CONESTOGA-ROVERS
& ASSOCIATES

1801 Old Highway 8 Northwest, Suite 114
St. Paul, Minnesota 55112
Telephone: (651) 639-0913 Fax: (651) 639-0923
www.CRAworld.com

April 5, 2012 Reference No. 074702

Mark Thimke, Esquire
Foley & Lardner LLP
777 West Wisconsin Avenue
Milwaukee, WI 53202-5306

Dear Mr. Thimke:

Re: Expert Opinion on Groundwater Quality
Holtz Krause Landfill
Wausau, Wisconsin

This letter provides an expert opinion on whether volatile organic compounds (VOC) in groundwater would remain stable if the current 35 -vent active system was converted to a 69 -vent passive system.

CONCLUSION

Should the Holtz Krause landfill gas management system be converted from a 35 -vent active system to a 69 -vent passive system, VOCs in groundwater will remain stable.

BACKGROUND

The Holtz Krause Potential Responsible Party (PRP) Group applied for closure under the Voluntary Pollution Liability Exemption (VPLE) program (CRA, 2012a). The intent is to develop the landfill as a soccer complex (see Attachment A) and to upgrade the active venting system, not for remediation, but for odor control. The VPLE program requires that the applicant evaluate the landfill as if it were using a passive system. Attachment B presents the proposed passive venting system layout, upgraded from the March 7, 2012 version previously presented to the Wisconsin Department of Natural Resources (DNR). The passive venting demonstration requirement has been the focus of a lot of evaluation and discussion over the past few months.

In order to evaluate the passive venting approach, a landfill site tour/technical meeting was held on March 7, 2012. At the March 7, 2012 meeting, Conestoga-Rovers and Associates' (CRA) technical presentation focused on the effectiveness of passive venting. At the end of the meeting, it was agreed that CRA would provide further information on the landfill, landfill gas and groundwater in order to assist DNR's review. Under the category of "next steps," it was

also agreed (i) CRA would prepare a technical report that addressed questions posed by the DNR and (ii) DNR would provide to CRA any analysis relating to landfill gas so that the analysis would be addressed in CRA's subsequent report. (CRA received an analysis conducted by Dennis Mak, which is addressed in this expert opinion report.) This technical report will be submitted to the DNR in April 2012 (CRA 2012b).

LANDFILL GAS TABLE PRESENTED TO THE DNR ON MARCH 7, 2012

One of the items discussed at the March 7, 2012 meeting was a table called "*Mass Loading Calculation*". CRA prepared this table solely to show that VOC air emissions met DNR air quality standards. The table does not show current levels of VOC in landfill gas. Rather, as explained in footnote 1 to the table, the VOC values represent the highest VOC value in landfill gas over the last 12 years. The purpose of this table was to show that landfill gas conservatively meets the air emission requirements.

Based on the materials we received from DNR, it appears DNR overlooked footnote 1 and assume this table reflected current VOCs. As stated above, it does not. Current VOCs are set in Table 1 attached to this report. Only five VOCs are detected in landfill gas, none of which include trichloroethylene, perchloroethylene or vinyl chloride. Moreover, the levels of VOC in landfill gas are substantially lower than those postulated in the March analysis.

EXPERT QUALIFICATIONS

Mr. Frehner is a licensed professional engineer in the State of Wisconsin and vice president of CRA. He holds Bachelor and Masters degrees in civil engineering. Mr. Frehner has worked his entire 30 year professional career with CRA working extensively in the area of landfill and VOC remediation and has been an expert witness for over 10 litigation cases related to either landfills, landfill gas or VOCs. Mr. Frehner's curriculum vitae is provided in Attachment D along with a table of 57 of his landfill projects and 57 his VOC projects.

EXPERT OPINION

Should the Holtz Krause landfill gas management system be converted from a 35 -vent active system to a 69 -vent passive system, VOCs in groundwater will remain stable.

BASIS FOR OPINION

1. **VOCs in Waste Have Been Treated**
The active gas collection system operated for the past 17 years. Over that period, VOCs were drawn from the waste into landfill gas and treated with the flare. Table 1 presents the maximum VOC detects in landfill gas based on current conditions (maximum VOCs at any vent for 2011). As shown, there are only 5 VOCs detected anywhere in landfill gas whereas there were 20 VOCs detected in early years. Figure 1 shows the history of benzene and vinyl chloride. While sporadic detects are noted at vents, these compounds were not detected in the blower inlet for the last 4 years.

2. **Residual VOCs in Landfill Gas Are No Longer a Potential Source to Groundwater**
The 5 VOCs presented in Table 1 will not affect groundwater quality. The VOC levels are too low to partition to groundwater. CRA took the maximum landfill gas concentrations from 2011 and using Henrys Law calculated the equilibrium concentration in groundwater. (see Table 2 and Attachment E) The result of the calculation shows only benzene would slightly exceed the Enforcement Standards in groundwater. As confirmation of this calculation, the Henry's Law value is similar to the currently measured levels of benzene. Vinyl chloride and potential parent compounds of vinyl chloride (TCE and PCE) were not detected in landfill gas. Tetrahydrafuran, a groundwater contaminant also was not detected in landfill gas. The small residual of VOCs in waste are not available for leaching because the cap prevents infiltration and dry VOCs in landfill gas would be passively vented.

3. **Examples of Active Venting Systems Turned Passive**
Examples of sites where active venting systems were converted to passive venting included The Reclamation Landfill (Racine County, Wisconsin) and the Detroit Lakes Landfill (Detroit Lakes, Minnesota). A summary of each site is presented in Attachment F. The Reclamation Landfill active system was shut off in 1997 and operated passively for the last 15 years. VOCs in groundwater are stable.

   At Detroit Lakes, the active system is shut down every winter for the last 4 years. VOCs continue to decline in groundwater.

4. **Examples of Cap and Passive Venting Sites That Show successful Groundwater Remediation**
Over 64 passive venting landfills exist in the Minnesota Pollution Control Agency (MPCA) closed landfill program. Information about the Minnesota experience with passive venting was passed on to the DNR Remediation Group by Doug Day and Peter Tiffany of MPCA. MPCA is an available resource for DNR waste.

There are many sites across the United States that have been capped and passively vented and resulted in remediation of groundwater without the need for active venting. Attachment G presents charts showing the successful remediation of VOCs in groundwater at several sites. Attachment H presents the 64 MPCA passive sites and several project summaries.

5. **It Was The Landfill Cap That Remediated Groundwater Rather than the Active Gas System at the Holtz Krause Landfill**
Prior to the construction of the 1995 cap, leachate was generated at a rate of approximately 4.6 million gallons of leachate per year (57 acres x 3-inches of infiltration per year through a soil cap). This translated to 4.6 million gallons per year of leachate migrating into groundwater because there is no bottom liner. The sheer magnitude of leachate is clearly the reason why VOCs were present in groundwater before remediation. Even under this heavy leachate loading, the VOCs in groundwater were only marginally above enforcement standards. After the 1995 cap was installed, leachate generation was essentially eliminated. Once the source of VOCs were eliminated, the groundwater was naturally attenuated.

6. **Pre-Remediation Groundwater Quality**
Figures 2 and 3 show benzene levels in groundwater at two wells immediately downgradient of the landfill. These plots show that before remediation in 1995, several rounds of groundwater samples were collected in the early 1990s. This period represents a condition where excessive leachate was being generated and migrating to groundwater. Even under there adverse conditions, the benzene concentrations were only slightly above the enforcement standards. This means that, even in an unremeditated condition, the landfill waste had only a marginal impact on groundwater quality.

7. **Current Groundwater Quality**
Also shown on Figures 2 and 3 are the current levels for benzene. Figures 2 and 3 show the downward trend of benzene over the 17 year remediation period. In 2011, the DNR

concluded that the VOC trends in groundwater were stable or decreasing and the DNR amended the remedy by approving a Monitored Natural Attenuation remedy.(DNR, 2011). In addition, the VPLE programs allows the closure of sites where VOCs remain above the enforcement standard and where there is a stable or decreasing trend of contaminants in groundwater. Clearly this is the case at the Holtz Krause landfill site.

All of which is respectfully submitted,

CONESTOGA-ROVERS & ASSOCIATES

Ron Frehner, P.E.
Wisconsin P. E. #31708 expires 7/31/12

RF/ma/1
Encl.

cc: Dave Eisenrich

TABLE 1

MASS LOADING CALCULATIONS
HOLTZ-KRAUSE LANDFILL
WAUSAU, WISCONSIN

VOC [1]	CAS #	Concentration [2] (ppbv)	Molecular Weight	Conversion Factor	Flare Station Inlet Concentration [2] (mg/m3)	Blower Discharge Flow Rate [3] (cfm)	Calculated Blower Discharge Mass (lbs/hr)	Calculated Blower Discharge Mass (lbs/yr)	Groundwater Contaminant?	WDNR Limit (lbs/hr)	WDNR Limit (lbs/yr)
Dichlorodifluoromethane (Freon 12)	75-71-8	456	120.92	5.03	2.29	178	0.0015	13.4	No	--	--
Benzene	71-13-2	384	78.11	3.25	1.25	178	0.0008	7.3	Yes		228
Ethylbenzene	100-41-4	2470	106.16	4.42	10.91	178	0.0073	63.7	No	23.3	177,688
M, P, O-Xylenes	1330-20-7	3982	106.16	4.42	17.58	178	0.0117	102.7	No	23.3	--
Chlorobenzene	108-90-7	332	112.56	4.68	1.55	178	0.0010	9.1	No	2.47	--

Notes:

[1] Detected VOC from 2011

[2] Maximum detected concentration from any location. Annual sampling in 2011

[3] Average 2011 flare station landfill gas flow rate.

-- No regulatory limit.

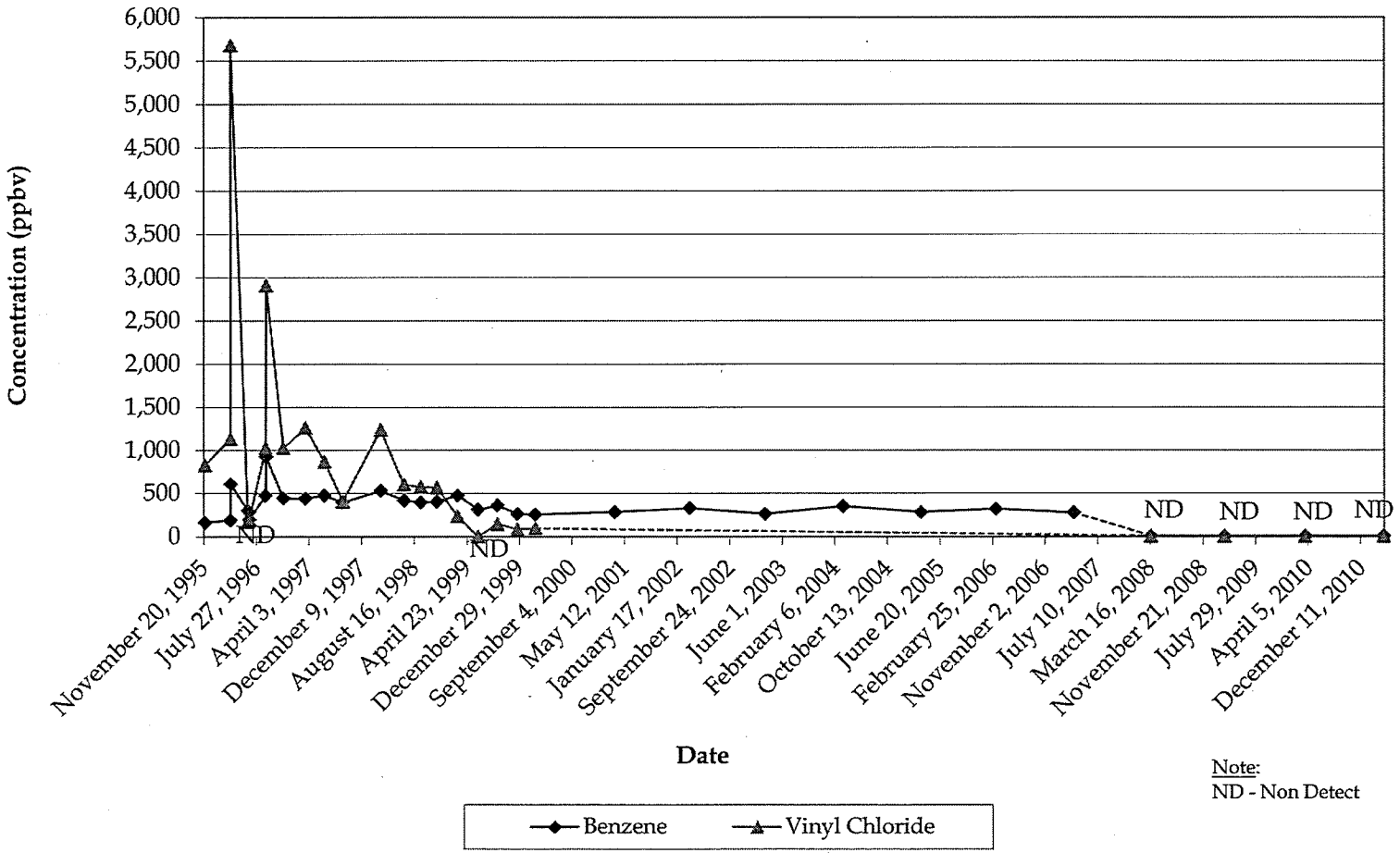
TABLE 2

MAXIMUM VOCs IN GROUNDWATER 2011
HOLTZ-KRAUSE LANDFILL
WAUSAU, WISCONSIN

VOCs	*Maximum 2011 VOC in Landfill Gas (ppbv)*	*Maximum 2011 VOC in Groundwater measured at MW4, MW8, MW12 or MW18 nest (ug/L)*	*Estimated 2011 VOC Concentration in Groundwater Based on Henry's Law (ug/L)*	*DNR Groundwater Enforcement Standard (ug/L)*
Freon 12	456	0.32	0.2	1,000
Benzene	384	**5.43**	**6.5**	5
Ethylbenzene	2,470	ND	44.0	700
Xylenes	3,982	ND	121	10,000
Chlorobenzene	332	5.97	11.8	100
Tetrahydrofuran	ND	12.5	ND in LFG	50
TCE	ND	ND	ND in LFG	5
PCE	ND	ND	ND in LFG	5
VC	ND	**0.51**	ND in LFG	0.2

Note:

Maximum VOC in groundwater based on data from the MW4, MW8, MW12 and MW16 well nests located immediately downgradient of the landfill
ND - Non-detect
LFG - Landfill Gas
Bold numbers exceed DNR enforcement standard



