as a listed waste is based on the previous electroplating activities at the site, and not because of any constituent levels in the material.

#### **4.4 COMPONENTS OR PROCESSES THAT ACCOUNT FOR MAJORITY OF COSTS**

##### **4.4.1 UTILITIES**

Heat and Electricity costs for the USACE contract period 1 November 1998 to 30 October 1999 were \$5,000 and \$13,000 respectively, or \$18,000 annually.

##### **4.4.2 NON-UTILITY CONSUMABLES AND DISPOSAL COSTS**

Based on the contract period 1 November 1998 to 30 October 1999 are as follows:

<i>Chemicals</i>		
Polymer	\$ 1,700	
Sulfuric Acid	\$19,000	
Sodium Hydroxide	\$13,000	
Sodium Hypochlorite	<u>\$ 3,500</u>	
<i>Subtotal Chemical Costs</i>		<u>\$37,200</u>
<i>Granular Activated Carbon</i>		<u>\$13,000</u>
<i>Sludge Disposal</i>		<u>\$25,650</u>
<b><u>Total Annual Cost Non-Utility Consumables</u></b>		<b><u>\$75,850</u></b>

##### **4.4.3 LABOR**

The staff consists of a plant superintendent and one operator. Annual operation costs are approximately \$280,000 including overtime.

##### **4.4.4 CHEMICAL ANALYSIS**

Sampling of approximately 10 monitoring wells occurs quarterly. Treatment plant influent/effluent concentrations are determined weekly. Analysis for VOC's is by methods 8260. Arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, silver, thallium, and zinc are by SW-846

methods. Cyanide is analyzed by method 624. Estimated annual cost for these analyses is \$70,000. The existing staff conducts sampling.

#### **4.4.5 OTHER COSTS**

Total annual O&M costs now exceed \$471,000. Other items beyond those listed above such as office supplies, safety equipment, and quick turn around sampling are approximately \$28,000.

### **4.5 RECURRING PROBLEMS OR ISSUES**

#### **4.5.1 CYANIDE SYSTEM CLEANING**

The cyanide reaction tanks CRT 201/211 require isolation, draining and cleaning due to CaCO<sub>3</sub> scale buildup on the reaction vessel walls, floors and mixing equipment. The scaling is so severe the units have to be taken out of service approximately every two weeks for cleaning. The cleaning process involves draining the tanks, pressure cleaning the walls, floors and mixers, then doing a confined space entry, to physically scrape the scale from the walls, floors and other components in the vessels. Flow is diverted around the cyanide treatment equipment for a minimum of one full shift during the semiweekly cleaning exercise.

#### **4.5.2 SUMP OVERFLOW**

Short filter runs have plagued the tertiary filters. Sodium hydroxide crystallization in the NaOH pump suction lines has resulted in low pH levels in the metals precipitation unit. The low pH results in poor metals precipitation and consequently, poor solids removal in the sedimentation unit. The unsettled solids, as well as high concentrations of polymer added to aid in the sedimentation, carry over into the tertiary filter causing very short filter runs. Due to the high loading on the filter, excessive volumes of backwash water are generated which must be processed through the plant. The filter backwash flow is discharged directly to the building sump that discharges to the head of the plant, equalization tank EQT-100. Equalization tank 100 then fills up and shuts down the extraction system and building sump pumps, but not the treatment facility feed pumps TFP 110/111 which causes the plant to continue operating and the sump to continue to fill, and eventually flood the plant.

### **4.6 REGULATORY COMPLIANCE**

There are no known exceedances of regulatory criteria for treatment and disposal. All sludge is transported to a RCRA facility. Many of the analytical parameters measured in the influent, however, are below the treatment standards.

#### **4.7 TREATMENT PROCESS EXCURSIONS AND UPSETS, ACCIDENTAL CONTAMINANT/REAGENT RELEASES**

Based on information made available to the team, there have been a few controlled releases of contaminated water within the facility during operation of the plant. On several occasions, the sump pumps shut down after overfilling the equalization tank (EQT 100). When power to the sump pumps is interrupted the pumps from EQT 100 continue to operate, as do the filter backwash pumps, the latter of which discharge to the sump resulting in plant flooding.

#### **4.8 SAFETY RECORD**

The plant appears to have had an excellent safety record.



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

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### **5.1 GROUND WATER**

The concentrations of TCE in MW15D (typically on the order of 30 ug/l) suggest that a portion of the plume is present in the shallow aquifer below the nearby residences. Furthermore, there is not convincing evidence to suggest that the groundwater plume in the vicinity of MW15D is delineated, nor is there convincing evidence that this area of contamination is captured by the extraction system. The domestic wells in the area produce water from the deeper bedrock aquifer and, to the extent allowed by the residents, the wells are sampled.

