CONESTOGA-ROVERS & ASSOCIATES

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

TRANSMITTAL

DATE: April 13, 2012

REFERENCE NO.: 074702-10

PROJECT NAME: Holtz-Krause Closed Landfill

TO: Ms. Erin Endsley
Wisconsin Department of Natural Resources
1701 North 4th Street
Superior, Wisconsin 54880

Please find enclosed:
- ☐ Draft
- ☐ Originals
- ☒ Prints
- ☐ Final
- ☐ Other

Sent via:
- ☐ Mail
- ☐ Overnight Courier
- ☐ Same Day Courier
- ☒ Other Overnight Courier - Standard

QUANTITY	DESCRIPTION
1	REMEDIAL ACTION PLAN - PROPOSED MODIFICATIONS TO HOLTZ KRAUSE LANDFILL, CRA APRIL 2012

- ☐ As Requested
- ☒ For Your Use
- ☐ For Review and Comment
- ☐
- ☐

COMMENTS:

Copy to:

Completed by: Robert Martin
[Please Print]

Signed: Robert Martin

Filing: **Correspondence File**

REMEDIAL ACTION PLAN

PROPOSED MODIFICATIONS TO HOLTZ KRAUSE LANDFILL

HOLTZ KRAUSE LANDFILL
WAUSAU, WISCONSIN

Prepared For:
Holtz Krause Steering Committee

REMEDIAL ACTION PLAN

PROPOSED MODIFICATIONS TO HOLTZ KRAUSE LANDFILL

HOLTZ KRAUSE LANDFILL
WAUSAU, WISCONSIN

Prepared For:
Holtz Krause Steering Committee

Prepared by:
Conestoga-Rovers & Associates

1801 Old Highway 8 Northwest, Suite 114
St. Paul, Minnesota 55112

Office: 651-639-0913
Fax: 651-639-0923

APRIL 2012
REF. NO. 074702 (8)
This report is printed on recycled paper.

TABLE OF CONTENTS

Page

TABLE OF CONTENTS

Page

LIST OF FIGURES
(Following Text)

LIST OF TABLES
(Following Text)

LIST OF APPENDICES

1.0 INTRODUCTION

This Remedial Action Plan (RAP) provides a description of the proposed modifications to be undertaken at the Holtz Krause Landfill in support of a Certificate of Completion request under by the Voluntary Pollution Liability Exemption (VPLE). Specifically, this report includes the following:

- Background information on the landfill history and remedial actions completed over the past seventeen years
- Phase I documentation supporting a determination that all of the recognized environmental conditions (REC) are defined.
- Phase II documentation supporting a determination that the nature and extent of groundwater contamination is delineated
- The technical justification supporting the granting of a Certificate of Completion.
- A description of the post-VPLE development called *Soccer Complex Development*. The key changes here are grading changes and an active gas venting system.
- An application for development at historic fill site or licensed landfill exemption.

In February 2012, the Holtz Krause Steering Committee submitted an application under the Voluntary Pollution Liability Exemption program with the intent of reaching closure and then developing the property as a soccer complex (CRA, 2012). Figure 1.1 presents the proposed soccer field layout. The Wisconsin Department of Natural Resources (DNR) provided an "Approval to Proceed" letter on February 22, 2012. In that letter, the DNR stated that "*a solid waste facility must be able to be closed without reliance on any active remedial system to ensure compliance with environmental and public health standards, such as groundwater monitoring; leachate or groundwater collection or treatment; or active gas extraction*".

This report addresses requirements.

2.0 BACKGROUND

2.1 SITE HISTORY AND FEATURES

The Holtz Krause Landfill is a 57 acre site that operated between 1957 and 1980. This landfill received approximately 2.0 million cubic yards (CY) of waste, including municipal solid waste, noncombustible waste, demolition material, and wood waste.

Figure 2.1 presents a site aerial photo. The Site is located at the end of East Kent Street east of Grand Ave.

DNR involvement with the landfill began in 1969, when the DNR suspected leachate from the landfill site was seeping into adjoining waters and issued an order in November 1972 resulting in a hydrogeologic investigation

From approximately 1989 to 1992, Remedial Investigation/Feasibility Studies (RI/FS) were conducted. The RI characterized the site, defined the migration pathways and described methods used to evaluate the extent and magnitude of contaminant migration within those pathways, assessed risk and provided data for the FS.

Figures 2.2, 2.3, 2.4 and 2.5 present cross-section locations and three cross-sections through the landfill. As shown, Figure 2.3 provides an east-west cross-section and shows that there is a shallow water table.

Figure 2.5 provides a north-south cross-section. The area south of the landfill is a wetland and floodplain area.

The DNR selected a remedy for the landfill in July 1992. As required by the remedy, a double-barrier cover and active landfill gas extraction system were constructed in 1994. Additionally, institutional controls and deed restrictions were implemented at the site to provide further protection to public health and welfare.