Note:
ND - Non Detect

figure 1

SELECT VOC CONCENTRATIONS IN
BLOWER DISCHARGE BEFORE FLARE
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

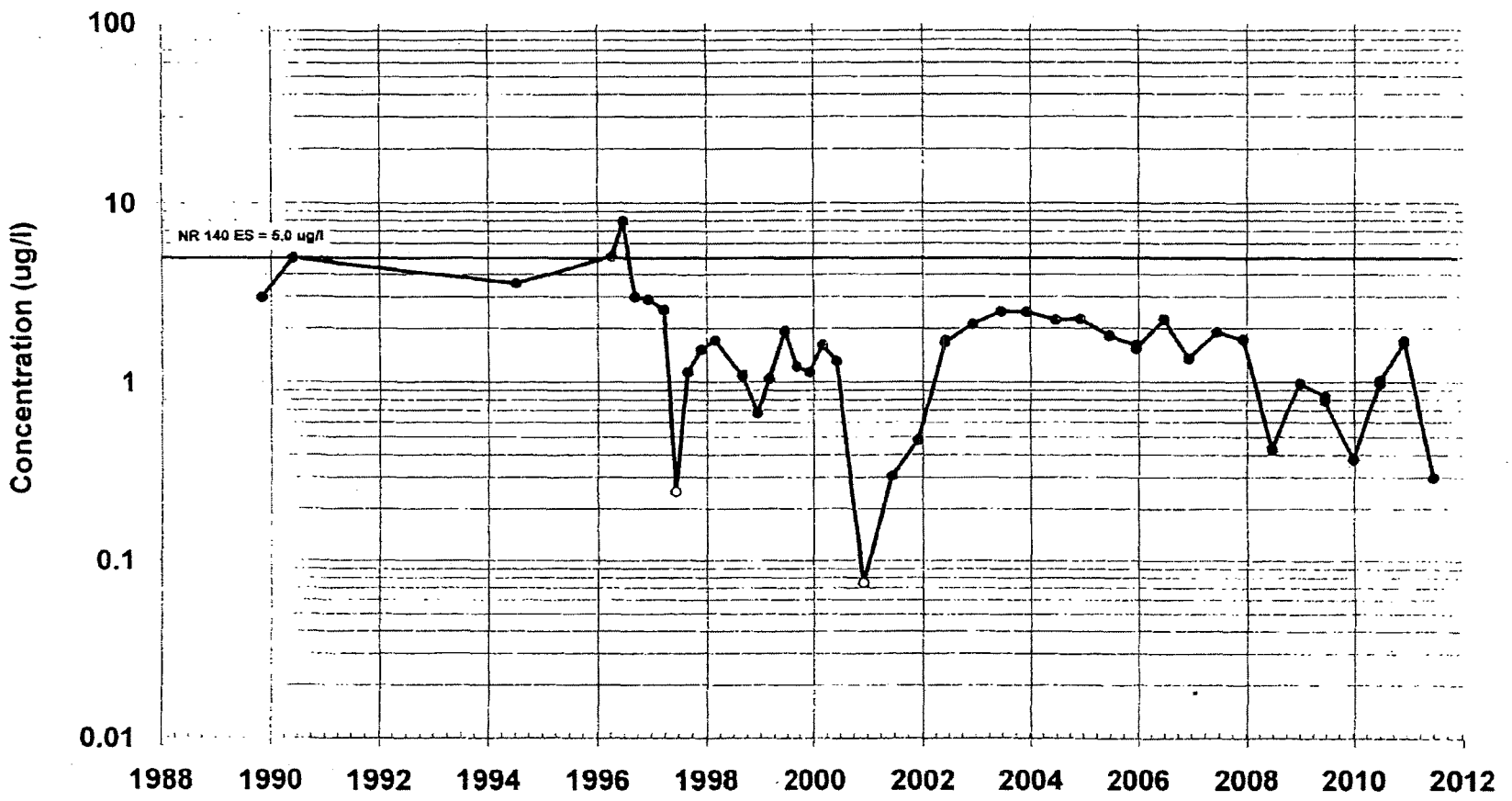
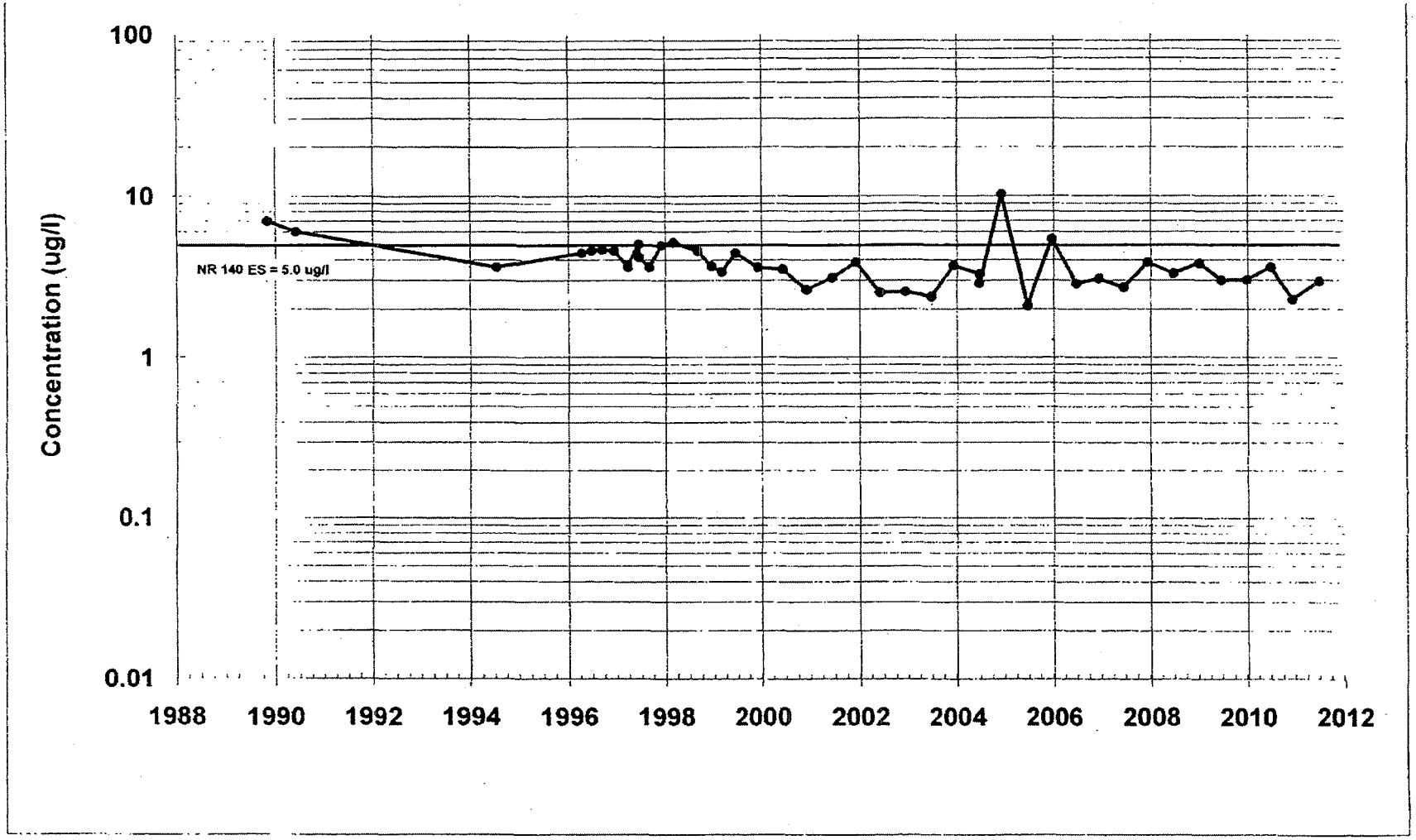


figure 2

Open circle indicates that compound was not detected. Non-detected data displayed at one-half reporting limit.

MW-4B
BENZENE CONCENTRAION
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

075704-10(THIM001)GN-SP002 APR 5/2012



Open circle indicates that compound was not detected. Non-detected data displayed at one-half reporting limit.

figure 3

MW-8B
BENZENE CONCENTRATION
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

075704-10(THIM001)GN-SP003 APR 5/2012

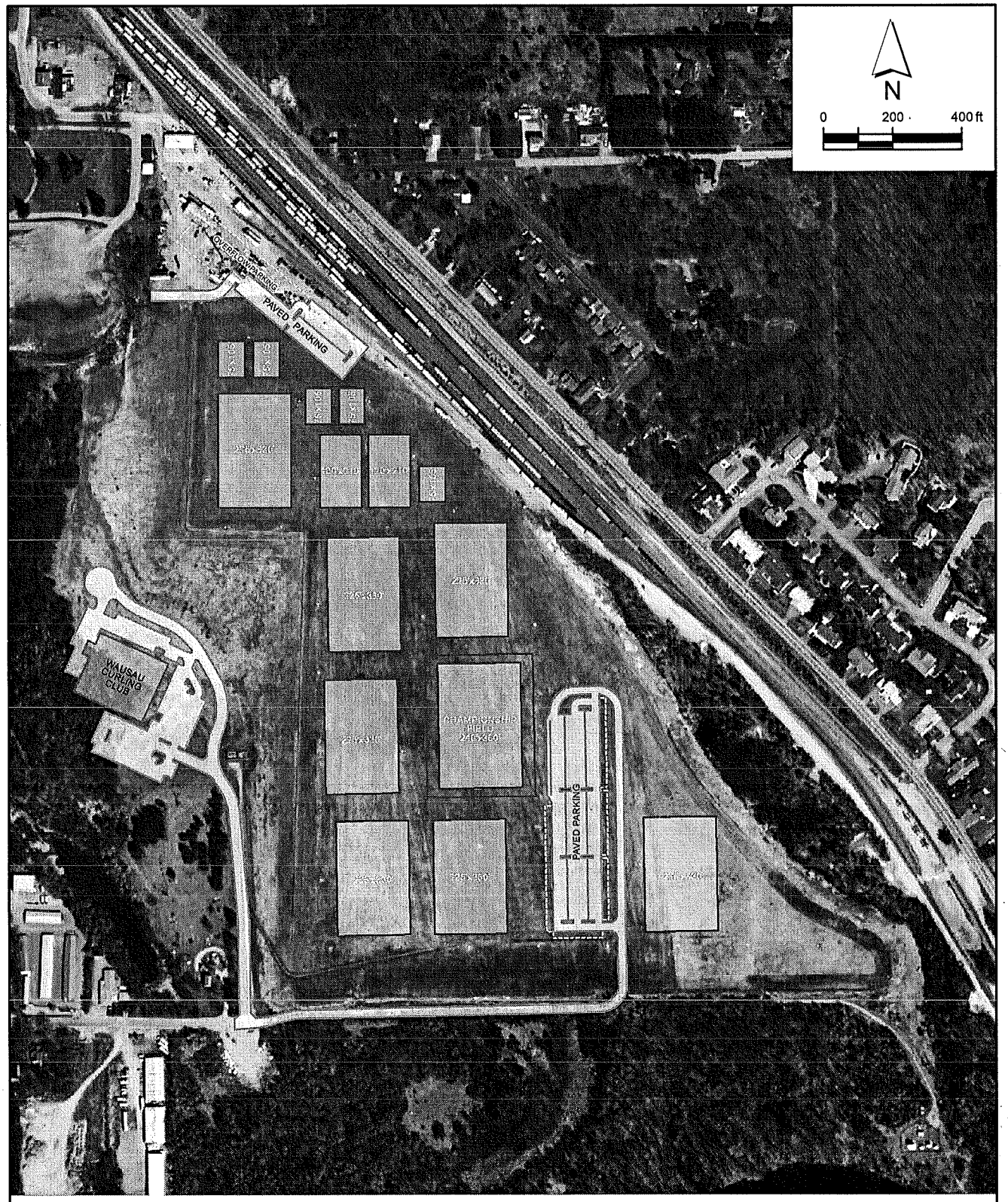
REFERENCES

- AECOM, January 2003, Technical Justification for ROD Amendment
- AECOM, January 2005, Work Plan for Additional Site Investigation
- AECOM, 2010, Five-Year Review Report for Holtz Krause Landfill, Wausau, Wisconsin
- AECOM, July 2010, Five-Year Review Report
- AECOM, February 2011, Technical Support for Record of Decision Amendment
- Bashew and Martin, July 1972, surface and groundwater quality report
- Becher-Hoppe Engineers, Inc., December 1975, Holtz Krause Sanitary Landfill Report
- Becher-Hoppe Engineers, Inc., February 1979, Holtz Krause Landfill Abandonment
- Becher-Hoppe Engineers, Inc., February 1980, Holtz Krause Landfill Final Abandonment Plan (revised). This document was summarized in Technical Memorandum Number One (Geraghty & Miller, 1989)
- Becher-Hoppe Engineers, Inc., April 1984, soil boring report of cover integrity
- CRA, 2011 Phase I Environmental Site Assessment, Holtz Krause Landfill
- CRA, 2012a Voluntary Party Liability Exemption Request, Holtz Krause Landfill
- CRA, 2012b Remedial Action Plan, Holtz Krause Landfill
- Dames & Moore, 1995, Operation and Maintenance Manual Landfill Cap & Gas Extraction System, Holtz Krause Landfill, Wausau, Wisconsin, May 1995
- Division of Environmental Protection, June 1969, water samples collected
- DNR, June 1992, Selected Remedial Alternative
- DNR, August 1994, Consent Decree
- DNR, June 2011, Declaration for an Amendment to the Remedy
- Foth and Van Dyke, August 1986, Work Plan submitted for hydrogeologic investigation and closure plan at Holtz Krause Landfill site
- Geraghty & Miller, February 1990, Technical Memorandum No. 2, Migration Pathway Assessment and Contaminant Characterization Vol. 1 & 2
- Geraghty & Miller, February 1991, Remedial Investigation Report and Baseline Risk Assessment
- Geraghty & Miller, February 1992, Feasibility Study
- G. Fred Lee, November 1972, Water Quality Report
- James B. McDonald, December 1974, Report of Investigation of DNR, Wausau Dump

- Lon C. Ruedisili and Donald Olson, September 1974, Hydrogeologic Investigation of the Holtz Krause Landfill
- Marathon County Planning Commission, September 1981, closing, monitoring, and long-term care requirements of the Holtz Krause Landfill
- Minnesota Pollution Control Agency - Closed Landfill Program, Pat Hanson: Project Manager, Peter Tiffany: Senior Engineer
- RMT, January 1996, Pre-Flare Compliance Test Program
- Ronald G. Hennings, February 1973, Water Quality and Hydrogeologic Assessment
- USEPA, December 1985, potential hazardous waste site assessment
- USEPA, July 1986, potential hazardous waste site assessment
- Wisconsin District 4 Sanitation, May to November 1969, water samples collected for bacteriological studies
- Wisconsin District 4 Sanitation, August 1969, surface water samples collected near Holtz Krause Landfill
- Wisconsin Department of Natural Resources, 2007, Guidance for Cover Systems as Soil Performance Standard Remedies, PUB-RR-709, January 2007
- Wisconsin Department of Natural Resources, September 2007, Fact Sheet 2, PUB-RR-661
- Wisconsin Department of Natural Resources, 2009, Guidance on Case Closure and the Requirements for Managing Continuing Obligations, PUB-RR-606, June 2009
- Wisconsin Department of Natural Resources, June 2010, Fact Sheet 13, PUB-RR-661
- Wisconsin Department of Natural Resources, June 2011, Declaration for an Amendment to the ROD

ATTACHMENT A

PROPOSED SOCCER COMPLEX



LEGEND

PROPOSED FIELD

FUTURE CURLING RINK

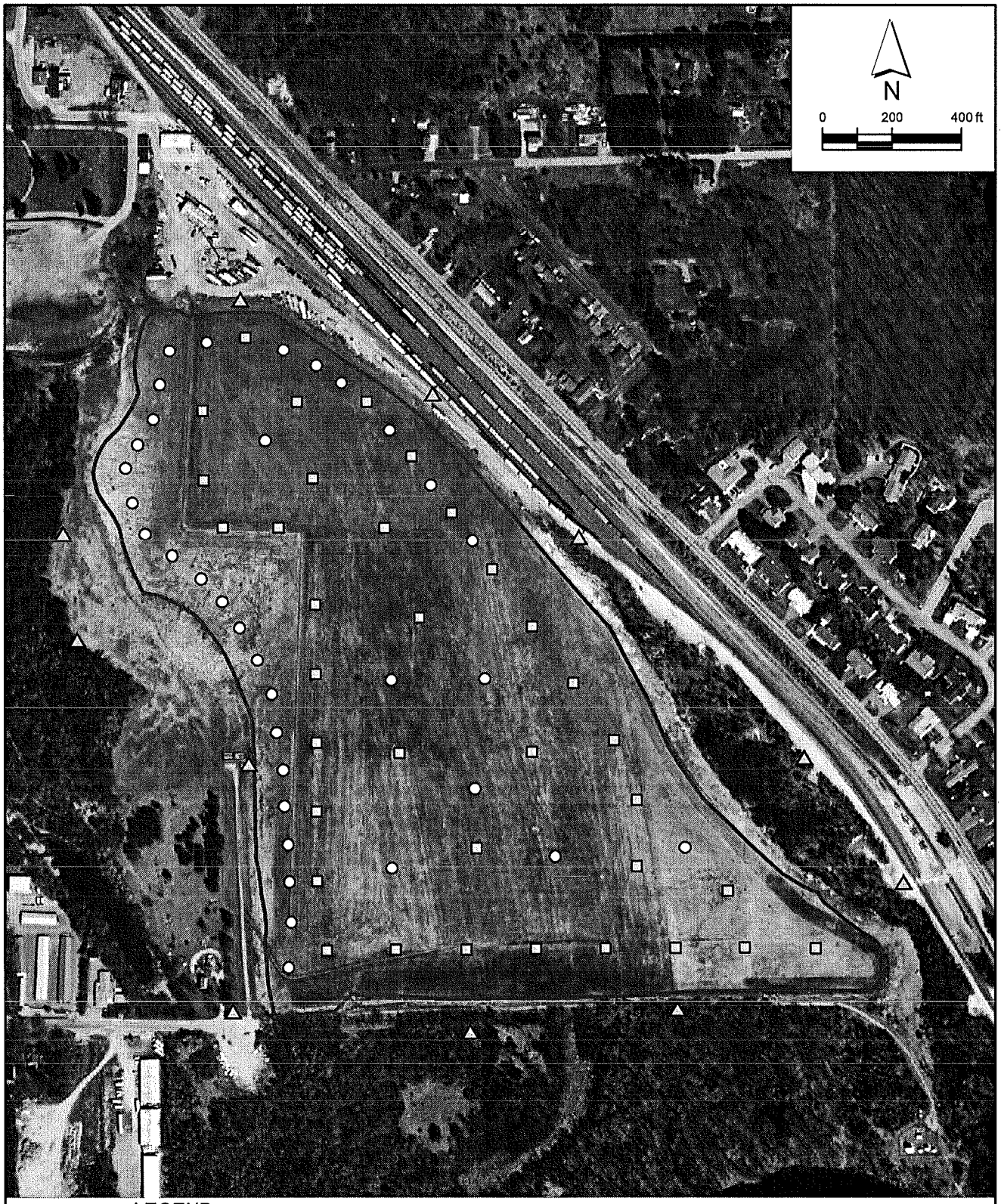
figure 1.1

FIELD LAYOUT
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

74702-10(008)GIS-SP012 MAR 26/2012

ATTACHMENT B

PROPOSED PASSIVE VENTING SYSTEM
(69 VENTS)



LEGEND

- FUTURE PASSIVE VENT CONVERTED FROM EXISTING GAS EXTRACTION WELL
- FUTURE PASSIVE VENT LOCATION
- EXISTING GAS PROBE LOCATION
- APPROXIMATE WASTE LIMIT

figure 4.2

CONCEPTUAL PASSIVE VENTING SYSTEM
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

74702-10(008)GIS-SP008 MAR 26/2012

TABLE 3.3

MASS LOADING CALCULATIONS
HOLTZ-KRAUSE LANDFILL
WAUSAU, WISCONSIN

Analand [1]	CAS #	Flare Station Inlet Concentration [2] (ppbv)	Molecular Weight	Conversion Factor	Flare Station Inlet Concentration [2] (mg/m3)	Blower Discharge Flow Rate [3] (cfm)	Calculated Blower Discharge Mass (lbs/hr)	Calculated Blower Discharge Mass (lbs/yr)	WDNR Limit (lbs/hr)	WDNR Limit (lbs/yr)	% of WDNR Limit (lbs/hr)	% of WDNR Limit (lbs/yr)
1,1,2,2-Tetrachloroethane	79-34-5	127	167.85	6.98	0.89	215	0.0007	6.3	0.369	--	0.19%	
1,2,4-Trimethylbenzene	25551-13-7	363	120.19	5.00	1.81	215	0.0015	12.8	6.6	--	0.02%	
1,3,5-Trimethylbenzene	25551-13-7	166	120.19	5.00	0.83	215	0.0007	5.9	6.6	--	0.01%	
Benzene	71-43-2	520	78.11	3.25	1.69	215	0.0014	11.9	--	228		5.23%
Bromomethane	74-83-9	256	94.95	3.95	1.01	215	0.0008	7.1	--	888		0.80%
Carbon Disulfide	75-15-0	929	76.14	3.17	2.94	216	0.0024	20.9	1.67	124,831	0.14%	0.02%
Chlorobenzene	108-90-7	332	112.56	4.68	1.55	215	0.0013	11.0	2.47	--	0.05%	
Chloromethane	74-87-3	695	50.49	2.10	1.46	216	0.0012	10.3	5.55	--	0.02%	
Dichlorodifluoromethane (Freon 12)	75-71-8	7073	120.92	5.03	35.57	215	0.0287	251.0	--	--		
Dichloromethane	75-09-2	3110	84.94	3.53	10.99	215	0.0088	77.5	9.33	3,781	0.09%	2.05%
Ethylbenzene	100-41-4	4350	106.16	4.42	19.21	215	0.0155	135.5	23.3	177,688	0.07%	0.08%
Trichlorofluoromethane (Freon 11)	75-69-4	195	137.38	5.71	1.11	215	0.0009	7.9	--	--		
Isopropylbenzene	98-82-8	160	120.19	5.00	0.80	215	0.0006	5.6	13.2	--	0.00%	
M, P, O-Xylenes	1330-20-7	5010	106.16	4.42	22.12	215	0.0178	156.1	23.3	--	0.08%	
Methyl Ethyl Ketone	78-93-3	14637	72.11	3.00	43.90	215	0.0354	309.7	--	--		
p-Isopropyltoluene	99-87-6	210	134.22	5.58	1.17	215	0.0009	8.3	--	--		
Tetrachloroethene	127-18-4	114	165.85	6.90	0.79	215	0.0006	5.5	9.11	301	0.01%	1.84%
Tetrahydrofuran	109-99-9	26500	72.11	3.00	79.48	215	0.0640	560.8	31.7	--	0.20%	
Toluene	108-88-3	2150	92.13	3.83	8.24	215	0.0066	58.1	10.1	71,075	0.07%	0.08%
Trichloroethene	79-01-6	130	131.40	5.47	0.71	215	0.0006	5.0	14.4	888	0.00%	0.56%

Notes:

[1] Historically detected analands (1999 to 2011).