### **5.2 SURFACE WATER**

There may be current ecological exposure to ground water or surface water contaminated with metals and chlorinated organics in the wetlands southwest of the site. The chlorinated organic concentrations are unlikely to be significant in the aquatic environment and do not exceed freshwater screening levels. Note that constructed wetlands similar to the natural wetlands adjacent to the site are used to treat water contaminated with organics. Also, it does not appear that the intent of the current system was to remediate the VOC's within the wetlands southwest of the site. With respect to metals, levels of copper in ground water from MW12D do significantly exceed freshwater criteria (screening levels are typically lower than 10 ug/L and Ambient Water Quality Standard is 11) and exceed the PAL (130 ug/L) and Enforcement Standard (1300 ug/L) for ground water. It is possible that the copper will be removed with the formation of iron hydroxides or by complexing with humic acids. Also note that these elevated copper concentrations are generally restricted to one monitoring well located within the wetlands, and these concentrations in groundwater would be subject to significant dilution within the wetlands.

### **5.3 AIR**

Although there is no treatment of the off gas from the air stripper and process tanks, this discharge to the atmosphere is very small. At 30 gal/min and 900 ug/L VOC's, atmospheric loading is only 0.15 kg/day. It seems unlikely that the air discharge poses a risk to the nearby population.

### **5.4 SOILS**

It appears the sources identified in the ROD that have been removed under the previous operable units have effectively removed the source of the contamination. The concentrations of metals and cyanide in the aquifer appear to be under control. Concentrations of metals in the plant influent are under the preventative action limits (PALs) with the exception of nickel, and occasionally total chromium.

## **5.5 WETLANDS**

Contaminated sediments in the wetlands were previously excavated and the wetlands were subsequently restored. Healthy vegetation and clear surface water was observed at the time of the site visit. It appears that generally the action was successful.

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## **6.0 RECOMMENDATIONS**

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### **6.1 RECOMMENDED STUDIES TO ENSURE EFFECTIVENESS**

#### **6.1.1 CAPTURE ZONE ANALYSIS**

A formal capture zone analysis should be performed on the basis of measured water levels, plus additional hydrogeologic analysis (i.e., analytical tools and/or a simple groundwater flow model). The goal is to better understand the capture zone dynamics at the site and evaluate the adequacy of the current capture zone. This should include an assessment of the contribution of water from the wetlands and the subsequent impact on the capture zone.

It is recommended that this analysis also include simple response (pump) tests for a couple of representative extraction wells, including EW-2, EW-4 and/or EW-5. These wells are constructed differently than the pump test well (EW-4) and are screened over a longer interval. The tests should be conducted following a system shutdown (done for other reasons such as maintenance) and the recovery of ground water levels to a "static" condition. The test should just consist of the restarting of the pump and the simultaneous monitoring of the draw down response, on a logarithmically increasing interval, in nearby monitoring wells over the course of 1-3 days. For EW-2, suggest that MW06, MW03, and MW02S be monitored. For EW-3, suggest that MW05 and MW05D be monitored and for EW-5 suggest that MW09S be monitored. Based on the draw down response, the transmissivity and storage coefficient should be computed for the location. Any indication of a boundary effect (i.e. the wetlands) should also be identified. These results can be used to predict the aquifer response and capture zone for each well compared to the existing plume.

These tests could be done with existing treatment plant personnel at a cost of approximately \$800 per well (8 hrs \* \$45/hour \* 2 persons + \$80/day rental of recorder/transducers). Data analysis for would need to be done by a hydrogeologist or engineer at an estimated cost of approximately \$2,000 (32 hours \* \$60/hour). Total cost of the pump tests would therefore be approximately \$5,000. Costs of the additional hydrogeologic analysis (i.e., analytical solutions, simple groundwater modeling) to evaluate system-wide capture zones would cost approximately \$10,000 additional.

The additional information on the site hydraulic conductivities provided by the simple pumping tests will be invaluable in determining, by whatever means, what flow rates are necessary to capture the contaminants most efficiently. The costs for the pump tests are extremely small compared to annual costs for operations. A numerical ground water model could be used very effectively to determine the optimal pumping configuration and to perform "what-if" analyses, especially if one were to consider alternatives such as a permeable reaction wall or sheet pile.

#### **6.1.2 PLUME DELINEATION WEST OF EVA STREET**

As noted above, the concentrations of TCE in MW15D suggest that a portion of the plume is present below the nearby residences, and there is no evidence that this is captured by the extraction system. Additional delineation of groundwater contamination should be performed in this area through the

installation of a few new monitoring wells at an estimated cost of \$1,800/well. In addition, groundwater sampling history from domestic wells should be compiled and evaluated. A more formal sampling schedule for domestic wells in that area should be considered.

### **6.1.3 SURFACE WATER SAMPLING FOR COPPER NEAR MW-12D**

Based on the observed high concentrations of copper in well MW12D, recommend that surface water samples be collected near MW12D, if filtered samples suggest the copper to be dissolved, to determine if copper concentrations in ground water may cause elevated levels in surface water. Costs for conducting the surface water sampling and analysis would be less than \$300.

## **6.2 RECOMMENDED CHANGES TO REDUCE COSTS**

### **6.2.1 RE-EVALUATION OF CLEANUP CRITERIA**

The RSE team recommends that the project staff document the discharge standards for the on site treatment facility. An exit strategy needs to be established for each site treatment process.