Groundwater monitoring and operation of the active gas system was undertaken. Long-term groundwater and landfill gas monitoring are summarized in annual monitoring reports from 1997 to present.

No leachate collection system was installed when the landfill was built, and a retrofit system was not required.

In 2011, an Amendment to the remedy was issued by the DNR that approved Monitored Natural Attenuation (MNA) as the final groundwater remedy. The decision to approve MNA was based on monitoring data from approximately 38 monitoring wells. These data show that the groundwater contamination plume is stable or decreasing and aquifer chemistry is favorable for anaerobic biodegradation of the contaminants of concern.

2.2 EXISTING LANDFILL CAP REMEDY

The cover system consists of (from ground surface):

- A Vegetative Layer consisting of 6 inches of topsoil and 2.5 feet of rooting zone soil
- Primary Barrier Layer consisting of a 40 mil VLDPE geomembrane liner
- Secondary Barrier Layer consisting of 2 feet of clay
- The 1982 soil cover (0 to 2 feet thick)

2.3 EXISTING ACTIVE LANDFILL GAS REMEDY

The active gas collection system began operation on December 22, 1994. Figure 2.6 shows the active gas collection flow rate and methane levels over the 17-year operating history. As shown, the flow rate declined from 375 cubic feet per minute (CFM) in 1995 to an average of 178 CFM in 2011. Conestoga-Rovers & Associates (CRA) evaluated the existing system in 2011 and concluded that the preferred flow rate (a balance between gas production and extraction) is approximately 100 CFM. However, the current gas extraction blower is oversized and unable to operate at this flow rate. The 100 CFM rate is much lower than the 1994 rate because landfill gas production has declined substantially due to waste decomposition. An evaluation of the system showed that a de minimis amount of landfill gas is produced and extracted from the southern quarter of the landfill.

The decline in landfill gas production with age is a well established condition for municipal waste. The landfill began receiving waste in 1957 and stopped receiving waste in 1980. Waste in the site is between 32 and 55 years old. Landfill gas production is typically greatest in the first 10 years after closure and declines significantly after that.

Figure 2.6 also shows that the methane levels have decreased significantly over time. This substantial decline is primarily due to (i) the lower gas production associated with landfill aging and also due to (ii) the extraction system drawing clean soil gas from the perimeter area.

2.4 PLANS FOR 2012

The Holtz Krause Steering Committee's plans for 2012 are as follows:

- Complete the VPLE process and obtain a Certificate of Completion
- Transfer ownership of the property
- Design and begin construction of a 15 field soccer complex with active gas extraction for gas control and flaring for odor control. Figure 1.1 of Section 1.0 presents the proposed soccer field layout.

3.0 VPLE ELEMENTS

3.1 PHASE I ENVIRONMENTAL SITE ASSESSMENT

A Phase I ESA was completed and submitted to the DNR in December, 2011 (CRA, 2011).

As discussed in the Phase I ESA, the assessment revealed no evidence of new recognized environmental conditions (RECs) at this site.

3.2 PHASE II ENVIRONMENTAL ASSESSMENT/REMEDIAL INVESTIGATION

NR 716 sets the requirements for site investigation. These requirements include reviewing the history of the Site, including nature and extent of the contamination, assessing adverse impacts to the area, and developing a work plan for field investigation which uses approved sampling techniques. The findings from the site investigation must be included in a report submitted to the DNR for review. The nature and extent of contamination was delineated, documented and approved by the DNR under the RI.

A summary of documents/activities used to characterize site conditions at the Holtz Krause Landfill is identified as follows (AECOM, 2010):

3.2.1 PRE-RI STUDIES

- June 1969: Division of Environmental Protection; water samples collected
- May to November 1969: Wisconsin District 4 Sanitation; water samples collected for bacteriological studies
- August 1969: Wisconsin District 4 Sanitation; surface water samples collected near Holtz Krause Landfill
- November 1972: G. Fred Lee; Water Quality Report
- July 1972: Bashew and Martin; surface and groundwater quality report
- February 1973: Ronald G. Hennings; Water Quality and Hydrogeologic Assessment
- September 1974: Lon C. Ruedisili and Donald Olson; Hydrogeologic Investigation of the Holtz Krause Landfill
- December 1974: James B. McDonald; Report of Investigation of DNR, Wausau Dump

- December 1975: Becher-Hoppe Engineers, Inc.; Holtz Krause Sanitary Landfill Report
- February 1979: Becher-Hoppe Engineers, Inc.; Holtz Krause Landfill Abandonment
- February 1980: Becher-Hoppe Engineers, Inc.; Holtz Krause Landfill Final Abandonment Plan (revised). This document was summarized in Technical Memorandum Number One (Geraghty & Miller, 1989)
- September 1981: Marathon County Planning Commission; closing, monitoring, and long-term care requirements of the Holtz Krause Landfill
- April 1984: Becher-Hoppe Engineers, Inc.; soil boring report of cover integrity
- December 1985: USEPA; potential hazardous waste site assessment
- July 1986: USEPA; potential hazardous waste site assessment
- August 1986: Foth and Van Dyke; Work Plan submitted for hydrogeologic investigation and closure plan at Holtz Krause Landfill site

These documents are incorporated by reference and are located in the DNR Eau Claire office files.