[2] Maximum detected concentration from well field and flare station inlet sampling (1999 to 2011) .

[3] Average 2010 flare station landfill gas flow rate.

-- No regulatory limit.

ATTACHMENT C

MARCH 7th TABLE USING HISTORIC DATA
(1999-2011 DATA)

ATTACHMENT D

RON FREHNER
EXPERT QUALIFICATIONS

- CURRICULUM VITAE
- LANDFILL EXPERIENCE
- VOC EXPERIENCE

RONALD FREHNER, P.E.

EDUCATION

M.A.Sc. Civil Engineering, University of Waterloo, 1985

B.A.Sc. Civil Engineering, University of Waterloo, 1982

EMPLOYMENT HISTORY

1982-Present Principal/Vice-President
Conestoga-Rovers & Associates, St. Paul, MN
Named CRA Principal/Vice President, 1992
Named CRA Associate, 1987

PROFESSIONAL REGISTRATIONS/AFFILIATIONS

Licensed Professional Engineer: Georgia, Idaho, Illinois, Kansas, Minnesota, New Jersey, North Dakota, Ohio, Oklahoma, South Dakota, and Wisconsin

PROFILE OF PROFESSIONAL ACTIVITIES

- Decommissioning/Demolition of former manufacturing building. Voluntary site remediation of PCB and BTEX, Chicago Heights, Illinois.
- Decommissioning/Demolition of former manufacturing building. Voluntary site remediation of PCB and VOCs, Pottstown, Pennsylvania.
- Brownfield development of soccer fields on former landfill, Glenview, Illinois.
- Brownfield development of soccer fields on former landfill, Woodstock, Illinois.
- Response to Urea Ammonium Nitrate spill in Ohio for Cargill. Monitoring of soil and surface water. Develop cleanup plan. Liaison with OEPA.
- Response to Anhydrous Ammonia spill in Iowa for Koch Pipeline. Monitoring soil and surface water. Assist in cleanup of soil and surface water. Liaison with Iowa DNR.
- Design and implementation of drum removal and wetland remediation for PCB and lead contamination in Detroit area.
- Evaluation of remediation and brownfield development of farm railyard in Minneapolis for Jefferson Bus Lines.
- Phase II Investigation of former rail shop in Joliet, Illinois.
- RD/RA for soil and groundwater contamination by VOCs at former Thiokol facility in Rockaway Borough, New Jersey.
- RD/RA for soil and groundwater contamination by VOCs at former Thiokol facility in Denville, New Jersey.
- Natural attenuation study of groundwater at 3M facility, Woodbury, Minnesota.
- Landfill cap construction at Fultz Landfill Superfund Site, Byesville, Ohio.
- Landfill cap design and construction oversight in Joliet, Illinois.
- Soil and groundwater evaluation of petroleum contamination at industrial facility, York, Pennsylvania.

- Soil and groundwater evaluation of nitrate contamination at former fertilizer plant, Maysville, Kentucky.
- Landfill cap design in Necedah, Wisconsin.
- Evaluation of closure and post-closure costs at 18 landfills throughout the United States.
- Site investigation, cap design, and construction oversight, Brockman Landfill, Ottawa, Illinois.
- Site evaluation and peer review of remediation for cleanup of petroleum contaminated soil, Roseville, Minnesota.
- Site evaluation for jet fuel spill, Lakeland, Minnesota.
- Site evaluation and development of remedial plan for UST sites in Indiana and Illinois.
- Site Assessment and Evaluation of remedial alternatives for VOC groundwater contamination in Skokie, Illinois.
- Site Assessment and review of remedial alternatives for former USTs and industrial facility in Chicago, Illinois.
- Peer review of steam injection with SVE recovery of diesel contaminated soil and groundwater, Minneapolis, Minnesota.
- Site investigation for VOC remediation and operating industrial facility in Pennsylvania.
- Site assessment of VOC contamination and peer review of SVE remediation at former industrial facility, Chicago, Illinois.
- Predesign Investigation, Remedial Design for landfill cap and groundwater remediation at the Woodstock Landfill Superfund Site, and Record of Decision Amendment, Woodstock, Illinois.
- Conduct Site Investigation, evaluation of remedial alternatives at former gasoline station, and secured No Further Action letter from MPCA, Golden Valley, Minnesota.
- Preparation of Feasibility Study for impoundment and groundwater remediation at 180-acre former petroleum terminal in Heath, Ohio.
- Investigation and RD/RA at former DDT disposal area; investigation of lead and arsenic discharge area in Selma, North Carolina.
- Investigation of former creosote wood treatment site in Indianapolis, Indiana.
- Site Investigation, evaluation of remedial alternatives for VOC contaminated soil and groundwater in Hopkins, Minnesota.
- Site Investigation, evaluation of remedial alternatives for VOC contaminated soil and groundwater, and secured a No Further Action letter in Eden Prairie, Minnesota.
- RD/RA for emergency removal of PCB, lead and dioxin contaminated soils at scrap yard in Elgin, Illinois.
- Technical Trustee for Potential Responsible Party (PRP) Group during RD/RA of VOC groundwater remedy in East Bethel, Minnesota.
- Site Investigation and RD/RA for PCB and diesel fuel contamination at former fill disposal area in St. Paul, Minnesota.
- Site Investigation, remedial alternative analysis for VOC groundwater contamination at closed landfill and landfill closure in River Falls, Wisconsin.
- Site Investigation and evaluation of remedial alternatives for VOCs in soil and groundwater, 3M, Woodbury, Minnesota.
- Site Investigation of pentachlorophenol and CCA contamination at wood treating site, Bell Pole, Carseland, Alberta.

- Technical assistance to PRP group during good faith negotiations, Fultz Landfill Superfund Site, Byesville, Ohio.
- Technical assistance to PRP group during good faith negotiations and RD/RA for PCB, PAH, and lead contamination at scrap yard, South Andover Superfund Site, Andover, Minnesota.
- Site Investigation of creosote contamination at former wood treating site, Bell Pole, Lumby, British Columbia.
- Site Investigation, Feasibility Study and Remedial Plan preparation for PCB contamination at a scrap yard, Peoria, Illinois.
- Peer review of RI/FS and RD/RA, American Chemical Service Site, Griffith, Indiana.
- Technical Review of Site Conditions at former rocket test site in Morris County, New Jersey.
- Technical Review of USEPA ROD and Proposed Plan, Rockaway Borough, New Jersey.
- Technical Representation for Uniroyal on Elmira Aquifer remediation and alternative water supply negotiations, Elmira, Ontario.
- Feasibility Study and Remedial Plan for remediation of 26,000 C.Y. of buried wastes containing VOCs, chlorophenols, pesticides, herbicides and dioxins at Uniroyal Chemical, Elmira, Ontario.
- Project management of groundwater extraction/treatment using ultraviolet oxidation/carbon adsorption at Uniroyal Chemical, Elmira, Ontario.
- Site Investigation of gasoline contamination for Ultramar Canada, Port Stanley, Ontario.
- Peer Review of Groundwater Remediation program for trichloroethylene, Scottsdale Water Supply, Scottsdale, Arizona.
- Site Investigation and RD/RA for pentachlorophenol soil and groundwater contamination, Bell Pole, Lumby, British Columbia.
- Technical representation in consent order negotiations, Feasibility Study for the Hassayampa Superfund site in Buckeye, Arizona.
- Design and Implementation of RI/FS and Ultraviolet Oxidation Treatability Study at Jadco-Hughes Superfund site in Gaston County, North Carolina.
- Site Investigation, RAP and expert testimony at criminal investigation in Scott County, Minnesota.
- Construction administration of water treatment plant in Hanover, Ontario.
- Construction Administration and performance evaluation of bioremediation of oil tar facility in Port Stanley, Ontario.
- Site investigation of pentachlorophenol at a wood treating site in Siren, Wisconsin.
- Site investigation and conceptual design of groundwater recovery and treatment system of creosote at a wood treating site in Bangor, Wisconsin.
- Preparation of hazardous waste management report (Part B permit application) for Schenectady Chemicals and FMC Corporation in New York State.
- Design and Implementation of Groundwater Investigation and IRMs for groundwater recovery and treatment for VOC contaminated groundwater at Synertek facilities in Santa Clara, California.
- Design and Implementation of RI/FS and IRM for creosote and pentachlorophenol groundwater contamination in New Brighton, Minnesota.
- Design of Remedial Facility Investigation (RFI) in Rochester, Minnesota.
- Design and Implementation of RI at a landfill in Burnsville, Minnesota.

- Design and Implementation of RI/FS, IRM and RD/RA for vinyl chloride and VOC groundwater contamination, representation at public meetings, Highway 96 Dump, White Bear Township, Minnesota.
- Design and Implementation of Scrap Removal Program, RI/FS and RD/RA for PCB, lead, and dioxin contaminated soil, Agate Lake Scrap Yard, Brainerd, Minnesota.
- Design and Implementation of RI/FS, IRM, RAP, representation at public meetings and post closure permit application for remediation of PCB and lead contamination at the Union Compressed site in Duluth, Minnesota.
- Construction Administration of the Boundary Groundwater Recovery System TCAAP, Minnesota.
- Design and Implementation of a Hydrogeologic Investigation over an 18 square mile area, preparation of a Groundwater Remedial Program Plan for TCAAP, Minnesota.
- Design and Implementation of RI/FS and RAP for remediation for sewer contamination, TCAAP, Minnesota.
- Design and Implementation of RI/FS, RAP and NPDES monitoring for Volatile Organic Compound (VOC) remediation, TCAAP, Minnesota.
- Design and Implementation of RI/FS, and Remedial Action Plan (RAP) for PCB remediation at the Twin Cities Army Ammunition Plant (TCAAP), Minnesota.
- Participation in Consent Order negotiations, Design and Implementation of Remedial Investigation (RI), preparation of Feasibility Study (FS), conceptual design of interim remedial measures (IRMs), representation at public meetings, implementation of remedial design/remedial action (RD/RA) and administration of Interim Remedial Measures for Wauconda Landfill Superfund site, Wauconda, Illinois.
- Pre-purchase Environmental Audit of eyeglass manufacturing facility in Minneapolis, Minnesota.
- Environmental Audit of resin, varnish and paint manufacturing facility in Schenectady, New York.
- Site Assessment and Operating Plan for a Sanitary Landfill in Lucan, Ontario.
- Project Management of water works program including 1.5 MGD water treatment plant and watermain installations for Southampton, Ontario.

EXPERT WITNESS EXPERIENCE

- Expert witness on soil and groundwater contamination by arsenic and other chemicals at former herbicide blending facility, North Kansas City, Missouri.
- Expert witness on solid waste landfill tipping fee costs, Minnesota.
- Expert witness on remedy selection at pipeline terminal for Williams Pipeline, Des Moines, Iowa.
- Expert witness on consistency with National Contingency Plan for a Response Action in Louisiana.
- Expert witness testimony on methane migration at Old State Street Dump for Port Authority, St. Paul, Minnesota.
- Expert Testimony for PCB and lead contamination remediation in Mahtomedi, Minnesota.
- 2001 - 2002 expert witness on PCB contamination issues at former Westinghouse Transformer Repair Shop in Minneapolis.
- Expert witness on compliance with the National Contingency Plan, Louisiana.
- Expert witness on landfill gas migration, White Bear Township, Minnesota.

- Expert witness on sources of PCE contamination, Sacramento, California.
- Expert witness on cost allocation, BJ Carney site, Minnesota.

PUBLICATIONS AND PRESENTATIONS

- Frehner, R. 1995. Technical Considerations Under Superfund, Clean Water Act and Toxic Substances Control Act. Presented at the Environmental Regulation Course by Executive Enterprises, Minneapolis, Minnesota. June 1995 (and on several other occasions in 1993 and 1994 for Superfund).
- Guy, B.T., Watson, T.A. and Frehner, R. 1993. Site Remediation at a Wood Preservation Facility in Central British Columbia, Canada. Paper presented at Second USA/CIS Joint Conference on Environmental Hydrology and Hydrogeology, Washington, D.C. May 1993.
- Frehner, R. 1992. Wastewater Treatment/Effluent Options Under the Clean Water Act. Presented at Environmental Regulation Course by Executive Enterprises, Minneapolis, Minnesota. July 1992.
- Warith, Mostafa A., Frehner, Ronald and Yong, Raymond N. 1990. Bioremediation of Organic Contaminated Soil at a Former Oil Gasification Site. Paper submitted to the Canadian Geotechnical Journal. January 1990.
- Frehner, Ronald. 1989. Hazardous Substances in Sanitary Landfills. Sanitary Landfill Leachate and Gas Management Seminar, University of Wisconsin. December 4-7, 1989.

LANDFILL EXPERIENCE
RON FREHNER

			Site Evaluation	*Landfill Gas Remediation*	*Liner System Design*	*Leachate Collection*	*Brownfield Development*	*Groundwater Remediation*	*Expert Witness*
1	Estes Landfill	AZ	X						X
2	South Broadway	AZ	X				X		X
3	Dawson Landfill	GA	X						X
4	Wauconda Landfill	IL	X	X	X	X			
5	Woodstock Landfill	IL	X	X	X		X		
6	Quincy Landfill	IL	X			X			
7	Brockman Landfill	IL	X	X	X				
8	Bellville Landfill	IL	X						X
9	Krohn Landfill	IL	X				X		
10	Yeoman Creek Landfill	IL	X	X					
11	Joliet Landfill	IL	X	X	X	X			
12	National Disposal #1	IL	X						
13	McLean County Landfill	IL	X						X
14	Lansing Landfill	IL	X						X
15	Beecher Development Landfill	IL	X						X
16	Blue Island Landfill	IL	X						X
17	Richton Park Landfill	IL	X						X
18	County Line Landfill	IL	X						X
19	31st Street Landfill	IL	X						X
20	Maryville Landfill	IL	X						X
21	Schiller Park Landfill	IL	X						X
22	Congress Development Corporation Landfill	IL	X						X
23	Griffith Landfill	IN	X					X	

LANDFILL EXPERIENCE
RON FREHNER

			Site Evaluation	*Landfill Gas Remediation*	*Liner System Design*	*Leachate Collection*	*Brownfield Development*	*Groundwater Remediation*	*Expert Witness*
24	Four County Landfill	IN	X						
25	Burley Belt	KY	X						
26	Jefferson Parish Landfill	LA	X						X
27	Lapeer County Landfill	MI	X						X
28	Whitefeather Landfill	MI	X						X
29	Saginaw Valley Landfill	MI	X						X
30	3M Woodbury	MN	X		X			X	
31	Hwy 96 Landfill	MN	X		X	X	X	X	X
32	Grand Rapids	MN	X	X					
33	Detroit Lakes	MN	X					X	
34	Freeway	MN	X						
35	East Bethel	MN	X		X			X	
36	Wahington County	MN	X					X	
37	State Street Dump	MN	X						X
38	Pigs Eye Landfill	MN	X		X		X		
39	Brooklyn Park Landfill	MN	X		X		X		
40	Herbst Dump	MN	X						
41	Old Miller Dump	MN	X						
42	Rosemont/Reiss	MN	X						
43	ADM280 Disposal Site	MN	X		X				
44	Leflore County Landfill	MS	X						X
45	Jadco Hughes	NC	X						
46	Fultz Landfill	OH	X	X	X	X			

LANDFILL EXPERIENCE
RON FREHNER

			Site Evaluation	*Landfill Gas Remediation*	*Liner System Design*	*Leachate Collection*	*Brownfield Development*	*Groundwater Remediation*	*Expert Witness*
47	Lucan Landfill	ON	X						
48	Rosencranse Corporation Landfill	PA	X						X
49	Tomah Landfill	WI	X	X	X			X	
50	Nacedah Landfill	WI	X		X				
51	River Falls	WI	X	X	X				
52	Brown County West Landfill	WI	X						X
53	Brown County East Landfill	WI	X						X
54	Cyril Landfills	OK	X						X
55	Holtz Krause Landfill	WI							
56	Lansing (Austin) Landfill	MN							
57	SKB Rosemount Landfill	MN							