### **6.2.2 ELIMINATION OF THE CYANIDE REMOVAL SYSTEM**

The cyanide removal system can be removed with no impact to the environment or the remainder of the remediation system. The existing alkaline oxidation cyanide removal system designed to remove cyanide in the ionic (CN) or hydrogen cyanide (HCN) form, designated as free cyanide. Based on data collected during January 2000, and conversations with the operators, the total cyanide concentration in the influent is generally below the discharge standard of 10 ug/L (the published ROD effluent concentration was 500 ug/L, and the current PAL is 40 ug/L). Free cyanide was not detected in the influent. The continued absence of free cyanide in the influent suggest that the cyanide is present as a ferro or ferric cyanide form which is insoluble in water, very stable, and not susceptible to oxidation. This insoluble fraction is most likely being removed in the sand media filter system, or potentially in the metals removal system. The cyanide removal efficiency in the filter system should be evaluated at the site through the development of a strategic performance sampling plan to prove to the state regulators the cyanide is not being discharged. Cost of additional cyanide sampling would be approximately \$2,000. Projected net annual chemical cost savings for deletion of the cyanide oxidation system is \$30,000, (\$32,000 gross savings less \$2000 in additional sampling costs). Potential hazards afforded by the confined space entry into the equipment, and doing strenuous work for prolonged periods in a confined space used as a reaction vessel for a chlorine compound poses a greater safety hazard than the HTW cleanup, and offer further reason to remove this treatment process.

### **6.2.3 ELIMINATION OF THE METALS PRECIPITATION SYSTEM**

The chemical precipitation metals removal system is an expensive part of the overall system, provides very little environmental benefit, and can probably be entirely removed in its present form with little or no impact to the environment. The only metal consistently present in the influent above the current PAL is nickel, which is usually present between 30 and 40 ug/L, compared to the PAL limit of 20ug/L and an enforcement level of 100 ug/l. The 1990 ROD did not identify a clean up level for nickel or identify it as a contaminant of concern. During January 2000, trivalent

chromium was present in one influent sample at 20 ug/L, compared to the PAL of 10ug/L, and an enforcement standard of 100ug/L. The one excursion above the PAL was quite likely related to sample turbidity. Iron is present in nuisance levels of 1.0 to 2.5 mg/L as is manganese, which is present at approximately 0.2 mg/L. Iron and manganese at these levels tend to result in precipitates forming that may foul treatment processes such as air strippers, sand filters and carbon adsorption systems such that they require more frequent maintenance. Discussions with equipment vendors indicate their equipment should be able to function properly with iron and manganese at these levels. The existing system efficiently removes metals identified as COC's, down to the standards required by the ROD, as well as nuisance chemicals such as iron and manganese to manageable levels, but also removes a portion of the volatile organics in the liquid stream. Current estimated VOC removal is 50%, based on verbal communications from the site operators. Disadvantages of the sludge removal system include large quantities of chemicals must be purchased, fed, reacted with unwanted inorganics, and handled safely and effectively prior to dewatering and disposal. These tasks prove to be expensive and are the most hazardous activities at the treatment facility. The cost savings allocated to this process includes only the cost of disposal. Based on 1 November 1998 to 30 October 1999 data, eliminating the current precipitation system could save approximately \$25,000 in sludge disposal costs annually. In order to maximize the use of existing plant equipment, and continue to derive benefits from its use while reducing the volatile loading and fouling potential of downstream units, other treatment options should be evaluated. These include:

- a) Using the tanks and mixers as is without chemical addition, hoping the agitation within the unit will allow for significant volatilization to reduce VOC concentrations, and sufficiently oxidize the iron and manganese to below nuisance levels. Cost for this option is essentially zero.
- b) Incorporate option a, and in addition replace the existing mixers with a diffused aeration system within existing CRT 201 and 211. Cost of this option is approximately \$15,000.
- c) Enhance iron and manganese oxidation through the use of  $\text{KMnO}_4$ . Capital cost for this modification would be approximately \$3,750. Costs include a new chemical feed pump,  $\text{KMnO}_4$  storage, application point and mixer. Annual cost for a supply of 6 percent  $\text{KMnO}_4$  would be approximately \$15,000.
- d) Bypass the equipment. Minor piping modifications should cost about \$1000. This option would rely on air stripping and/or carbon to remove the VOC's to acceptable levels and the tertiary filter remove complexed cyanide, nickel and trivalent chromium that might be related to the influent turbidity.

#### **6.2.4 DELISTING METALS PRECIPITATION SLUDGE**

A petition meeting the formal de-listing procedure under 40 CFR 260.20 and 40 CFR 260.22 must be filed to delist the sludge. The petitioner must prove the waste contains no constituents for which the waste was initially listed by EPA, and the waste does not exhibit a characteristic under 40 CFR 261 Subpart C. The petition may be considered an administrative requirement or a substantive requirement. However, since the waste is ultimately going to be managed off-site, it is suspected that all administrative requirements would need to be met. A minimum of four rounds of existing or future analytical data for the sludge will be required. The process is outlined in detail within the above referenced regulations. The Regional Administrator has final authorization to approve a petition to delist the sludge. A de-listed sludge could be managed off-site in a subtitle D landfill at a

cost of \$50 per ton versus the present cost of \$350/ton at a RCRA subtitle C landfill. Potential disposal cost savings afforded by delisting the sludge is approximately \$17,000 annually, assuming the cyanide and/or metals removal systems remain operational.