3.2.2 REMEDIAL INVESTIGATION

Geraghty & Miller, Inc. conducted the RI (Geraghty & Miller, 1990 and 1991) beginning in September 1989 and ending in 1991. The RI reports are incorporated by reference and copies are located in the DNR Eau Claire office files. The objective of the data collection activities was to characterize the site, define the migration pathways and describe methods used to evaluate the extent and magnitude of contaminant migration within those pathways, assess risk and provide data for the FS. The data collection scope of work consisted of the following activities: completion of shallow auger borings in the existing landfill cover material and geotechnical and laboratory analysis of the soil samples; collection and laboratory analysis of soil and waste samples from borings completed through and near the landfill; collection and analysis of geologic, geotechnical and hydrogeologic information from borings, water-table monitoring wells and piezometers; collection and laboratory analysis of two rounds of groundwater samples obtained from these monitoring wells; completion of air monitoring surveys near the perimeter of the landfill; collection and laboratory analysis of two rounds of surface water samples; collection and chemical analysis of sediment samples and resident aquatic biota; and, collection and chemical analysis of a leachate sample.

Consistent with the requirements of the National Contingency Plan (NCP), a Quantitative Baseline Risk Assessment was performed on the RI data to evaluate the potential present and future risks to human health.

3.3 REMEDIAL ACTION OPTIONS REPORT /FEASIBILITY STUDY

NR 722 provides details regarding the requirements of selecting a remedy for the Site. The requirements of NR 722 include public participation and notification of Site activities, identifying and evaluating (technical and economic) remedial options including possible engineering and institutional controls used to protect human health and the environment. These findings were summarized in a report and presented to the DNR for approval of the chosen remedial action plan.

Geraghty & Miller, Inc. was retained by the DNR and the Holtz Krause Steering Committee through Holtz Krause Contractors, Inc. to complete a FS (Geraghty & Miller, 1992). The FS report is incorporated by reference and a copy is on file at the DNR Eau Claire office. The FS identified and evaluated alternatives for remediation of the landfill.

The FS resulted in compilation of seven alternative measures for the Holtz Krause Site. Based on the RI/FS, the risk assessment, the comments received during the public comment period, and the Summary of Remedial Alternative Selection prepared by DNR, the DNR selected Modified Alternative 4 as the remedial action for Holtz Krause. Modified Alternative 4 is outlined as the selected remedy in the July 22, 1992 DNR decision document.

The DNR approved implementation of the following remedy components on October 5, 1995:

1. Construction of a low permeability landfill cover consistent with WAC Chapter NR 504 (refer to Section 4.1 for details)
2. An active gas extraction system containing thirty-five gas extraction wells, a blower house and a candlestick flare, and a condensate collection system
3. Installation of groundwater monitoring wells to complete the long-term groundwater monitoring network
4. Operation and maintenance of all systems
5. Long-term groundwater monitoring
6. Abandonment of monitoring wells that did not conform to NR 141 WAC or were not necessary for long-term monitoring

7. Disposal of investigative wastes generated during the RI and Remedial Action (RA) phases of the project
8. Institutional controls, deed restrictions and site controls

In 2011, the DNR issued an Amendment to the remedy that approved MNA for groundwater remediation.

3.4 ENVIRONMENTAL REMEDIATION

NR 726 lists the requirements for obtaining Site closure. The Site complies with federal, state and local laws regarding environmental remediation. Documents and data collected show that the site does not pose a risk to public health or the environment.

The remediation is documented in the following reports:

- June 1992: DNR; Record of Decision (ROD) - Selected Remedial Alternative
- August 1994: DNR; Consent Decree
- January 1996: RMT; Pre-Flare Compliance Test Program
- January 2003: AECOM; Technical Justification for ROD Amendment
- January 2005: AECOM; Work Plan for Additional Site Investigation
- July 2010: AECOM; Five-Year Review Report
- February 2011: AECOM; Technical Support for ROD Amendment
- June 2011: DNR; Declaration for an Amendment to the ROD

All of these reports are incorporated by reference and are on file at the DNR Eau Claire office.

4.0 SITE CLOSURE SUPPORTING THE CERTIFICATE OF COMPLETION

The planned end use for the Holtz Krause Landfill is as a soccer complex providing for 15 soccer fields. This development fulfills the original goal of DNR when it contributed over $4 million to the closure of the site and with the Holtz Krause PRP Group, which substantially upgraded the closure design so as to support a recreational end use.