VOC EXPERIENCE
RON FREHNER

	Site Name	*Location*	*Site Evaluation*	*Groundwater Remediation*
1	Estes Landfill	AZ	X	
2	Twin Cities Army Ammunition Plant	MN	X	X
3	TCAAP Building 103	MN	X	X
4	TCAAP Building 502	MN	X	X
5	Wauconda Landfill	IL	X	
6	Trio Solvents	MN	X	
7	Woodstock Landfill	IL	X	
8	Confidential	IL	X	X
9	Quincy Landfill	IL	X	
10	Brockman Landfill	IL	X	
11	Four County Landfill	IN	X	
12	3M Woodbury	MN	X	X
13	Hwy 96 Landfill	MN	X	X
14	Grand Rapids	MN	X	
15	Detroit Lakes	MN	X	X
16	East Bethel	MN	X	X
17	Jadco Hughes	NC	X	
18	Fultz Landfill	OH	X	
19	Tomah Landfill	WI	X	X
20	River Falls	WI	X	
21	Synertek Building #1	CA	X	X
22	Synertek Building #3	CA	X	X
23	American Chemical Service	IN	X	X
24	Indian Bend Wash	AZ	X	
25	Uniroyal	ON	X	X
26	Radiation Technology	NJ	X	
27	Joliet Landfill	IL	X	X
28	Denville Technical Park	NJ	X	X
29	Rockaway Borough	NJ	X	X
30	Bristol Aerospace	MB	X	X
31	Pottstown	PA	X	X

VOC EXPERIENCE
RON FREHNER

	Site Name	*Location*	*Site Evaluation*	*Groundwater Remediation*
32	Chicago Heights	IL	X	X
33	Agate Lake	MN	X	
34	Lake Superior Paper - Well # 7	MN	X	
35	Lenz Oil	IL	X	X
36	Castwell	IL	X	X
37	Williams Pipeline	IA	X	X
38	Cargill - London	KY	X	X
39	Great Lakes Container	MI	X	X
40	Tower Asphalt	MN	X	
41	Baytown	MN	X	
42	Confidential	IN	X	
43	Norm's Dry Cleaning	MN	X	X
44	Ameripride	CA	X	
45	Hassayampa Landfill	AZ	X	
46	Selma	NC	X	X
47	ITT Schadow	MN	X	
48	Honeywell - Golden Valley	MN	X	X
49	Confidential	CO	X	
50	Hitchcock	MN	X	
51	South Andover	MN	X	
52	Cargill - Dawson	GA	X	
53	Confidential	QC	X	
54	Confidential	Mexico	X	
55	Safety Kleen	IL	X	
56	Confidential	ON	X	
57	Beech Creek	PA	X	X

ATTACHMENT E

HENRY'S LOW CALCULATIONS
FOR VOC EQUILIBRIUM
BETWEEN LANDFILL GAS AND GROUNDWATER

ESTIMATED MAXIMUM GROUNDWATER CONCENTRATION
HOLTZ-KRAUSE LANDFILL
WAUSAU, WISCONSIN

		Henry's Law Constant[1]		C_{air}			C_{water}	
	Molecular Weight	*mol/kg-bar*	*mol/kg-atm*	*Maximum VOC ppb in air (2011)*	*atm*	*mol/kg*	*ug/kg*	*ug/L*
Dichlorodifluoromethane (Freon 12)	120.9	0.0031	0.00	456	0.000000456	1.40E-09	0.169	0.2
Benzene	78.1	0.22	0.22	384	0.000000384	8.34E-08	6.512	6.5
Ethylbenzene	106.2	0.17	0.17	2470	0.00000247	4.14E-07	43.996	44.0
M, P, O-Xylenes	106.2	0.29	0.29	3982	0.000003982	1.14E-06	120.988	121.0
Chlorobenzene	112.6	0.32	0.32	332	0.000000332	1.05E-07	11.802	11.8

Notes

[1] Maximum value noted at http://webbook.nist.gov/chemistry/name-ser.html

ATTACHMENT F

PROJECT SUMMARIES OF
ACTIVE VENTING SYSTEM CONVERTED TO PASSIVE VENTING

RECLAMATION LANDFILL

The Reclamation Landfill is one example of a municipal waste landfill that was originally closed with an active venting system, converted to a passive venting system and VOCs in groundwater remained stable after conversion to passive venting.

The Reclamation Landfill is a 46 acre municipal waste landfill located in the Town of Raymond, Racine County, Wisconsin. The landfill was closed and an active gas collection system was installed in 1992. In 1997, the DNR provided approval for the conversion from active venting to passive venting (DNR approval April 7, 1997 signed by James Walden). Since 1997, landfill gas has been passively venting and VOCs in groundwater have been stable.

DETROIT LAKES

A second example is the Detroit Lakes landfill in Detroit Lakes, Minnesota which is described in Attachment H. The active venting system has been shut down every winter for the past 4 years and perchloroethylene levels in groundwater continue to decline.

ATTACHMENT G

EXAMPLES OF VOCS ATTENTUATION
WITH CAP AND PASSIVE
(NO ACTIVE VENTING OR ACTIVE GROUNDWATER REMEDIATION)

MW5 VINYL CHLORIDE
FORMER RIVER FALLS LF

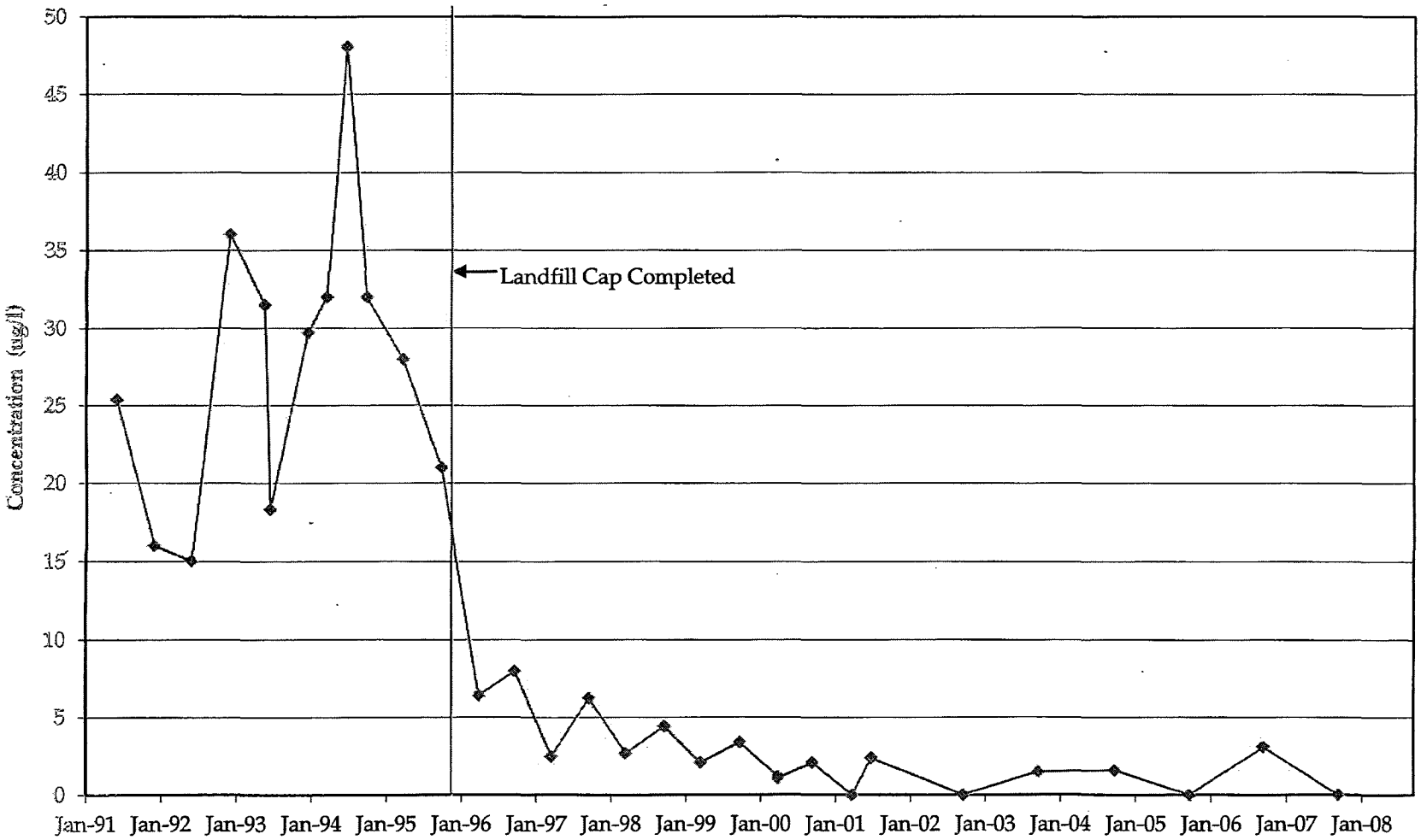
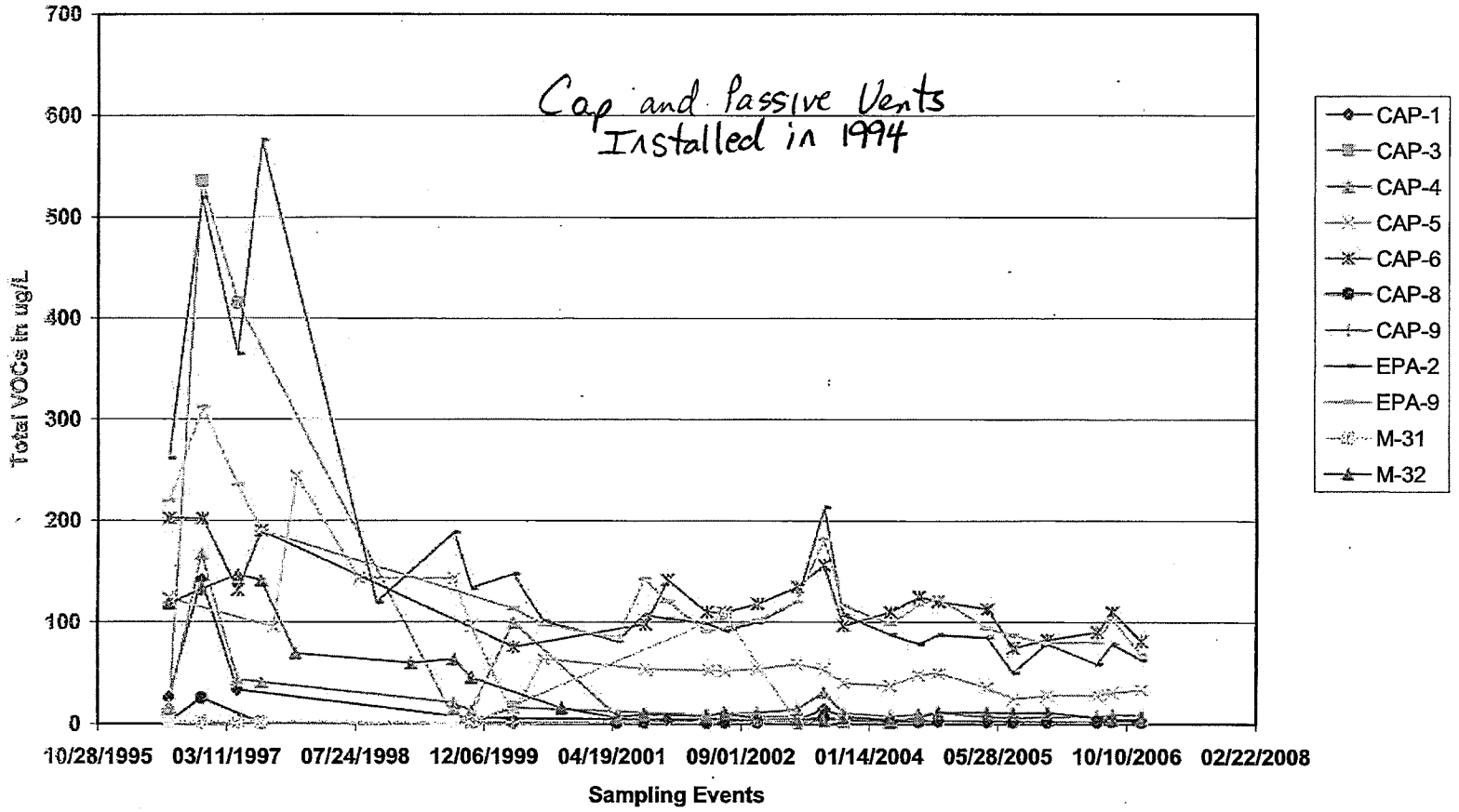
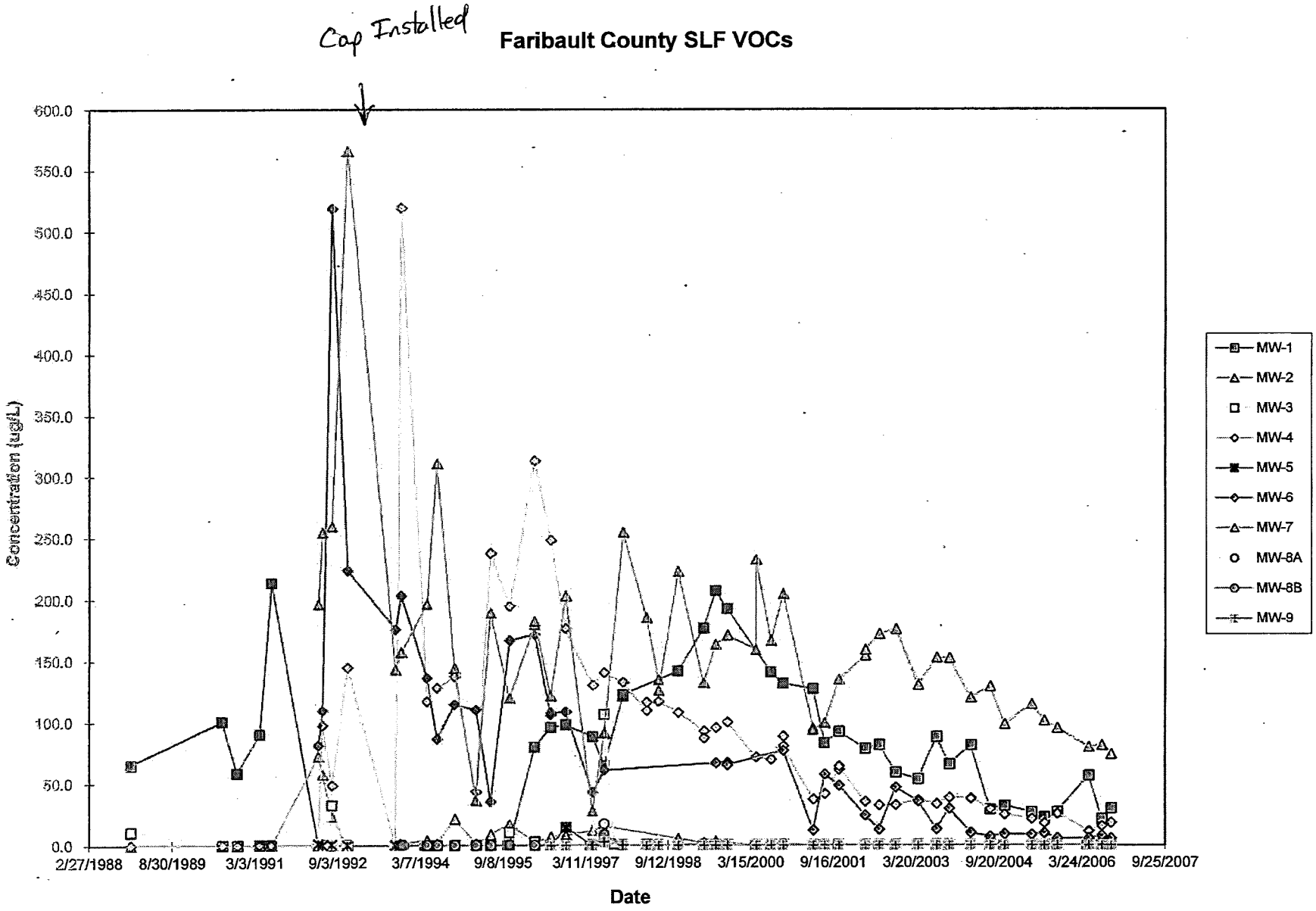


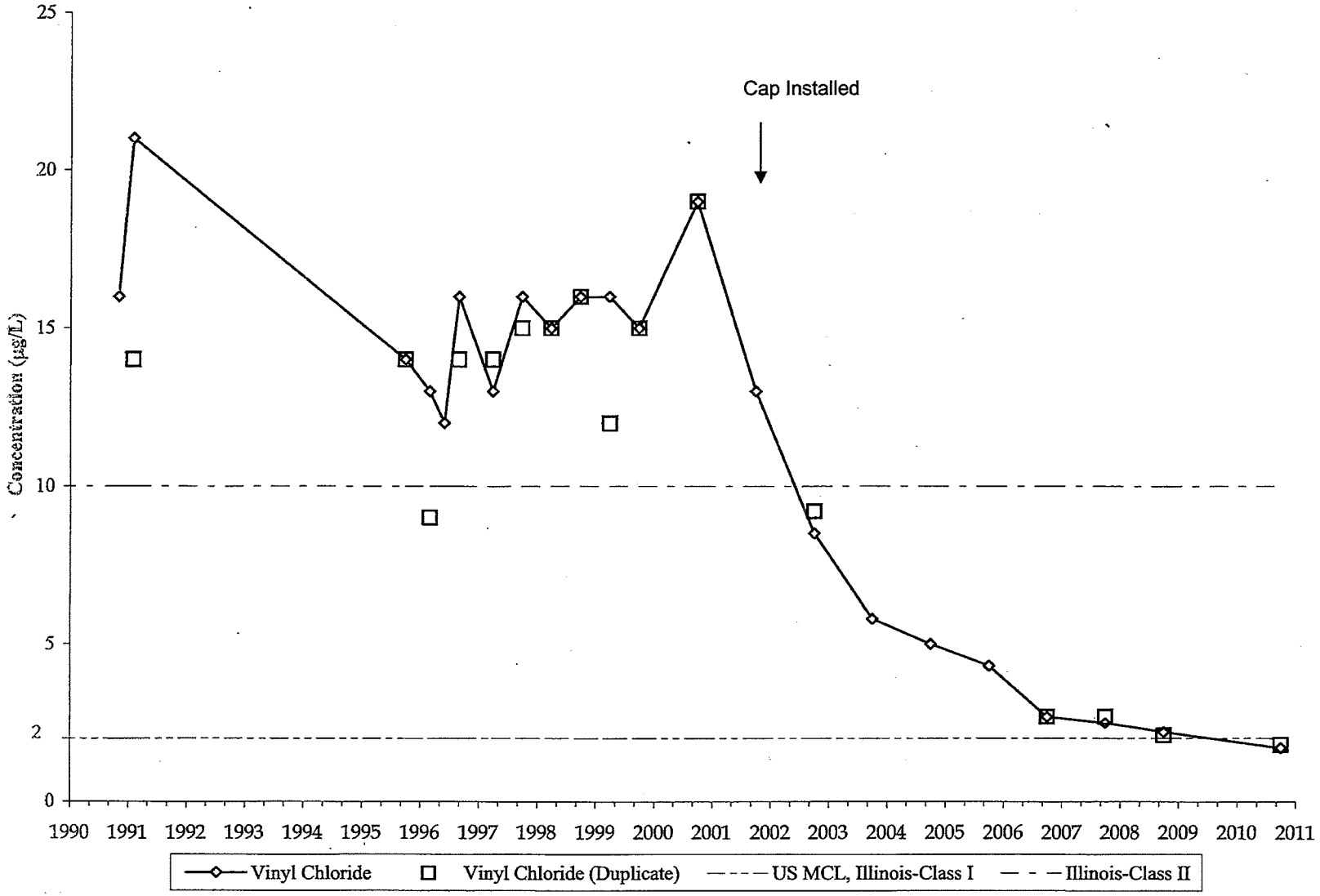
Figure 7

CROSBY AMERICAN PROPERTIES LANDFILL: Total VOCs
Station List: Shallow Aquifer Wells
Parameter List: 8260