## **6.3 MODIFICATIONS INTENDED FOR TECHNICAL IMPROVEMENT**

### **6.3.1 CHANGES TO MONITORING PROGRAM AND DATA EVALUATION PROTOCOLS**

It was not apparent that the responsibility for evaluating the subsurface performance of the system is clearly assigned. Recommend that the project team use the EPA data quality objective process or the USACE Technical Project Planning process (refer to USACE Engineer Manual EM 200-1-2, available at <http://www.usace.army.mil/inet/usace-docs/eng-manuals/em200-1-2/toc.htm>) to refine the strategy for monitoring performance at this site. Suggest that specific criteria for subsurface performance be developed and a monitoring program to verify attainment of these criteria also be assembled. The USACE HTRW CX can advise on this process.

### **6.3.2 VERIFICATION OF WELL ELEVATIONS AND DEPTHS**

Recommend also that sampling personnel sound the bottom of the wells to verify the depths of the wells so that the wells' labels reflect the correct construction. For those wells that have shown signs of frost jacking of the concrete pad, recommend that the top of casing in these wells be resurveyed, and the wells be checked for internal damage by downhole camera if the surveys show impact to the well casing itself. The costs for this would be less than \$1,000.

### **6.3.3 ADDITIONAL MONITORING POINTS**

Measurement of the water levels should be conducted in all available monitoring wells at the site, including MW07, MW07, MW01S and D, MW09S, MW02S and D, MW04S and D (if the bailer stuck in the well can be retrieved), and if possible, the fire well at the corner of Oak and Elm Streets. Additional water level monitoring points would be useful, especially east of EW-3 and EW-5 and in the central part of the site. The additional labor hours required for this activity would be minimal. If some of the monitoring wells are typically dry, it may be useful to install slightly deeper replacement wells. Estimated cost per shallow well is approximately \$1,800. Therefore, 5 new wells for purposes of water level measurements could be installed for approximately \$9,000. Furthermore, water level measurements (in feet above MSL) should be plotted for the shallow aquifer, at least quarterly for one year, to evaluate the capture zone of the system under pumping conditions. This should be compared to the potentiometric surface for pre-pumping conditions, which should also be prepared. These analyses can be performed by a hydrogeologist or engineer for approximately \$3,000.

### **6.3.4 LOW-FLOW SAMPLING**

Recommend that samples be obtained by low-flow sampling methods in accordance with EPA/540/S-95/504, April 1996, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures (available on the web in Adobe format at <http://www.epa.gov/ada/issue.html>). If this is not feasible, recommend that both filtered and unfiltered samples be obtained for one or two sampling rounds to better identify the component of the total metals concentrations derived from leaching of metals in suspended solids. This would double the costs for metals analysis for those rounds.

### **6.3.5 ELECTRONIC DATA MANAGEMENT**

Recommend that analytical data for both process and subsurface monitoring be managed electronically through the use of a database, or better, a geographic information system. The current operator is proposing the development of such a system and we support the effort. The electronic transfer of analytical results from the lab to the database should be investigated.

### **6.3.6 EXPANSION OF WELL SAMPLING PROGRAM**

Recommend that additional sampling for one or two rounds be conducted from other wells at the site to expand the horizontal and vertical definition of the plume, including the upgradient side of the extraction system. The additional sampling should include wells MW02S, MW03D, MW09S, MW04S or MW04D, and MW01S or MW01D. This would increase sampling costs by an estimated \$2,500 per round, including labor and analyses.

### **6.3.7 MEDIA REPLACEMENT FOR TERTIARY FILTER**

The tertiary filter media is likely partially fouled due to excess polymer fed to the unit during caustic feed malfunctions to the cyanide and metals removal treatment equipment. Cost for this modification is approximately \$3,250.

### **6.3.8 CONTROL MODIFICATIONS**

Remote System Monitoring. Because of the frequent alarms the RSE team recommends a remote monitoring system tied to the existing in plant computer monitoring system to be installed. This improvement will allow on-call staff to evaluate the severity of the alarms prior to mobilizing to the site for corrective action. Cost for this change should be approximately \$3000, but will depend upon the computer purchased, and the cost of the software (modem communications, and process monitoring software).

Shut Down Control Modifications. The treatment feed pumps (TFP 110/111) should be deactivated either when the equalization tank (EQT-100) level or the sump level within the plant reaches the high level. This will eliminate the current problem of overflowing the sump during frequent filter backwashing caused by high headloss in the filters. Other equipment such as polymer and chemical feed pumps should be evaluated to determine if it would be beneficial to switch them off if a high-high level alarm activation event occurs. Cost of this modification should be approximately \$2,000.