At the present time, the ROD for the landfill recognizes that the groundwater contamination related to the landfill does not require an active treatment system. This determination was supported by a long history of monitoring data. The only remaining active system addresses landfill gas. Given the low gas levels, consistent with an older landfill site, the active system can be converted to a passive system. However, as the end use of the site is as a soccer complex, an active system will be used to address any aesthetic odor related concerns.

For purposes of this application, the analysis will first address closure in an undeveloped condition. Then the analysis will discuss the closure as it will occur after redevelopment into an athletic complex.

4.1 LANDFILL CAP AND ENGINEERING CONTROLS

Under the undeveloped closure scenario, the 1995 remedial cover system would remain as an undeveloped grass field. The cover consists of (from ground surface):

- A Vegetative Layer consisting of 6 inches of topsoil and 2.5 feet of rooting zone soil.
- Primary Barrier Layer consisting of a 40 mil VLDPE geomembrane liner.
- Secondary Barrier Layer consisting of 2 feet of clay.
- The 1982 soil cover which varies in thickness from 0 to 2 feet.

A landfill cover system is an engineering control, as defined in NR 700.03(17): "Engineering control" means an action designed and implemented to contain contamination and minimize the spread of contamination within a media or to another media. Engineering controls include, but are not limited to: the installation of a cover with low permeability, groundwater extraction and treatment, slurry walls, solidification, and stabilization".

DNR Guidance for soil covers are listed in Guidance for Cover Systems as Soil Performance Standard Remedies (DNR, 2007). The Holtz Krause cover system meets or exceeds these requirements as follows:

- Greater than a 2-foot thickness of clean soil over the waste.
- The cover is vegetated.
- There is 6 inches of topsoil.
- The slope is not steeper than 3:1 (horizontal: vertical).

In addition, this guidance specifically states that an NR 504.07 landfill cover is an acceptable soil cover. The Holtz Krause cover system meets NR 504.07 requirements.

The "Guidance on Case Closure and the Requirements for Managing Continuing Obligations" (DNR, 2009) identifies as an acceptable closure the use of a soil cover to be maintained by the future property owner. Here, the maintenance plan is already in place and approved by the DNR in the form of the landfill cover maintenance requirements (Dames & Moore, 1995).

4.2 INSTITUTIONAL CONTROLS

Institutional controls are in place and include restricted access to the Site and inclusion of the Site to the DNR's GIS Registry. (The 2011 ROD Amendment provides these institutional controls (DNR, 2011).) In addition, NR 506 prohibits activities on the landfill property that would compromise the integrity and protectiveness of the cover. Finally, DNR requires any activity undertaken on a landfill that may disturb existing conditions to be pre-approved before the activity is undertaken.

4.3 NATURAL ATTENUATION OF GROUNDWATER

4.3.1 PLUME STABILITY AND MONITORED NATURAL ATTENUATION (MNA)

The Holtz Krause Landfill remedy is based on a stable or decreasing VOC plume and monitored natural attenuation (MNA). The 2011 DNR ROD Amendment represents approval of MNA as the remedy for groundwater (DNR, June 2011). The DNR ROD Amendment was issued based on groundwater data showing that the volatile organic compound (VOC) plume is stable or decreasing. In addition, the groundwater at the Holtz Krause site is not used as a potable water supply as municipal water is supplied throughout the area. Conditions at the Site continue to provide a favorable environment for natural attenuation. The DNR ROD Amendment of 2011 includes an MNA evaluation by AECOM (AECOM, 2011) and demonstrates that the VOC plume is defined and is stable or decreasing as required by NR 726.05(2)(b). The DNR ROD Amendment itself also states that the MNA requirements of NR 726.05(2)(b) were met (DNR, 2011).

4.3.2 GROUNDWATER MONITORING

Groundwater monitoring is extensive, occurring over 20 years, with 17 of the 20 years being after the remedy was completed in 1995. As determined by DNR in the 2011 DNR ROD Amendment, the plume is stable with VOCs showing decreasing levels in groundwater. In addition, there are no receptors of groundwater. All water users are connected to a municipal well. As such, groundwater monitoring is no longer needed and would be discontinued.

Because the Holtz Krause PRP Group is seeking a Certificate of Closure (COC) prior to groundwater reaching enforcement standards, the group is required to pay an environmental insurance fee pursuant to NR 754. As explained in Fact Sheet 13 (DNR PUB-RR-661, June 2010), if the Site needs to be re-opened due to a failure of the MNA remedy, the insurance will cover certain state cleanup and investigation costs. The insurance program is administered by the State and insurance is purchased through the State. The fee would be $18,574 because landfills fall under the definition of Heavy Industrial use and the Site is more than 5 acres in area (DNR PUB-RR-661, June 2010).