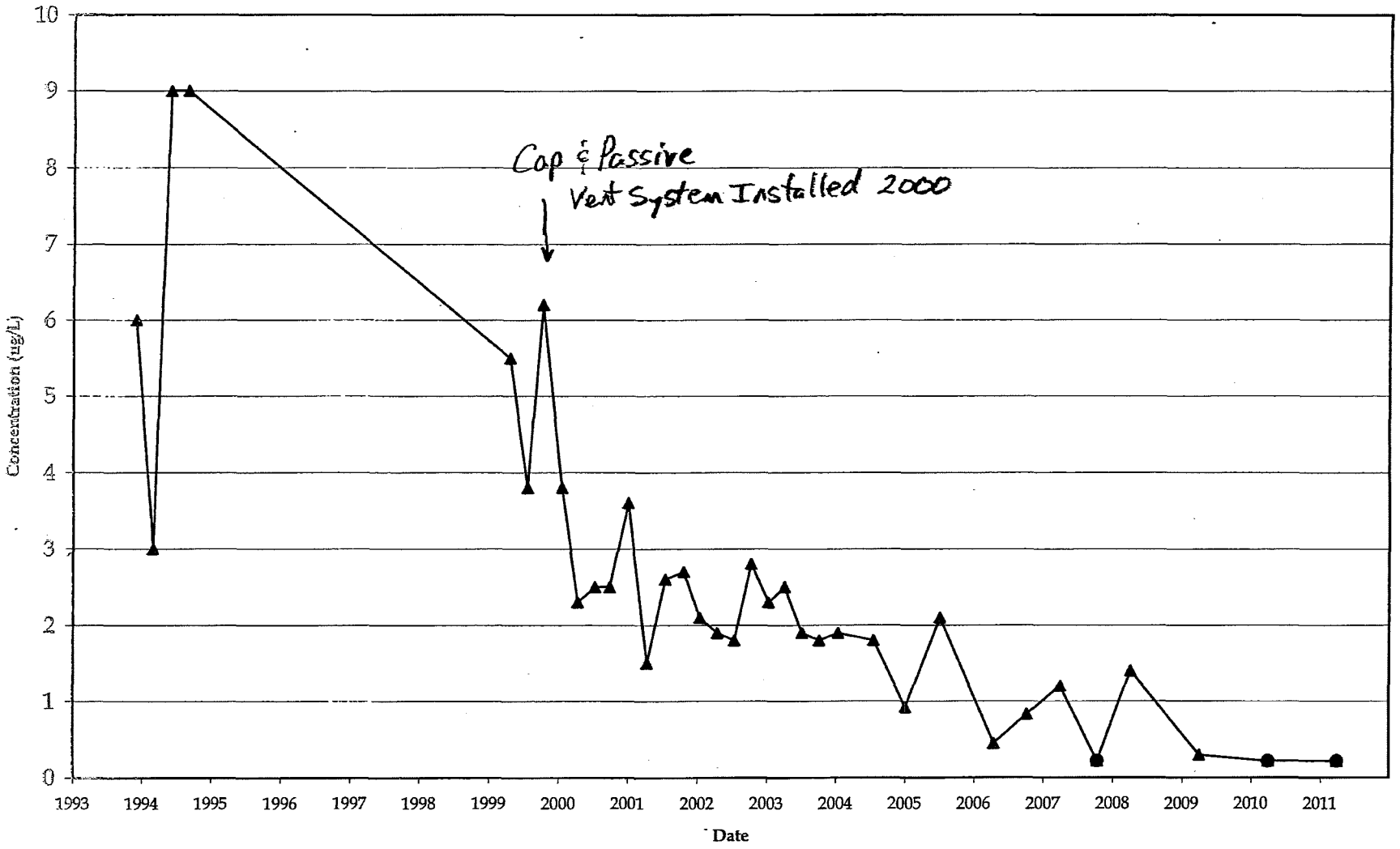

Cap Installed
Faribault County SLF VOCs
600.0
550.0
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Concentration (ug/L)
2/27/1988
8/30/1989
3/3/1991
9/3/1992
3/7/1994
9/8/1995
3/11/1997
9/12/1998
3/15/2000
9/16/2001
3/20/2003
9/20/2004
3/24/2006
9/25/2007
Date
MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MW-7
MW-8A
MW-8B
MW-9

PLOT OF VINYL CHLORIDE CONCENTRATION vs. TIME
MONITORING WELL MW-4D
2010 ANNUAL MONITROING EVENT
WOODSTOCK MUNICIPAL LANDFILL SITE
WOODSTOCK, ILLINOIS



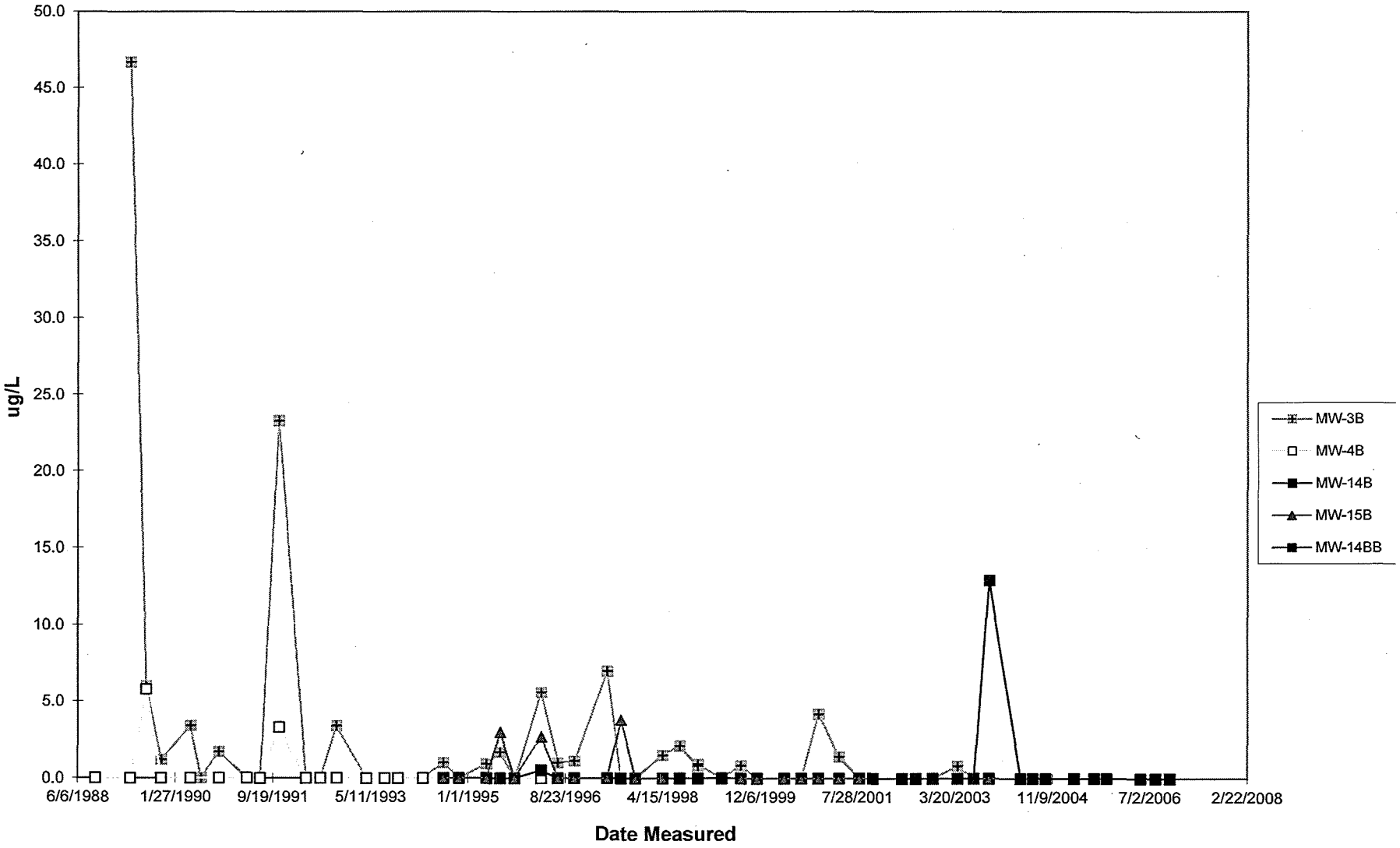
CRA 017224 (14)

M-24
VINYL CHLORIDE CONCENTRATIONS
FULTZ LANDFILL SUPERFUND SITE
BYESVILLE, OHIO

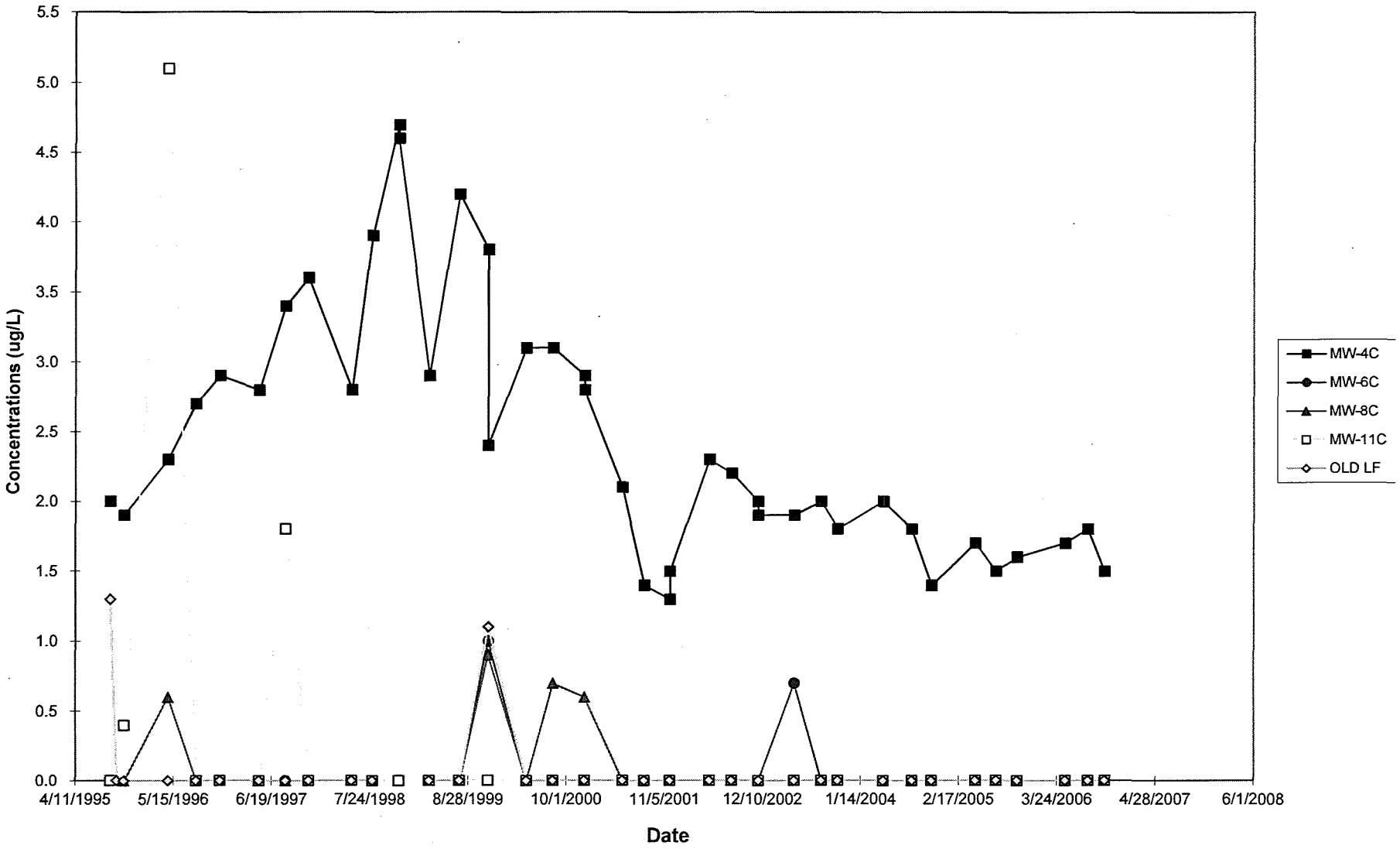


CRA 004710SCHO48-ATTC

Chippewa County SLF Total VOCs B Horizon



Red Rock VOCs



ATTACHMENT H

SITE SUMMARIES OF PASSIVE VENTING SITES

TABLE 4.1

PASSIVELY VENTED CLOSED LANDFILLS
MINNESOTA CLOSED LANDFILL PROGRAM

Landfill Name	*Landfill Location*	*Disposal Area Size (acres)*	*Estimated Volume of Waste (yd^3)*	*Gas Control Method*	*Number of Passive Vents*	*Number of Passive Vents per Acre*	*Yd^3 of Waste Per Vent*	*Off-Site Migration*	*Comments*
Red Rock	Mower County, Minnesota	35	1,738,500	Passive	15	0.4	115,900	None reported	
Hibbing	St. Louis County, Minnesota	30	1,445,566	Passive	21	0.7	68,836	None reported	
Crosby American	Dakota County, Minnesota	37	1,400,000	Passive	?	?	-	Yes - reported	Unable to confirm if migration resloved
Paynesville	Stearns County, Minnesota	13	870,000	Passive	13	1.0	66,923	None reported	
Leech Lake	Hubbard County, Minnesota	17	850,000	Passive	24	1.4	35,417	None reported	
Carlton County 2	Carlton County, Minnesota	29.5	815,000	Passive	18	0.6	45,278	None reported	
Faribault County	Faribault County, Minnesota	23.2	785,000	Passive	21	0.9	37,381	None reported	
Kummer	Beltrami County, Minnesota	23	750,000	Passive	23	1.0	32,609	Yes - reported	Confirmed not resolved
East Mesaba	St. Louis County, Minnesota	20	720,000	Passive	21	1.1	34,286	None reported	
Chippewa County	Chippewa County, Minnesota	18	690,000	Passive	13	0.7	53,077	Yes - reported	Unable to confirm if migration resloved
Roseau/Salol	Roseau County, Minnesota	30	670,000	Passive	31	1.0	21,613	None reported	
Lindala	Wright County, Minnesota	13	560,000	Passive	23	1.8	24,348	None reported	
Redwood County	Redwood County, Minnesota	32	550,000	Passive	11	0.3	50,000	None reported	
Kluver	Douglas County, Minnesota	17.7	525,000	Passive	28	1.6	18,750	Yes - reported	Unable to confirm if migration resloved
Wadena	Wadena County, Minnesota	17.8	525,000	Passive	18	1.0	29,167	None reported	
Gofer	Martin County, Minnesota	12	523,000	Passive	15	1.3	34,867	None reported	
Korf Brothers	Pine County, Minnesota	16	445,000	Passive	23	1.4	19,348	None reported	Concern of potential off-site migration
Northeast Ottertail	Ottertail County, Minnesota	13.25	404,297	Passive	9	0.7	44,922	None reported	
Meeker County	Meeker County, Minnesota	25	400,000	Passive	20	0.8	20,000	None reported	plus 6 riser vents in 4 trenches
Waseca County	Waseca County, Minnesota	15.5	400,000	Passive	18	1.2	22,222	None reported	
Long Prairie	Todd County, Minnesota	22	375,000	Passive	8	0.4	46,875	None reported	
Benson	Swift County, Minnesota	11	360,178	Passive	11	1.0	32,743	None reported	
Dodge County	Dodge County, Minnesota	11	328,000	Passive	26	2.4	12,615	Some concern reported	
Cass County Maple	Cass County, Minnesota	21	307,000	Passive	15	0.7	20,467	None reported	
Houston Co.	Houston County, Minnesota	5.7	303,000	Passive	3	0.5	101,000	None reported	plus 7 trenches
Pipestone County	Pipestone County, Minnesota	20	300,000	Passive	18	0.9	16,667	None reported	plus 3 horizontal vents
Bueckers #1	Stearns County, Minnesota	17	287,000	Passive	16	0.9	17,938	None reported	
Aitkin County	Aitkin County, Minnesota	4	271,000	Passive	8	2.0	33,875	None reported	
Stevens County	Stevens County, Minnesota	15.8	265,000	Passive	27	1.7	9,815	None reported	
Rock County	Rock County, Minnesota	16.5	250,000	Passive	20	1.2	12,500	None reported	
Hansen	Blue Earth County, Minnesota	14.7	240,000	Passive	6	0.4	40,000	None reported	
Murray County	Murray County, Minnesota	9.5	230,000	Passive	14	1.5	16,429	None reported	
Killian	Todd County, Minnesota	9	221,000	Passive	8	0.9	27,625	None reported	
Jackson County	Jackson County, Minnesota	19	213,820	Passive	3	0.2	71,273	None reported	
Cook County	Cook County, Minnesota	4.5	200,000	Passive	4	0.9	50,000	None reported	
French Lake	Wright County, Minnesota	6.3	200,000	Passive	7	1.1	28,571	None reported	
Ironwood	Fillmore County, Minnesota	13	200,000	Passive	19	1.5	10,526	None reported	
Hickory Grove	Aitkin County, Minnesota	8	192,000	Passive	7	0.9	27,429	None reported	
Northwoods	St. Louis County, Minnesota	12	192,000	Passive	12	1.0	16,000	None reported	
Big Stone	Big Stone County, Minnesota	11	180,000	Passive	13	1.2	13,846	None reported	
Minnesota Sanitation Services	Le Sueur County, Minnesota	9	178,000	Passive	11	1.2	16,182	Minor Concern	
Vermilion Modified	St. Louis County, Minnesota	7	170,000	Passive	9	1.3	18,889	None reported	
Sibley County	Sibley County, Minnesota	14	160,000	Passive	8	0.6	20,000	None reported	
LaGrande	Douglas County, Minnesota	5.2	155,094	Passive	11	2.1	14,099	None reported	
Iron Range	Itasca County, Minnesota	8.7	150,000	Passive	5	0.6	30,000	None reported	
Battle Lake	Ottertail County, Minnesota	7	140,000	Passive	13	1.9	10,769	None reported	
Hoyt Lakes	St. Louis County, Minnesota	10	133,000	Passive	9	0.9	14,778	None reported	