### **6.3.9 CONDUIT RELOCATION**

Control conduits located in front of the granular activated carbon adsorbers should be removed and relocated overhead and the control boxes relocated so the skid mounted units can be removed as designed. This will give the contractor the option to store additional 1000 pound GAC units on site for change out, or simply allow the delivery and replacement as necessary when breakthrough occurs, whichever is the lowest cost. This is much simpler than the present labor intensive removal and replacement process the operators currently use to manually remove and replace the GAC from a spent column, and place it in drums to send off site for regeneration. Cost of the conduit relocation will be approximately \$2000. The cost of using portable exchangeable granular activated carbon units is approximately equal to the cost of the existing system, assuming only a single carbon column is changed out. Presently both columns are changed out each time a carbon delivery is made. This

practice results in some savings due primarily due to labor savings and the need to replace the carbon contactors after approximately 5 years of service.

### **6.3.10 PIPING MAINTENANCE**

Piping between the wells and treatment plant should be cleaned periodically based upon past history.

### **6.3.11 WELL MAINTENANCE**

Recommend that the maintenance program for the wells be developed that includes a preventative maintenance approach. Refer to USACE Engineer Pamphlet 1110-1-27 (Jan 2000). A copy can be accessed at <http://www.usace.army.mil/inet/usace-docs/eng-pamphlets/ep1110-1-27/toc.htm>. Suggest that the use of the blended heat and chemical treatment (BHCT) process be considered for well rehabilitation. Draft guidance on well rehabilitation is in preparation at the USACE HTRW CX and a copy of the current draft of the guidance will be provided as soon as a draft-final version is available.

### **6.3.12 INDEPENDENT REVIEW OF ANALYTICAL DATA**

The chemical data from site and process monitoring should be subject to independent review for usability and compliance with contract requirements. The USACE can arrange for this support. Typical costs for such a review would be \$1500.

### **6.3.13 TREATMENT PROCESS OPTIMIZATION**

The RPM should consider procuring the services of an independent contractor to look at optimizing the treatment system, particularly the metals removal system, and explore potential technology alternatives based upon the clearly defined discharge standards and compared to Table 3-1.

### **6.3.14 WASTE SLUDGE STORAGE OPTIONS**

Evaluate the substantive RCRA Part B permit requirements for storage of hazardous waste in excess of the 90 day criteria for a large quantity hazardous waste generator (LQG). An analysis should be conducted to determine if the facility does in fact meet the definition of a large quantity generator ( $\geq 1000$  kg/month) vs. small quantity generator ( $\geq 100$  kg/month,  $< 1000$  kg/month). Small quantity generators can store up to 180 days (270 in certain situations). If the facility is a LQG, it may be practical to meet additional substantive requirements to store the listed waste sludge on-site for up to one (1) year. If substantive requirements can be met, then sludge can be aggregated over the course of a year and consolidated transportation and disposal can be conducted on an annual basis, thereby reducing the transportation related costs associated with quarterly shipments as a large quantity generator. A review of the requirements under 40 CFR 264 should be evaluated to determine if any requirements necessary under the standard are not being met by the facility. A cost analysis should be conducted to determine any shortcomings to the 264 standards and what "cost of compliance" will be. Modification of existing plans and any potential additional construction (i.e. secondary containment for containers etc.) should be evaluated to determine if long-term storage is a cost



effective option. It is anticipated the vast majority of requirements for “permitted storage” are already being met. A cost for this task has not been formulated.

## **6.4 MODIFICATIONS INTENDED TO GAIN SITE CLOSE-OUT**

### **6.4.1 ESTABLISH CLOSURE CRITERIA**

The Oconomowoc treatment facility RPM and the State of Wisconsin must clearly define the closure criteria. The RPM and State of Wisconsin must also evaluate and clearly document if the treatment facility discharge standards are surface water or groundwater based.

### **6.4.2 ADDITIONAL SOURCE AREA IDENTIFICATION/REMOVAL**

It is not clear that the soil removal previously completed at the site fully addressed the sources of the VOC's. Recommend that the extent of the VOC's in the vadose zone be evaluated, through a careful analysis of data generated during the soil removal, the remedial investigation, and pre-design investigation. If there are areas of known VOC concentrations in soil outside of the soil removal areas, recommend that soil gas sampling be conducted in those areas to confirm current presence. A soil gas survey of areas not previously tested, but which appear to be consistent with the extent of high levels of VOC's in ground water, would also be warranted. Based on these results, a decision should be made as to the need for VOC source removal. Soil vapor extraction (SVE) would be the most likely applicable technology. The shallow depths to water may require extraction trenches or a surface cover (i.e. sealed asphalt cover directly on the soil). A soil gas survey could be conducted at the site for approximately \$5,000.

## **6.5 OUTSTANDING VALUE ENGINEERING PROPOSAL FOR ADDING A SECOND AIR STRIPPER**

The operations contractor has proposed removing the GAC units at the plant and installing a second 2 tray low profile air stripper similar to the 6 tray stripper currently at the facility. The existing 6 tray unit currently removes VOC's to below detection limits with the exception of TCE. The initial concentration into the stripper is approximately 600 ug/L, and the effluent is approximately 2 ug/L. The second stripper would reduce the TCE concentration to approximately 0.1 ug/L if installed, and would reduce the dependence of the plant on the GAC for final polishing. The RSE team feels it is too early to endorse this proposal until the other options, primarily the metals removal options are fully evaluated.