As required by DNR Guidance on VPLE sites that use natural attenuation (DNR 2009), the Holtz Krause site is included on the GIS Registry. (see 2011 DNR ROD Amendment)

4.4 VPLE PASSIVE GAS VENTING DEMONSTRATION

Under the undeveloped scenario, the 1995 landfill remedy would be used, but the method of landfill gas management would be converted to passive. Passive venting system for landfill gas is a proven method to control landfill gas. A design for a passive landfill gas venting system is included for evaluation purposes, it being understood that redevelopment of the site is the intended approach.

4.4.1 NATURAL BARRIERS TO LANDFILL GAS MIGRATION

Figures 2.2, 2.3, 2.4 and 2.5 (discussed in Section 2.0) present cross-section locations and three cross-sections through the landfill. As shown, Figure 2.3 provides an east-west cross-section and shows the shallow water table. The railroad wetland, located immediately east of the landfill provides a barrier to eastward landfill gas migration. The Cemetery Slough, located 800 feet west of the landfill, also provides a barrier to landfill gas migration. In the area between the landfill and the Cemetery Slough, there is only one potential receptor, a house located on Kent Street. The locations where the groundwater/surface water acts as a barrier to landfill gas are shown in blue on Figure 2.1.

Figure 2.5 provides a north-south cross-section and shows that the Horseshoe Slough provides a barrier to migration to the south.

4.4.2 LANDFILL GAS CONDITIONS PRIOR TO REMEDIATION

Active gas extraction and flaring began on December 28, 1994. Prior to start up, a round of methane measurements was taken on December 22, 1994 (see Figure 4.1). Methane levels were elevated at some probes located in close proximity to the waste. However, many other probes had low levels. For example, GP-9 located between the landfill and the nearest house, west of the landfill, showed 2.3 percent methane, a low reading considering there was no landfill gas remediation in place at the time of monitoring.

Methane migration was not observed east of the landfill in the area of GP-5, GP-7 and GP-8 because the wetland provides a barrier to gas migration.

4.4.3 PASSIVE VENTING DESIGN

Passive venting of gas from landfills is used as an effective means of controlling off-Site landfill gas migration. The State of Minnesota uses passive venting as a method of controlling landfill gas at 64 closed landfills managed by the Minnesota Pollution Control Agency (MPCA) under the Minnesota Closed Landfill Program (CLP). (Table 4.1 provides a summary of closed landfills that the MPCA CLP program manages with passive venting systems.) These landfill were permitted by the State of Minnesota in the early 1970s and closed by the early 1990s. Similar to the Holtz-Krause landfill, almost all the landfills in the MPCA CLP do not have liners below the waste for leachate or lateral gas migration control. Just like the Holtz Krause Landfill, many of these landfills began accepting waste in the 1950s and 1960s, through the 1970s when they were permitted, and typically closed in the 1980s and early 1990s.

Critical components of passive venting are screening across the complete vertical waste profile, large bore-holes (24 to 36-inches) completed to the bottom of waste, and gas vent spacing. It is the general spacing and key placement location of vents that is important. For a successful passive venting system, landfill variables such as surface topography, waste type, waste age, waste thickness, waste compaction, landfill cover type and condition, groundwater and leachate water levels, surrounding geology, compliance points, and potential receptors need to be considered in vent placement and spacing. Experience shows that one passive vent per acre is an effective design parameter based on the Sites listed on Table 4.1. Due to the number of variables associated with unlined landfills, there is no standard type or configuration that works in all cases. CRA's approach in designing a passive venting system is to consider available research, general guidance, site features, direct experience at the Site, and others experience at similar sites.

For a passive venting system at Holtz-Krause landfill under the undeveloped scenario, CRA recommends the installation of 69 passive vents (1.2 vents per acre). Figure 4.2 provides the passive vent layout. Of the 69 passive vents, 35 of the existing extraction wells would be converted into passive vents and 34 new passive vents would be installed. The borings for the new gas vents would be 36-inch in diameter and completed to the bottom of waste or water table, whichever occurs first. A 6-inch diameter, schedule 80 PVC slotted screen and riser would be centered in the bore-hole and backfilled with 1 to 3-inch non calcareous stone to within 2-feet of the liner. A geotextile ring and 3-foot bentonite plug would be installed to seal around the riser. The riser would be extended and finished to approximately 5 to 6-feet above ground surface.

The existing active gas extraction wells would be converted to passive vents by removing the various fittings, appurtenances, containment vaults at the wells. The existing 6-inch diameter PVC well riser would be extended and finished to approximately 5 to 6-feet above ground surface. Soil would be used to backfill the area of the former containment vault to ground surface.