PASSIVELY VENTED CLOSED LANDFILLS
MINNESOTA CLOSED LANDFILL PROGRAM

Landfill Name	*Landfill Location*	*Disposal Area Size (acres)*	*Estimated Volume of Waste (yd^3)*	*Gas Control Method*	*Number of Passive Vents*	*Number of Passive Vents per Acre*	*Yd^3 of Waste Per Vent*	*Off-Site Migration*	*Comments*
Sun Prairie	Le Sueur County, Minnesota	20	130,411	Passive	6	0.3	21,735	None reported	
Hudson	St. Louis County, Minnesota	15	126,000	Passive	12	0.8	10,500	None reported	
Brookston	St. Louis County, Minnesota	8	101,005	Passive	6	0.8	16,834	None reported	
Cass Co. Walker-Hackensack	Cass County, Minnesota	10	100,000	Passive	10	1.0	10,000	None reported	
Mankato	Blue Earth County, Minnesota	13.7	100,000	Passive	5	0.4	20,000	None reported	plus 14 riser vents
Pickett	Hubbard County, Minnesota	9	93,269	Passive	9	1.0	10,363	None reported	vents connected by trenches
Highway 77	St. Louis County, Minnesota	4.67	88,391	Passive	?	?	-	None reported	
Crosby	Crow Wing County, Minnesota	8	87,000	Passive	8	1.0	10,875	None reported	
Eighty Acres	Beltrami County, Minnesota	4	87,000	Passive	10	2.5	8,700	None reported	
Northome Modified	Koochiching County, Minnesota	5.5	85,000	Passive	2	0.4	42,500	None reported	
Cass Co. Longville/Remer	Cass County, Minnesota	3.5	80,000	Passive	5	1.4	16,000	None reported	
Carlton South	Carlton County, Minnesota	7	77,000	Passive	5	0.7	15,400	None reported	
Lake of Woods	Lake of the Woods County	15	72,033	Passive	6	0.4	12,006	None reported	
Anderson	Wadena County, Minnesota	5.1	53,500	Passive	10	2.0	5,350	None reported	
Cook Area	St. Louis County, Minnesota	8	46,000	Passive	5	0.6	9,200	None reported	
Cotton Area	St. Louis County, Minnesota	6.3	38,000	Passive	8	1.3	4,750	None reported	
Fifty Lakes	Crow Wing County, Minnesota	4	28,000	Passive	8	2.0	3,500	None reported	
Average						1.0			

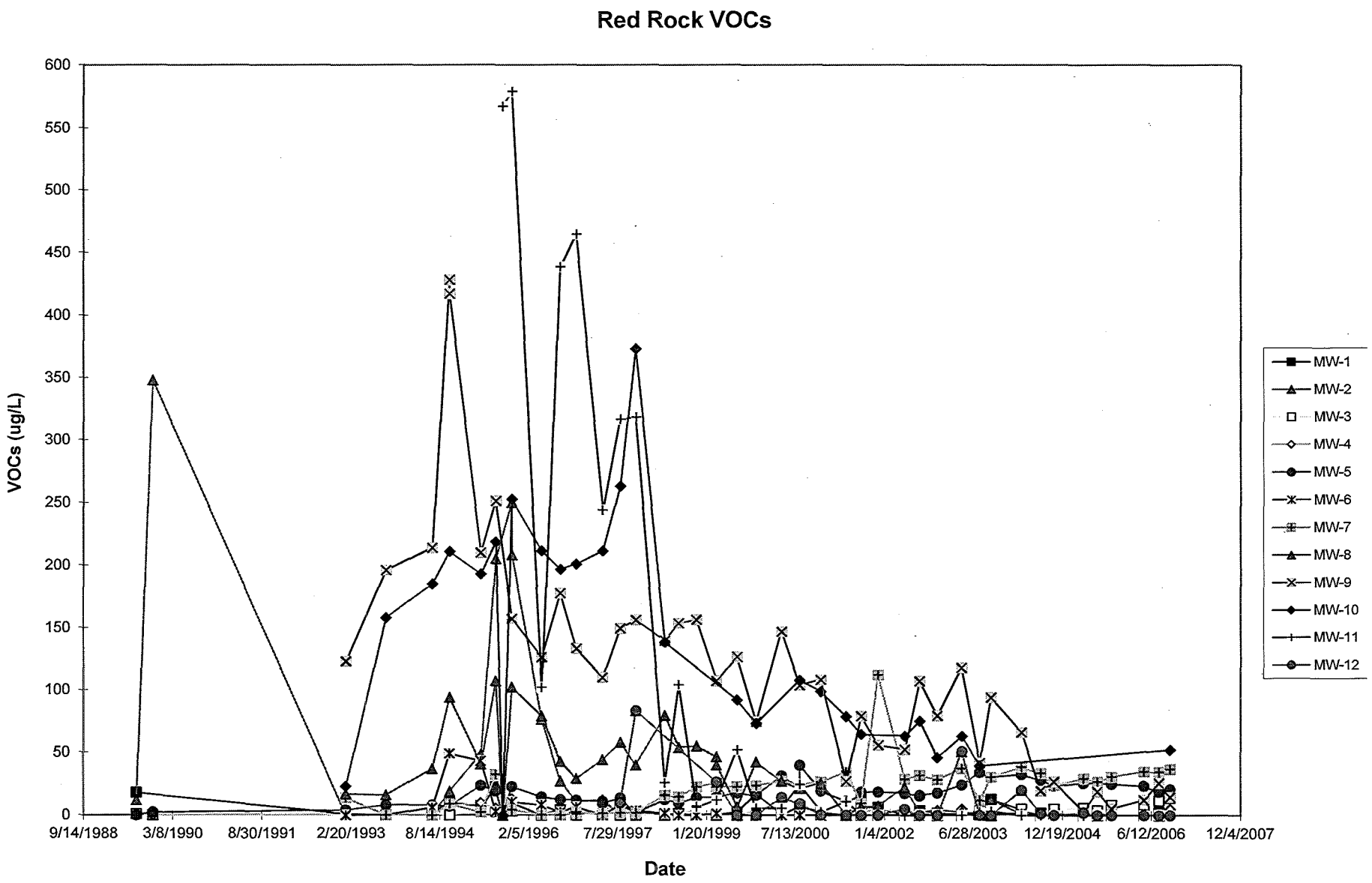
PASSIVE VENTING CASE STUDIES

Three case studies are presented below:

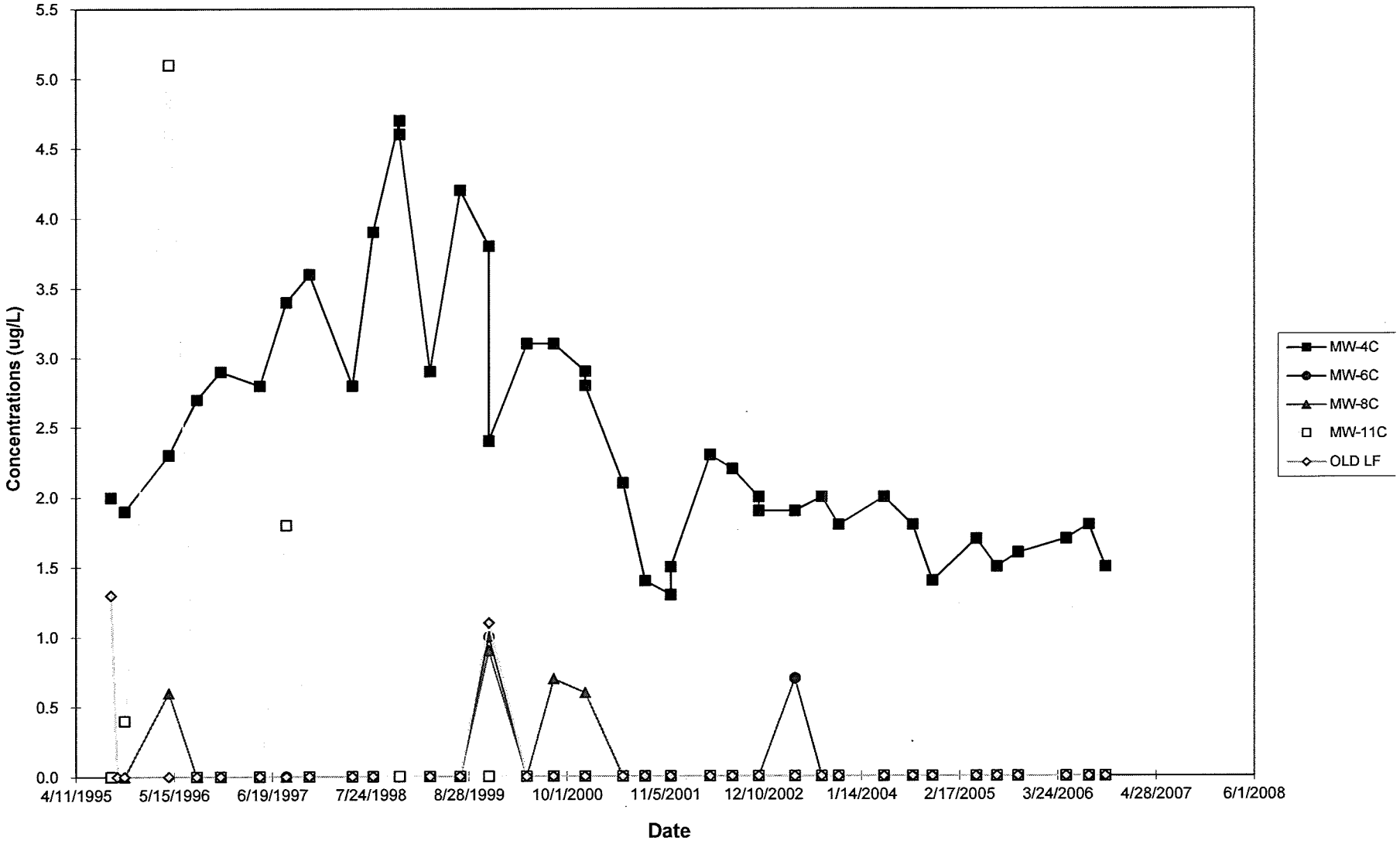
Project Name: Red Rock Closed Sanitary Landfill
Project Location: Mower County, Minnesota
Project Owner: Minnesota Pollution Control Agency
Project Contact: Shawn Ruotsinoja–MPCA Project Manager Ben Klismith– MPCA Project Engineer

Site Description: The Red Rock Closed Sanitary Landfill (Landfill) is located near Austin, Minnesota in Mower County. The Landfill is 35 acres in size and contains approximately 1,738,500 cubic yards of waste. The Landfill originally operated as an open dump from 1958 until 1971. The Landfill was permitted by the MPCA to accept waste as a sanitary landfill on 12/2/71 and continued operating until October 1980. When the landfill closed in October 1980, less than 2 feet of final cover was in place. Construction of a four-foot cover system with a passive venting system was completed in 1996. The passive venting system consists of 15 fully penetrating vents and 41 surficial waste trench risers.

The groundwater monitoring system consists of 17 monitoring wells of which 3 wells are located in an up-gradient direction, 11 are down-gradient, and 3 are side-gradient. Eleven of these wells are completed in the surficial aquifer, and six are completed in the Cedar Valley aquifer. Types of VOCs include benzene, ethyl benzene, various chlorinated VOCs including freons, tetrahydrofuran, ethyl ether, xylene, and toluene. As stated above, a compliant landfill cover was completed in 1996. There has been no active gas extraction or groundwater remediation conducted at the Site other than the installation of an improved landfill cover. The following figures present total VOCs versus time for samples collected from site wells. As shown on both figures, total VOCs have continually declined since the installation of the improved landfill cover in 1996.


Red Rock VOCs
VOCs (ug/L)
600
550
500
450
400
350
300
250
200
150
100
50
0
9/14/1988
3/8/1990
8/30/1991
2/20/1993
8/14/1994
2/5/1996
7/29/1997
1/20/1999
7/13/2000
1/4/2002
6/28/2003
12/19/2004
6/12/2006
12/4/2007
Date
MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MW-7
MW-8
MW-9
MW-10
MW-11
MW-12

Red Rock VOCs



Project Name: Crosby American Properties Landfill
Project Location: Inver Grove Heights, Minnesota
Project Owner: Minnesota Pollution Control Agency
Project Contact: Shawn Ruotsinoja-MPCA Project Manager Ben Klismith- MPCA Project Engineer

Site Description: The Crosby American Properties Landfill (Landfill), located in City of Inver Grove Heights, Minnesota, received its first permit to accept waste on September 15, 1970, and continued operating until June 1, 1989. The Landfill is 37 acres in size and contains approximately 1,400,000 cubic yards of waste. The Landfill was under private ownership when in operation.

A cover for the Landfill was installed in accordance with current MPCA Solid Waste rules along with a passive gas venting system in 1994. It is unknown as to the construction of the passive gas venting system. The groundwater monitoring system for the landfill includes 12 monitoring wells. The monitoring wells are completed in either the shallow drift aquifer at the water table and at intermediate depths in the drift aquifer.

VOCs in the landfill waste have impacted groundwater. Types of VOCs include benzene, various chlorinated VOCs including freons, ethyl ether, and tetrahydrofuran. As stated above, a Minnesota rule compliant landfill cover was installed in 1994. There has been no active gas extraction of groundwater remediation conducted at the Site other than the installation of an improved landfill cover. The following figures present total VOCs versus time for samples collected from site wells. As shown on both figures, total VOCs have continually declined since the installation of the improved landfill cover in 1994.

Figure 7

CROSBY AMERICAN PROPERTIES LANDFILL: Total VOCs
Station List: Shallow Aquifer Wells
Parameter List: 8260