## **6.6 CHANGES IN CURRENT APPROACH TO SITE REMEDIATION REQUIRING REDESIGN**

### **6.6.1 PERMEABLE REACTION WALL**

The current use of pump and treat technology could be replaced by the use of a permeable reaction (iron filings) wall installed along Elm Street. Given the low natural ground water flow rate, the shallow depth to water and bedrock, and the predominance of chlorinated organics as the contaminants currently of concern at this site, a PRW would be feasible at this site. Assuming a 24-inch-thick wall with a length of 500 feet and a 25-foot depth, an estimated cost would be approximately \$1,500,000. Based on a \$470,000/year O&M cost for the current system, less \$50,000/year for monitoring, which would still be required, a payback time (based on avoided costs

of operating the treatment plant) of less than 4 years is indicated.

### **6.6.2 ADDITIONAL VOLATILE ORGANIC SOURCE REMOVAL**

It is not clear that the soil removal previously completed at the site fully addressed the sources of the VOC's. A soil gas survey of areas not previously tested, but which appear to be consistent with the extent of high levels of VOC's in ground water, would be warranted. Based on these results, a decision should be made as to the need for VOC source removal. Soil vapor extraction (SVE) would be the most likely applicable technology. The shallow depths to water may require extraction trenches or a surface cover (i.e. sealed asphalt cover directly on the soil). An SVE system to remediate a one-half acre area adjacent to the southwest corner of the water treatment facility would cost approximately \$62,000 to install and have annual operating expenses of \$6,000. Anticipated treatment time would be approximately 2 years.

### **6.6.3 INSTALLATION OF A SUBSURFACE BARRIER**

A sheet pile or slurry wall could be installed to prevent capturing water from wetlands and processed by the pump-and-treat system. This could potentially cut total pumping rate by 50% or more. This may be cost effective if the metals precipitation and cyanide systems could be eliminated. The remaining volatile organics could most likely treated by GAC or air stripping alone. No costs have been developed for this option due to its dependence upon implementation of other recommendations.

## 7.0 SUMMARY

In general, the RSE team found the system to be well operated and maintained. The system cost effectiveness is subject to some questions. It appears contaminants are continuing to travel towards the wetlands adjacent to the site and may continue to migrate in the shallow glacial till aquifer into a nearby residential neighborhood served by individual (deep) domestic wells only limited reductions of contaminant concentrations in ground water have been observed. A number of changes in the remedial approach or the operations of the system are suggested to possibly reduce future operations and maintenance costs and are summarized in the following Cost Summary Table (Table 7-1).

The RSE team recognizes the difficulties in implementing changes to the permit under which the system operates and the costs for obtaining regulatory acceptance. If the changes to the treatment process and monitoring program could be proposed as a package to the State of Wisconsin, then some time and cost efficiencies could be realized.

**Table 7-1. Cost Summary Table**

Recommendation	Reason	Additional Capital Costs (\$)	Estimated Change in Annual Costs (\$/yr)	Estimated Change In Lifecycle Costs (\$) *
Capture Zone Analysis	Effectiveness	\$5,000	\$0	\$5,000
Groundwater Modeling	Effectiveness	\$10,000	\$0	\$10,000
Plume delineation west of Eva Street (New Well)	Effectiveness	\$20,000	\$1,000	\$40,000
Surface water sampling for copper near MW-12D	Effectiveness	\$300	\$0	\$300
Eliminate cyanide treatment	Cost reduction		(\$30,000)	(\$600,000)
Eliminate metals precipitation <sup>1</sup>	Cost reduction		(\$25,000)	(\$500,000)
Alternate Metals Removal Technologies for Fe, Ni & Mn (select one)	Cost reduction			
a. no chemical addition		\$ 0	\$ 0	\$ 0
b. Aeration		\$15,000	\$ 0	\$ 15,000
c. KMnO <sub>4</sub>		\$ 3,750	\$15,000	\$303,750
d. Bypass tankage		\$ 1,000	\$ 0	\$ 1,000
Alternate Sludge Disposal (Use Subtitle D Landfill) <sup>2</sup>	Cost reduction	\$0	(\$17,000)	(\$340,000)

**Table 7-1. Cost Summary Table (cont.)**

<b>Recommendation</b>	<b>Reason</b>	<b>Additional Capital Costs (\$)</b>	<b>Estimated Change in Annual Costs (\$/yr)</b>	<b>Estimated Change In Lifecycle Costs (\$) *</b>
Reduce Staffing <sup>4</sup> to three visits per week (42% reduction)	Cost reduction	\$3,000	(\$117,000)	(\$2,337,000)
Sound Bottom of Wells	Technical Improvement	\$1,000	\$ 0	\$1,000
Additional Water Level Monitoring Points	Technical Improvement	\$12,000	\$ 0	\$12,000
Expand Well Sampling Program	Technical Improvement	\$2,500	\$ 2,500	\$52,500
Replace Tertiary Filter Media	Technical Improvement	\$ 3,250	\$ 0	\$ 3,250
Control Modifications a. Emergency Stop b. Remote Monitoring	Effectiveness Cost reduction	\$ 2,000 \$ 3,000	\$ 0 \$ 0	\$ 2,000 \$ 3,000
Revise Carbon System a. conduit relocation b. change containers with GAC	Technical Improvement Cost reduction	\$ 2,000 \$ 0	\$ 0 \$ 0	\$ 2,000 \$ 0
Analytical Data Review	Technical Improvement	\$ 1,500	\$ 1,500	\$ 31,500
Soil Gas Survey	Site Close-out	\$5,000	\$ 0	\$ 5,000
Permeable Reaction Wall	Site Close-out	\$1,500,000	(\$420,000)	(\$6,900,000)
SVE System <sup>3</sup>	Site Close-out	\$62,000	\$6,000 <sup>3</sup>	\$74,000
Re-evaluate cleanup criteria	Site Close-out	\$5,000	\$ 0	\$ 5,000