Horizontal spacing and placement are important components in creating an effective system. In practice, a passive vent spacing of 200 feet is typically effective and is recommended for the perimeter of the landfill and one vent per acre for the landfill interior. Of the Sites listed in Table 4.1, the vast majority are effective with one vent per acre. In order to be conservative, CRA recommends a 100-foot spacing for perimeter vents along the west, north, and northeast. The tight spacing is unnecessary to the south and east where groundwater/surface water prevent landfill gas migration. In addition to experience, a research paper supports this spacing and presents a numerical simulation of gas flow around a passive vent in a sanitary landfill. (See Appendix A (Chen, Chen, and Wu, *Numerical Simulation of Gas Flow Around a Passive Vent in a Sanitary Landfill*, June 1999, revised August 2000).) In this paper, the numerical simulation shows that a passive vent will have an effective radius of 60 feet. Hence, a 120-foot spacing would be required on the perimeter. CRA's recommended spacing is 100 feet, which is tighter than the numerical model.

Given the above, passive venting can be constructed and would meet the requirements of NR 506.07.

4.4.4 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 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 passive venting system mitigated the potential for off-site migration, and no methane is being detected in the gas probes.

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 , 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.

A cover for the landfill was installed in accordance with current MPCA Solid Waste rules along a passive gas venting system in 1994. Historical VOC monitoring results for groundwater indicate substantial and continued declines in total VOC concentrations from the time of the landfill cover and passive venting system installation.

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 than 60 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.

4.4.5 PASSIVE VENTING WILL EFFECTIVELY PREVENT OFF SITE MIGRATION

Figure 2.1 of Section 2.0 shows the limit of waste, the landfill and surrounding area. Potential receptors are very limited in the area. The nearest house is located approximately 200 feet west of the landfill on Kent Street. The remainder of the area west of the landfill is open and is the proposed site of a new curling rink. The area to the north of the landfill has a few businesses but no residential use. The Canadian National Railway is located east of the landfill and open land is present south of the landfill.

The Operation and Maintenance Plan for the Holtz Krause Landfill identifies the performance requirements for landfill gas and states:

"the concentration of those gases should not exceed 25% of the lower explosive limit (LEL) at the property boundary for explosive gases at any time."

This requirement is measured at the gas probes shown on Figure 4.2. The passive venting system presented in Section 4.4.3 and shown on Figure 4.2 will prevent off site landfill gas migration.

4.4.6 CONSTRUCTION VERIFICATION OF PASSIVE VENTING PERFORMANCE

As part of the passive vent construction program, each passive vent would be evaluated to ensure performance. This would involve the following work:

- Documentation of waste profile and construction details for each vent to demonstrate effective flow of landfill gas from waste to each vent.
- Measurement of pressure, methane, carbon dioxide, oxygen and landfill gas flowrate at each vent and also at each of the perimeter gas probes.

The construction verification period would be conducted over a two month period following the passive vent construction. In the unlikely event that any segment of the perimeter is not performing as designed, additional passive vents would be installed until a contiguous capture line along the west, north and northeast perimeter is demonstrated.

4.4.7 UTILITY EVALUATION

As requested by the DNR, CRA evaluated the existing and proposed utilities surrounding the landfill.

Figure 4.3 presents the utilities surrounding the landfill. CRA evaluated the utilities in each segment of the landfill perimeter and concluded that there are no preferential pathways for landfill gas migration via a utility trench. Appendix B provides details of this evaluation.

4.4.8 PASSIVE VENTING WILL NOT IMPACT AIR QUALITY

Wisconsin Administrative Code NR 506.08(6) requires the installation of an air contaminant control system to efficiently collect and combust hazardous air contaminants emitted from landfills, which (i) accepted MSW, (ii) had a design capacity greater than 500,000 cubic yards and (iii) were approved before 1988. However, an air contaminant control system is not required if the owner can demonstrate that the performance criteria of Wisconsin Administrative Code NR 504.04 (4)(f) can be achieved without implementing such a system. Wisconsin Administrative Code NR 504.04 (4)(f) requires an air contaminant control system if there is a reasonable probability that the landfill will cause the emission of any hazardous air contaminant exceeding the limitations for those substances.

CRA evaluated the probable hazardous air contaminant emissions of a passive venting system using historical landfill gas analytical monitoring results and landfill gas flare operational data. For this evaluation, CRA assumed that the landfill gas volume and quality of a future passive venting system would be the same or less than what is currently being collected using an active landfill gas extraction/flare system. CRA compared estimated emissions for a future passive venting system to the Hazardous Air Contaminant criteria provided in Wisconsin Administrative Code NR 445.07. The data evaluated consisted of detected VOCs in the annual sampling of the influent gas stream to the Site landfill gas extraction/flare system from 2011. A mass flow rate was calculated for each of the detected contaminants and compared to the applicable criteria. Table 4.2 presents the results of the comparison and the finding that no hazardous air contaminants are currently, or would be emitted using a passive venting system, above the criteria provided in Wisconsin Administrative Code NR 445.07.