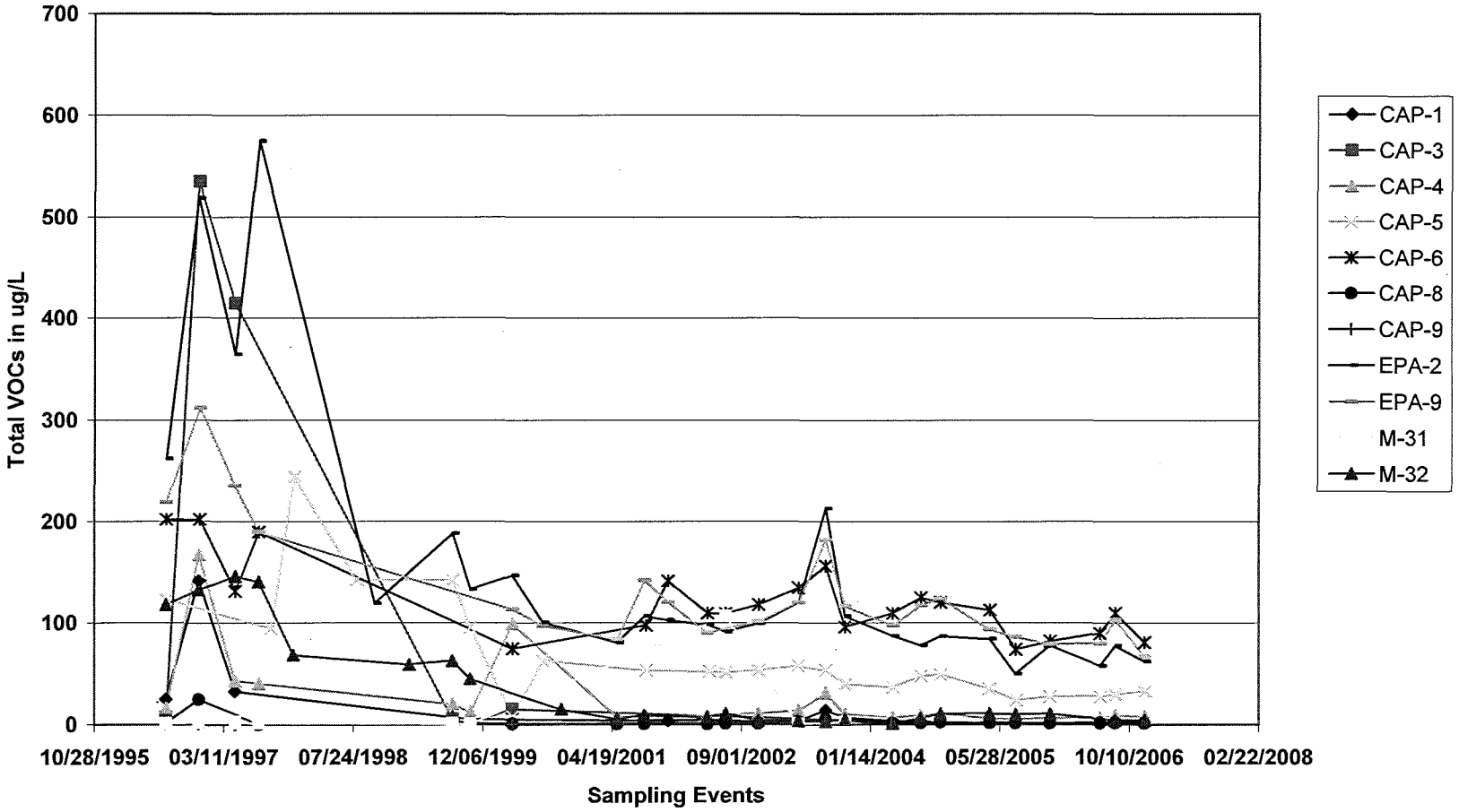
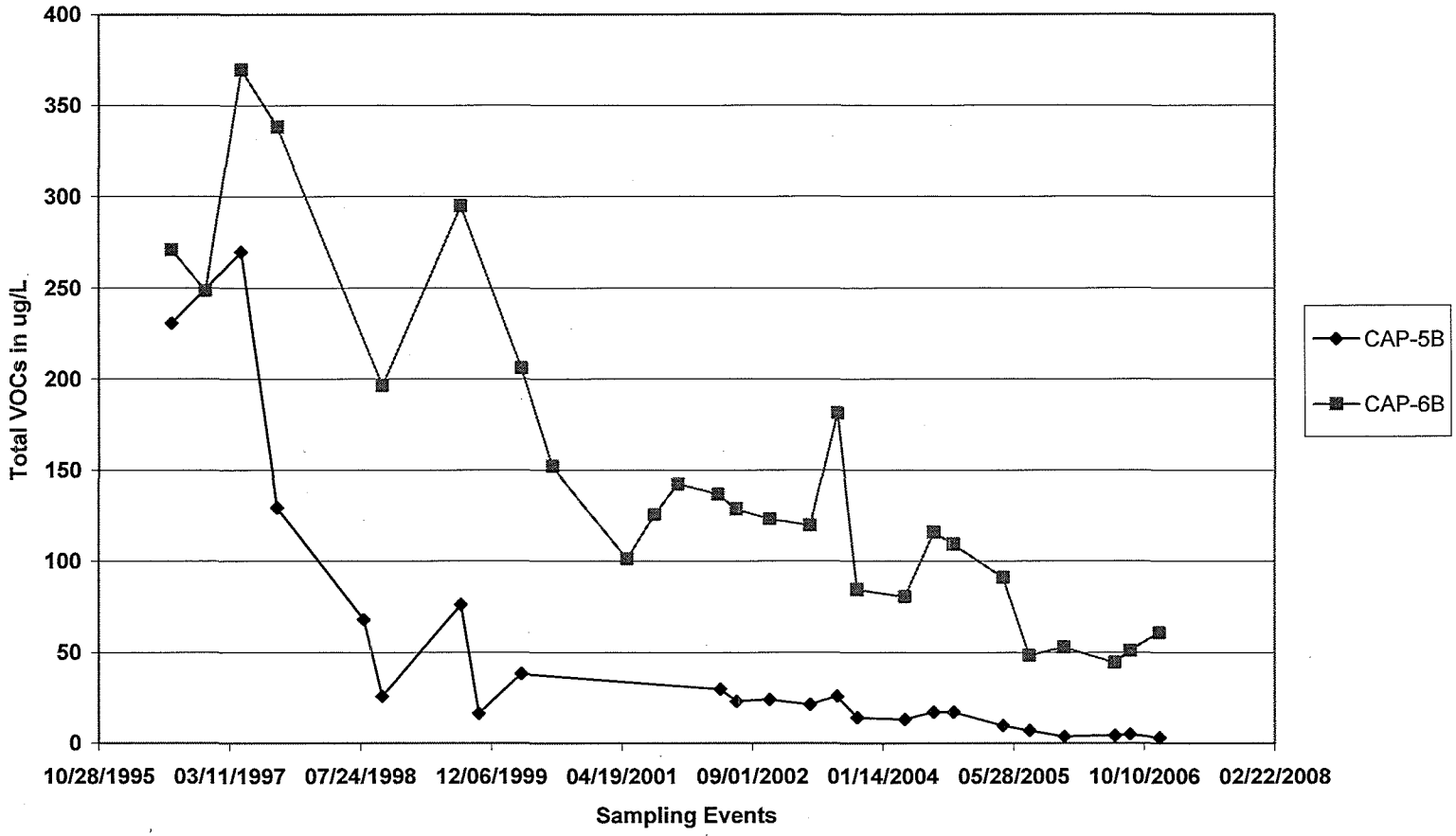


Figure 8

CROSBY AMERICAN PROPERTIES LANDFILL: Total VOCs
Station List: Intermediate Aquifer Wells
Parameter List: 8260



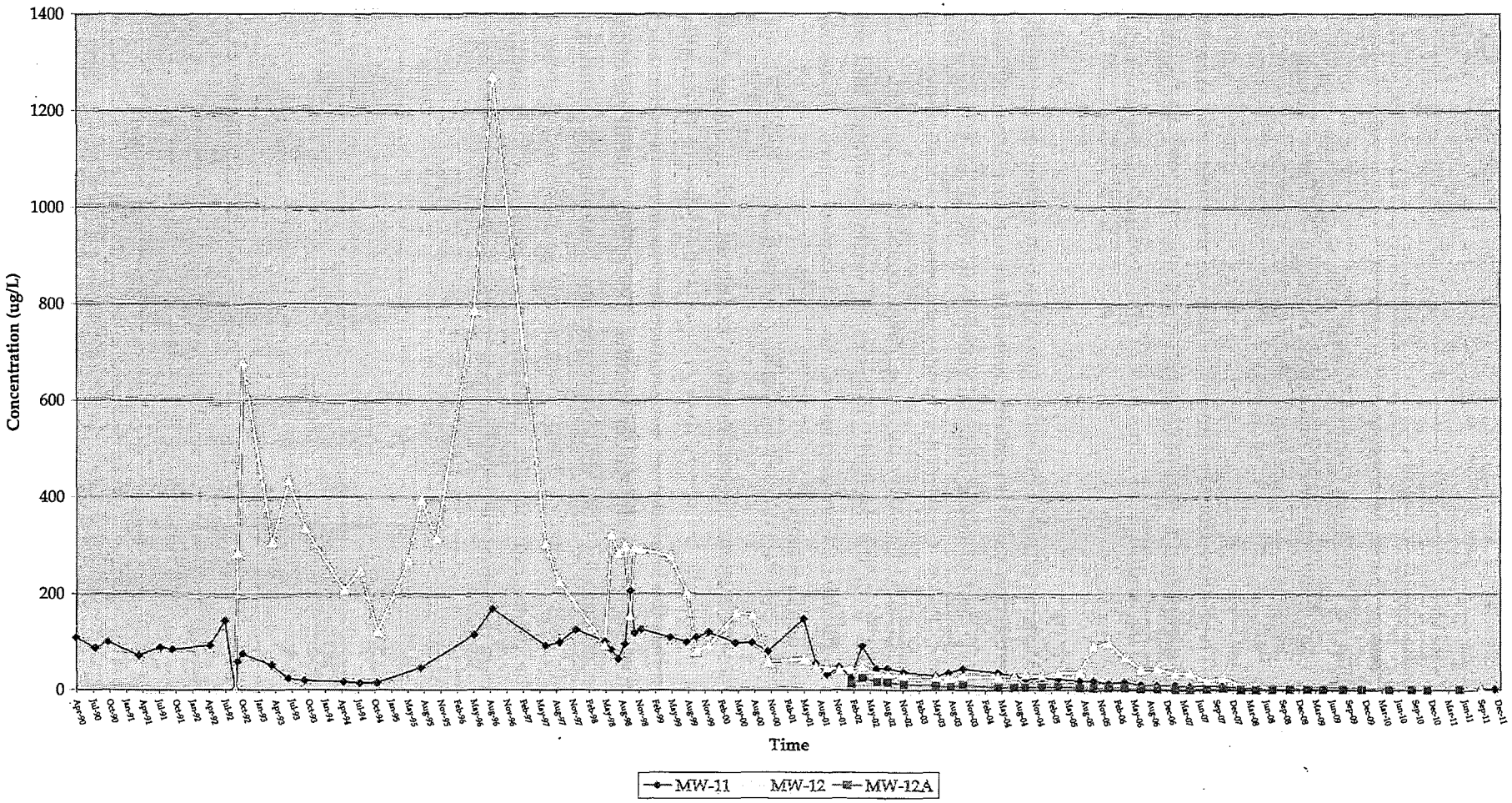
Project Name: Becker County Landfill
Project Location: Detroit Lakes, Minnesota
Project Owner: Minnesota Pollution Control Agency
Project Contact: Tom Newman-MPCA Project Manager Peter Tiffany- MPCA Project Engineer

Site Description: The Becker County Landfill is located near Detroit Lakes, Minnesota. The landfill received its first permit to accept waste on November 15, 1972, and continued operating until July of 1990. The landfill is 33 acres in size and contains approximately 1,372,000 cubic yards of waste.

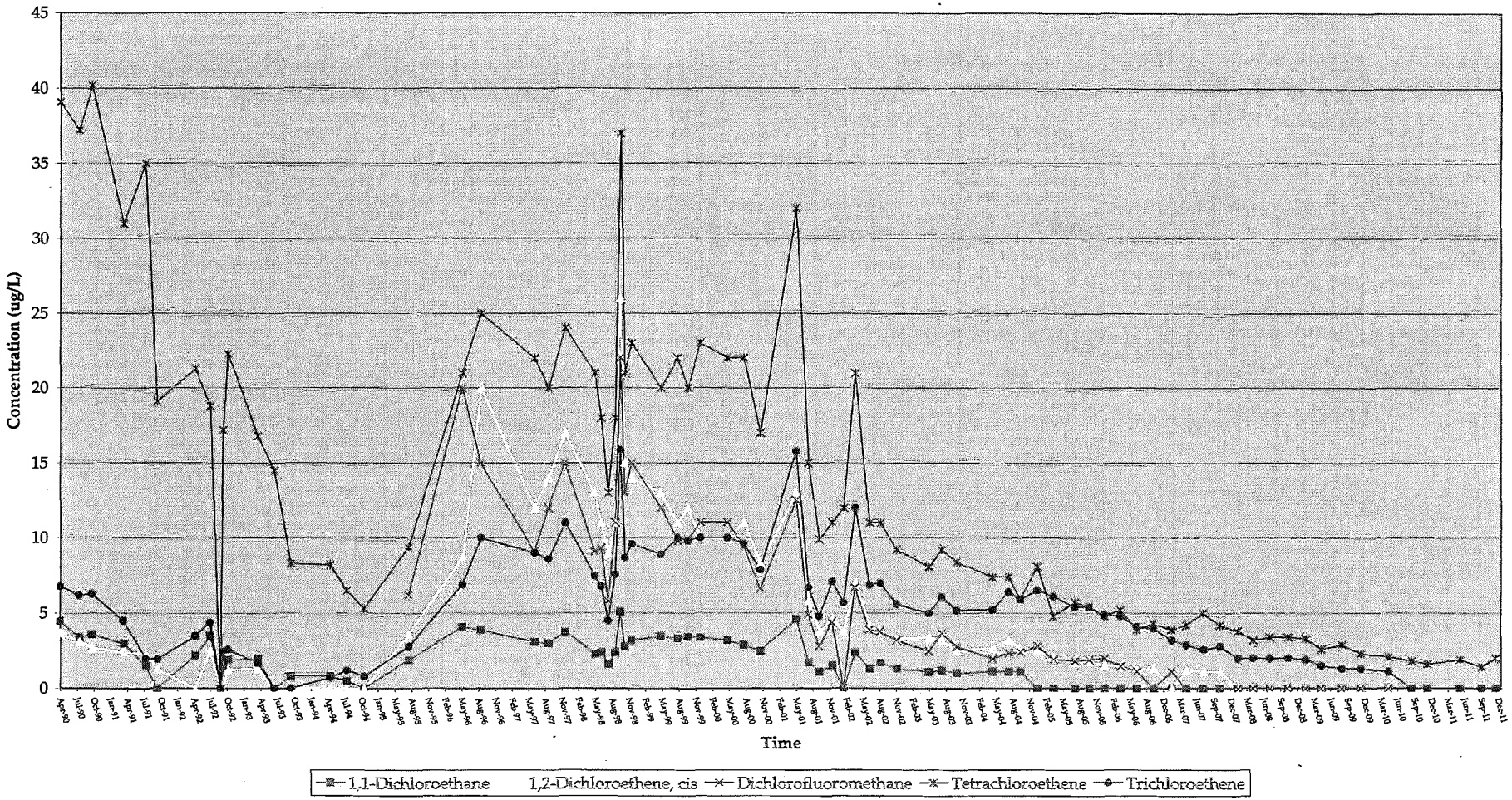
In late 1996, the MPCA constructed an active gas extraction system at the landfill. During the installation of the extraction wells it was discovered that half of the landfill was covered with only six inches to one foot of cover material rather than the three to four foot cover system required by Minnesota Rules. Construction of the gas system was halted throughout the spring and summer of 1997 until a final cover upgrade design could be completed. In October of 1997 construction resumed with the westerly 15 acres of waste excavated and relocated to the easterly 19 acres of fill area. Construction of the redesigned active gas recovery and cover system was completed in November of 1998.

The active gas recovery system began operation in July of 1998. The upgraded final cover system consists of a synthetic membrane barrier layer and 2.5 feet of cover soils. In 2008, the MPCA determined that the landfill does not produce sufficient gas (less than60 cfm) to support full-time operation of the flare in the winter months. Since 2008, landfill gas extraction has been suspended each year typically from mid-November until late March. During these periods, landfill gas is passively vented. There have been no observed increases of VOCs in groundwater at the downgradient edge of waste as a result of winter shut down of active venting. If fact, perchloroethylene levels in groundwater continue to decline over the past 4 years.