\*estimated change in life-cycle costs assumes 20 years, no discount rate. Costs in parenthesis imply a cost reduction.

<sup>1</sup> Assumed savings is for sludge disposal

<sup>2</sup> Assumed savings is for use of an alternate sludge disposal site and the metals precipitation unit is still being used

<sup>3</sup>SVE costs based upon RACER cost estimating program, assume 2 years of operation

<sup>4</sup>Two staff personnel will visit the facility for 8 hours approximately three times per week. The existing cyanide and metals removal systems are no longer required. \$3000 reflects the cost for a computer and software for remote monitoring when the site is not occupied.

## **Figures**



Figure 1-2. Site layout (current).

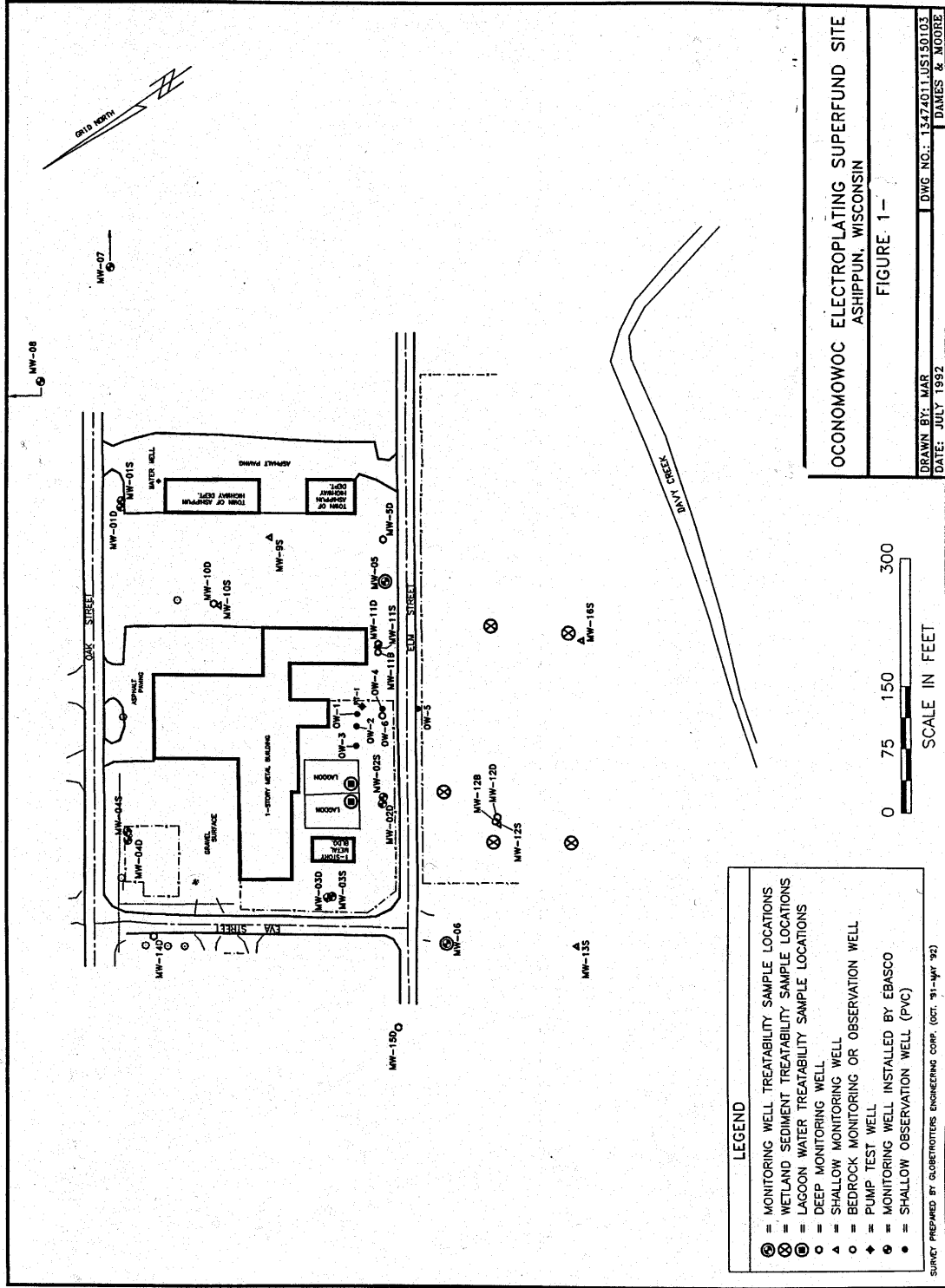


Figure 4-1. Observed concentrations, MW-05D

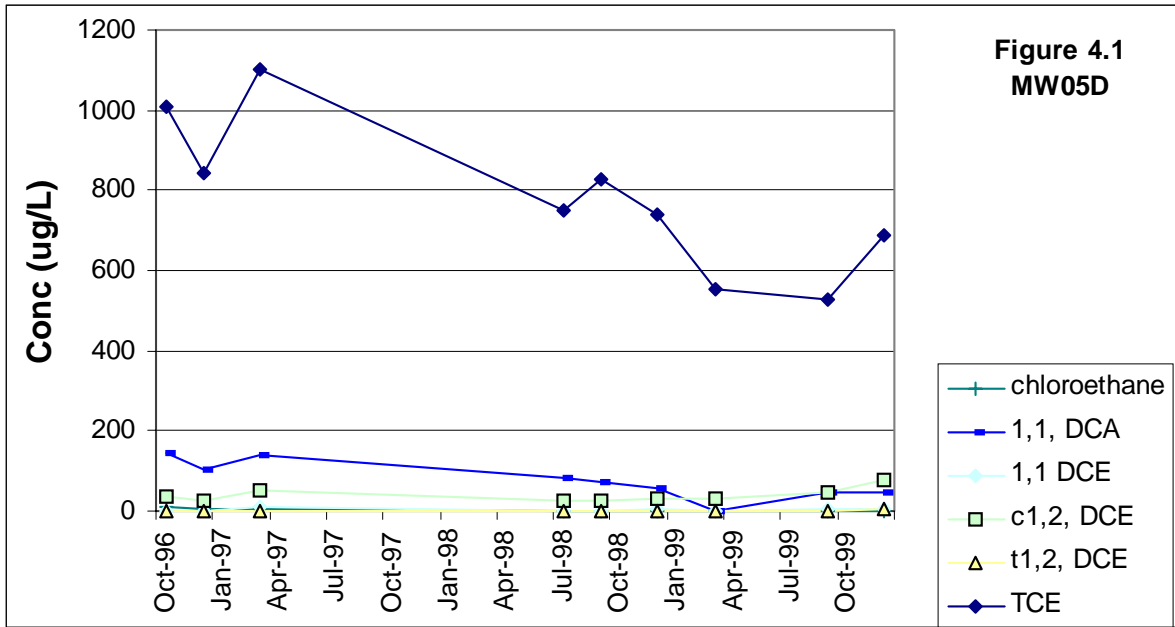
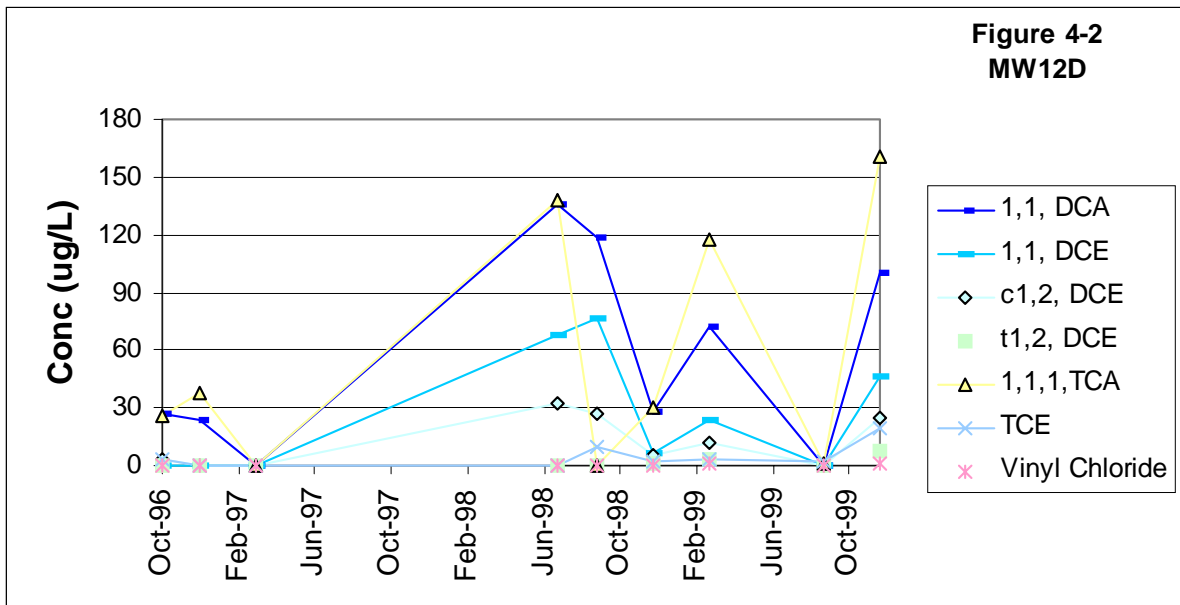


Figure 4-2. Observed concentrations, MW-12D.







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