4.4.9 PASSIVE VENTING WILL NOT IMPACT GROUNDWATER QUALITY

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 continue to remain stable.

This conclusion is based on the following:

1. **VOCs in Waste Were 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 4.2 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 4.4 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 4.2 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 4.3 and Appendix C) 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 Appendix D. 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 transmitted to the DNR Remediation Group by Doug Day and Peter Tiffany of MPCA.

There are many capped landfill sites across the United States with passive venting. Appendix E shows the successful remediation of VOCs in groundwater at several of these sites. Appendix F presents the 64 MPCA passive sites and several project summaries.

5. **The Landfill Cap 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 the reason for the presence of VOCs 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 naturally attenuated.

6. **Pre-Remediation Groundwater Quality Minimally Affected By Waste**

Figures 4.5 and 4.6 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. Thus, landfill waste caused only marginal degradation of groundwater quality.

7. **Current Groundwater Quality**

Figures 4.5 and 4.6 show the current levels for benzene, which are on a downward trend 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. This is the case at the Holtz Krause Landfill site.

5.0 POST VPLE CLOSURE - SOCCER COMPLEX DEVELOPMENT

The proposed post VPLE plan for the Holtz Krause Landfill calls for redevelopment of the site as part of the regional sports center being completed in the area. Under this scenario, the 1995 remedy remains intact, but the landfill would be developed, with grading changes and no interference with the landfill cap. For aesthetic reasons only, possible odors would be addressed through an active venting system.

5.1 GRADING MODIFICATIONS

The existing cover system was constructed in 1994 with the intent of building soccer fields. As such, the 36 acre surface of the landfill is relatively flat with grades of 1 to 2 percent. The soccer development takes place entirely within the flat area and will not modify the existing grades and vegetation of the sideslope areas. The following describes the grading sequence during construction:

1. Prior to grading, the active gas modifications described in Section 4.0 will be completed.
2. The existing 6 inch topsoil layer will be salvaged and stockpiled on site.
3. Additional fill will be imported and added to the rooting zone to establish the desired subgrades. No grading cuts will be made into the rooting zone layer. However, swales, drains or utilities will be installed in the rooting zone layer.
4. Before soccer field construction, the utilities will be installed. These include drainage swales, storm drains, irrigation lines, electrical services, telephone, sanitary services and water services.
5. For each of the 8 adult soccer fields, a sand drainage layer or field drain tile system will be installed. The 7 junior fields will not have a underdrain.
6. An 8 inch topsoil layer will be added above the drainage layer for all 15 soccer fields (18 acres). The topsoil used for the soccer fields will be specifically manufactured for athletic field use and each field will have a specific sports field turf seed mix.
7. The support areas represent 18 acres of the 36 acres and will have 4 acres of paved roadway/parking. In the grass areas surrounding the fields, the salvaged topsoil will be placed and vegetated.

5.2 ACTIVE VENTING FOR SOCCER COMLEX

For the planned future use of the Holtz-Krause landfill as recreation sports fields, subsurface active gas extraction with flaring will be used only for odor control. A substantial portion of the existing gas extraction system such as the gas/condensate conveyance piping and gas wells will continue be utilized with minor modifications. The flaring station will be completely replaced. Due to the declining gas production rate of the landfill, the current system is substantially oversized and is unable to operate at the desired extraction rate.

Figure 5.1 provides a conceptual layout of the recreational sports fields along with the proposed layout of the odor control extraction system flaring station. Odor control will be supplemented by using the perimeter wells. Due to interferences with the proposed recreation field layout, three existing gas extraction wells, EW-16, EW-21, and EW-27 will be abandoned. For EW-16 and EW-21, replacement extraction wells will be installed approximately 50' east of their current locations for odor control purposes. For EW-27, two new extraction wells (for odor control purposes) and associated piping will be installed both east and west of the current location.

Well construction for the odor control system will be similar to existing gas wells. A 3-foot borehole will be advanced to the bottom of waste. A 6-inch diameter schedule 80 PVC slotted screen and riser will be installed in the borehole. A non-calcareous clear stone will be placed around the screen. Above the clear stone will be a geotextile ring, filter sand, and bentonite seal. The bentonite seal will extend to the bottom of the 2-foot clay layer. A high density polyethylene (HPDE) vault and cover, which will house the flow control equipment, will be installed such that the top of the cover is completed at or near the surrounding ground surface. An extrusion welder will be used to weld the existing membrane liner to the HPDE vault. The intent of the at-grade vault installation is to reduce a potential trip hazard for the recreational field users.