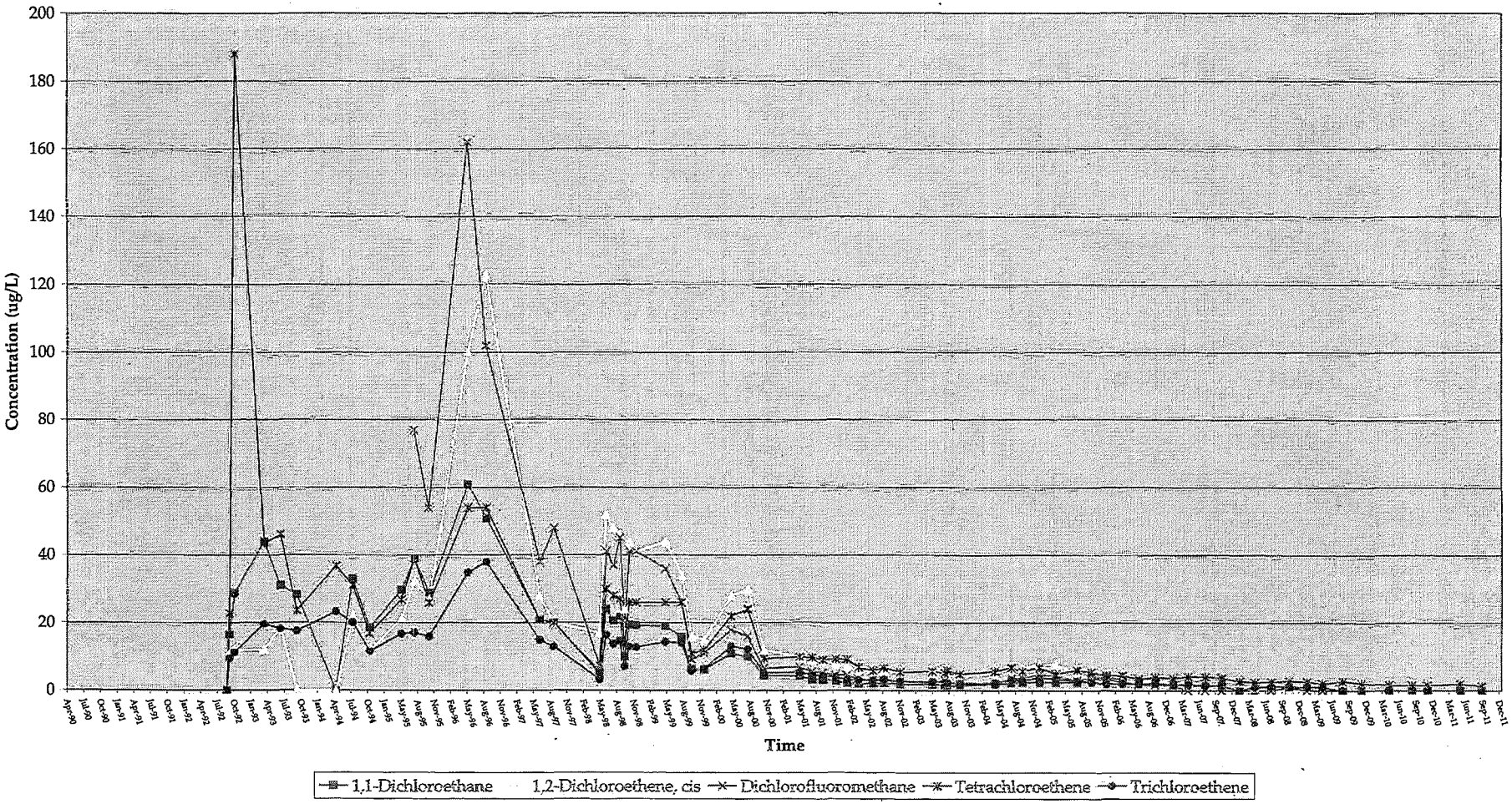
Total VOC Concentrations



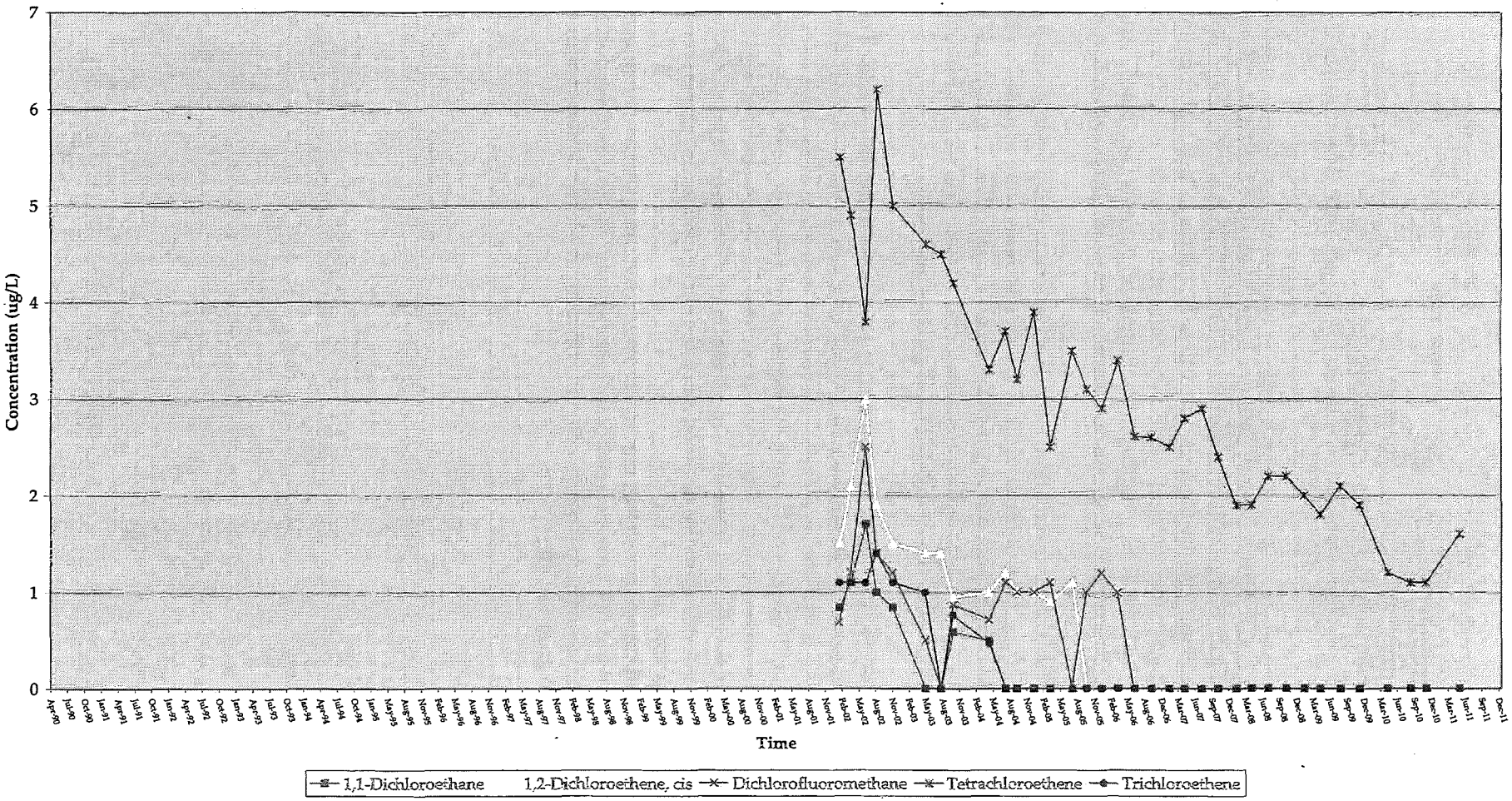
Select VOC Concentrations (MW-11)



Select VOC Concentrations (MW-12)



Select VOC Concentrations (MW-12A)



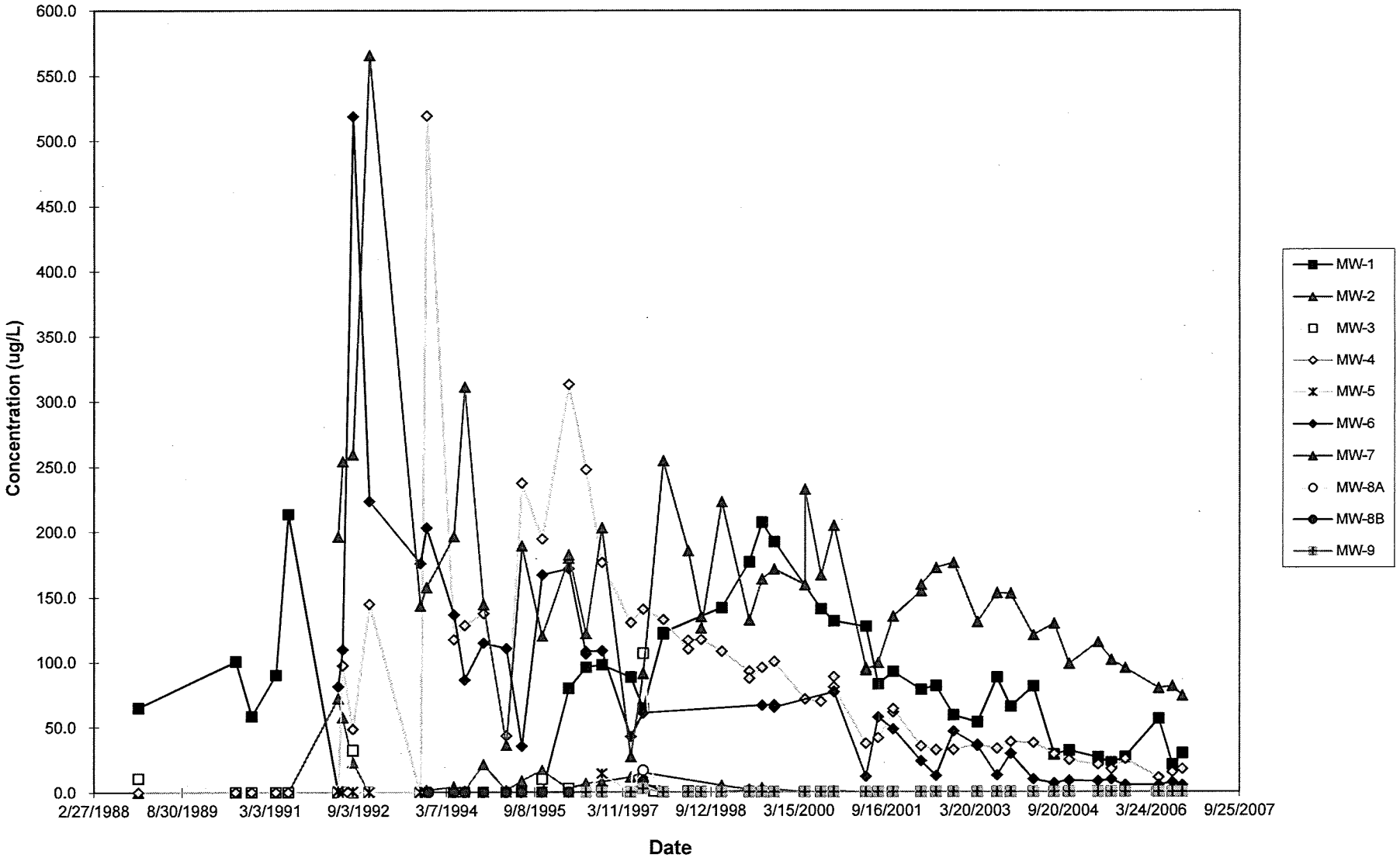
Project Name: Faribault Closed Landfill
Project Location: Faribault County, Minnesota
Project Owner: Minnesota Pollution Control Agency
Project Contact: Shawn Ruotsinoja-MPCA Project Manager Ben Klismith- MPCA Project Engineer

Site Description: The Faribault County Sanitary Landfill located in Faribault County, Minnesota, received its first permit to accept waste on 5/10/72, and continued operating until May 1990. The Faribault County Sanitary Landfill is 23.2 acres in size and contains approximately 785,000 cubic yards of waste. The Landfill was under mixed ownership when in operation. When the landfill closed, three feet of final soil cover was in place. Additional construction in 2002 addressed problems with settling, erosion, drainage, and well access.

At the time of the final cover installation, a shallow passive venting system was installed. Following MPCA acquisition of the landfill, eighteen gas vents were installed in 2000 as the MPCA determined that the shallow venting system was ineffective. The new gas vents were completed to the depth of waste and screened across the waste horizon. Additional passive vents were installed in 2008 that mitigated localized gas migration.

Shallow groundwater at the Site has been impacted by VOCs in landfill waste. Types of VOCs that have impacted groundwater include BETXs, chlorinated solvents, freons, and tetrahydrafuran. As stated above, a 3-foot soil cover was in place at the time of closure in the early 1990's. The landfill does not have a membrane cover system, active gas collection, or a groundwater remediation system. The figure presented in Attachment F shows the total VOCs measured in samples collected from site wells over time. As shown, total VOCs concentrations have continually and substantially declined since the early 1990's. As can be seen in the figure, there was no noticeable effect in the downward VOC trend for the period in which an ineffective gas venting system was in place. Moreover, the installation of an effective passive gas venting system did not provide a noticeable acceleration in the downward VOC trend rate. From the data, the installation of the soil cover is the primary factor in the continued reduction in VOC impacts to groundwater.

Faribault County SLF VOCs

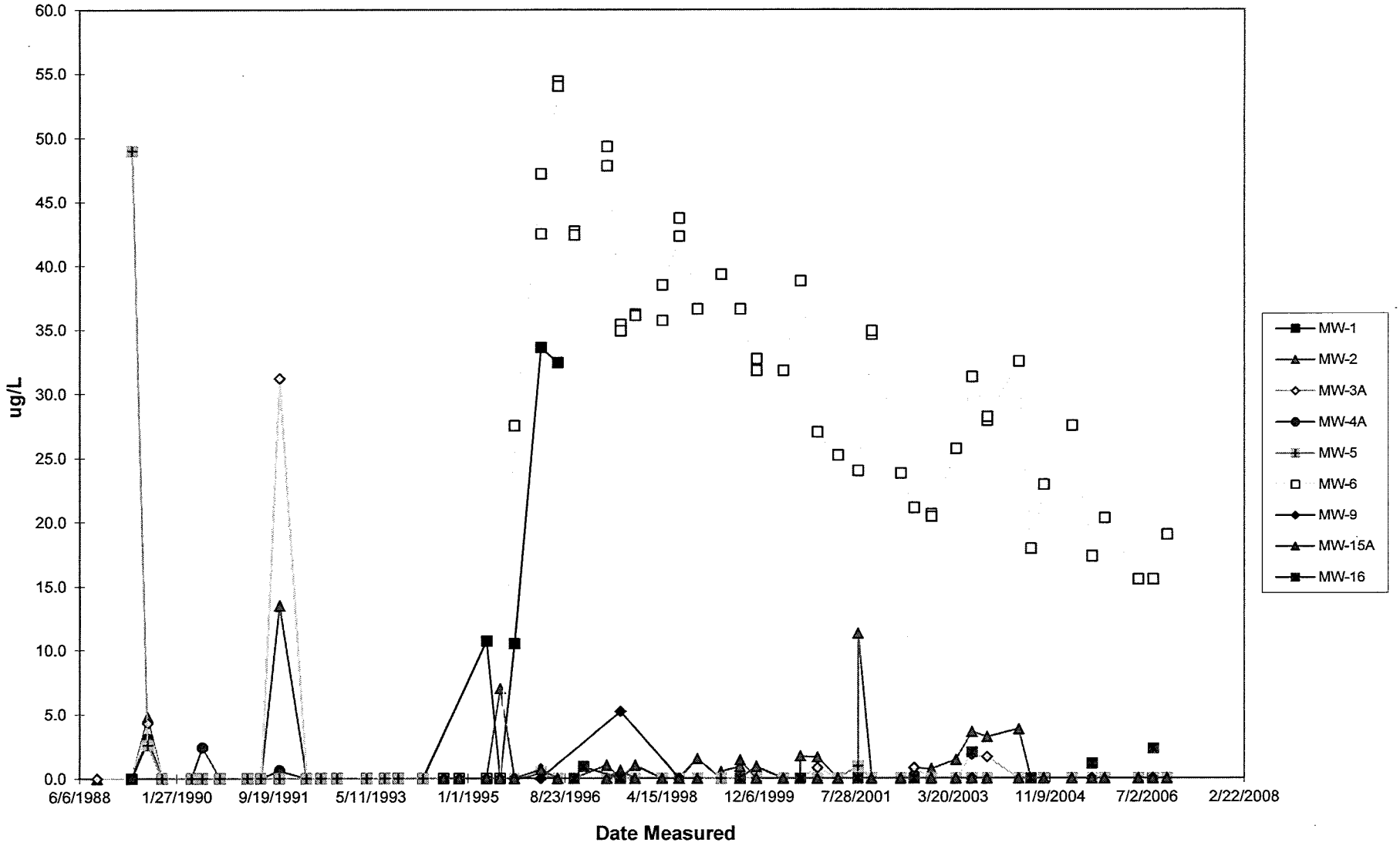


Project Name: Chippewa County Closed Sanitary Landfill
Project Location: Chippewa County, Minnesota
Project Owner: Minnesota Pollution Control Agency
Project Contact: Tom Newman–MPCA Project Manager Ben Klismith– MPCA Project Engineer

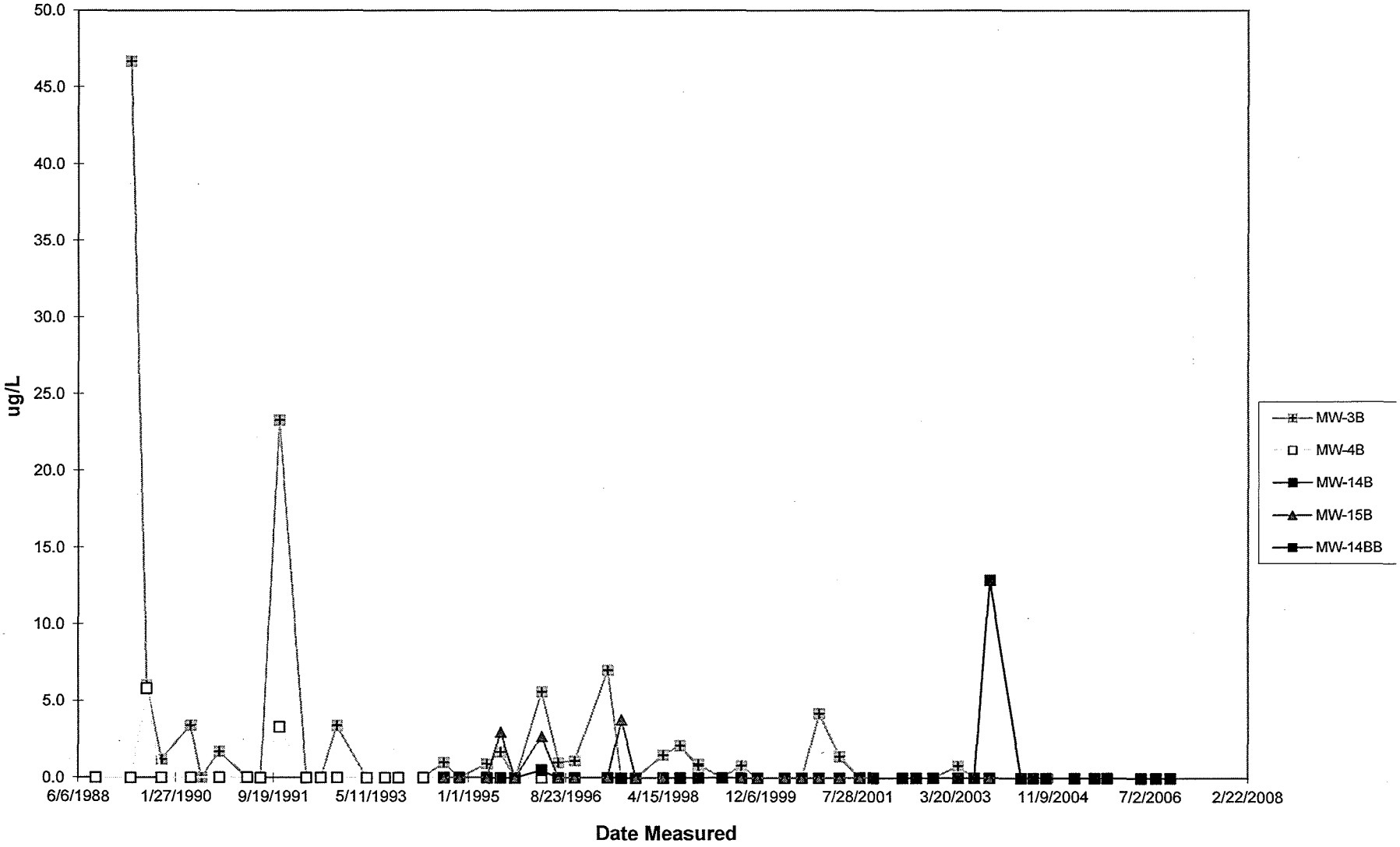
Site Description: The Chippewa County Sanitary Landfill (Landfill) located in Chippewa County, Sparta East received its first permit to accept waste on October 6, 1971, and continued operating until April 1994. The Chippewa County Sanitary Landfill is 18 acres in size and contains approximately 690,000 cubic yards of waste. The Landfill was under mixed ownership when in operation. The landfill was closed with a four-foot final cover system with an engineered two-foot clay barrier overlain by a sand drainage layer on the western portion. The eastern portion has a synthetic cover system. The cover system was constructed in 1993-1994 with a passive gas venting system consisting of 13 vents over the western one-half of the site. The MPCA assumed responsibility of the landfill in February 1997.

The groundwater monitoring system consists of 11 monitoring wells. Of these, four wells are located in an upgradient direction and seven are downgradient. VOCs in the landfill waste have impacted groundwater. Types of VOCs include benzene, various chlorinated VOCs including freons, ethyl ether, xylene, and toluene. As stated above, an engineered landfill cover was completed in 1994. There has been no active gas extraction or groundwater remediation conducted at the Site other than the installation of an improved landfill cover. The following figures present total VOCs versus time for samples collected from site wells. As shown on both figures, total VOCs have continually declined since the installation of the improved landfill cover in 1994.

Chippewa County SLF Total VOCs A Horizon



Chippewa County SLF Total VOCs B Horizon



Chippewa County SLF MW-6 VOCs