Installation of gas conveyance piping will be required as part of the odor control system. In addition, sections of the existing gas conveyance piping will require replacement or sloping adjustment due to settlement. Existing and planned gas conveyance piping is and will be installed below the membrane liner. Installation and repair work will consist of excavating cover soils above the membrane liner and staging the cover soils along the excavation. The membrane liner will be hand cut in the desired locations. Excavation will then continue to the desired depth. Excavated waste will be immediately transported and staged off-cover in a designated area lined and covered with plastic. The volume of waste generated is minor and the excavated waste will be disposed off-Site at a licensed solid waste facility. Once at the desired excavation depth, the base of the excavation will be compacted and at least 6-inches of granular material will be placed for piping bedding. The pipe bedding will be adjusted as necessary to achieve the desired pipe sloping and minimum pipe bedding material thickness of 6-inches. The conveyance piping will be placed and granular material will be placed around and over the piping to a minimum height of 12-inches above the top of the pipe. The conveyance piping size will range from the current size of 6-inches to 12-inches depending upon location and desired gas flow rates.

Following pipe bedding material placement, a fine grained low permeability soil will be placed and compacted in 12-inch lifts up to the elevation of the membrane liner. A new section of 40-mil membrane will be welded to the existing 40-mil membrane. Following installation of the membrane, the excavated cover soils will be placed into the excavation in 12-inch compacted lifts to the desired surface elevation.

The replacement odor control flare station will installed in the vicinity as the current system and will also likely be a candlestick flare. It is anticipated that the odor control flare station will have an operational flow rate range of 35 to 185 cfm. The odor control flare station will be fully automated. Major odor control flare station components will likely consist of the following:

- Flare mast assembly of black iron pipe, blasted, primed, and coated
- Stainless steel burner tip
- Stainless steel flare shroud with ceramic fiber insulation
- Electrically actuated/spring loaded shutdown valve assembly
- Aluminum flame arrestor
- Thermocouple flame supervision system
- Propane gas pilot ignition system
- Structural skid with mounting feet and lifting lugs
- Stainless steel piping
- Variable frequency drive centrifugal blower
- Insulation and heat tracing of blower drain line and demister filter assembly drain line
- Stainless steel demister/filter system with multiple layers of knitted polyethylene mesh.
- Velocity averaging, differential pressure flow metering system
- Control Panel

- Fused disconnect service entrance
- Electrical surge suppression
- Blower motor breaker and overload system
- Thermostatically controlled panel heating and air conditioning system
- PLC supervision and logical control system
- Touch screen operator interface system
- Remote monitoring and trouble shooting capable
- Digital chart recorder
- Alarm and Shutdown message annunciation
- Autodialing alarm call-out system

The odor control flare station orientation will likely be changed from the current east-west alignment to a north-south alignment to better accommodate utilities, access road, and parking facilities for a nearby curling club. However, the subsurface main gas conveyance to the flare station will not be modified. All condensate from the odor control system will continue to gravity flow to the odor control flare station area. In the odor control flare station area, condensate is gravity discharged, via permit, to a publically operated treatment system. Access into the odor control flare station area will continue to be controlled via fencing with screening and a locked gate.

6.0 APPLICATION FOR DEVELOPMENT AT HISTORIC FILL SITE OR LICENSED LANDFILL EXEMPTION APPLICATION

Appendix G presents the application for development of the Site. A possibility that a concession/restroom facility may be constructed on the landfill in the future. As such, an exemption is requested to allow this construction.

7.0 CERTIFICATE OF COMPLETION REQUEST

A Certificate of Completion is requested for the Holtz Krause Landfill. This request is being made in accordance with Fact Sheet 2 (DNR PUB-RR-506, September 2007) and Fact Sheet 13 (DNR PUB-RR-661, June 2010). The voluntary party is requesting a certificate of completion from the DNR because, in our opinion and as demonstrated by the remedial actions undertaken at the Holtz Krause Landfill, the environment is restored to the extent practicable with respect to the discharges and the harmful effects from the discharges are minimized.

In support of the COC, the following is/was submitted:

- Completed application forms (Form 4400-178) for each parcel of property containing waste have been submitted to the Land Recycling Team contact and the required $250 application fee. The applicant agrees to pay for DNR oversight costs related to the review of the site.
- An advance deposit of $3,000 was submitted to DNR.
- A Phase I Environmental Site Assessment was completed. Based on the results of the Phase I ESA, a Phase II ESA is not necessary since no new RECs were discovered during the Phase I ESA.
- A remedial action plan was prepared in accordance with NR 722 and approved by DNR.
- Environmental cleanup of the Holtz Krause Landfill was performed and meets the requirements for case closure in ch. NR 726 or NR 746.
- All applicable fees were submitted.
- Since MNA is part of the remedy for cleanup and the COC is requested prior to groundwater meeting enforcement standards, an insurance fee and application as required by ch. NR 754 was submitted.

8.0 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

FIGURES

LEGEND

PROPOSED FIELD

FUTURE CURLING RINK

figure 1.1

FIELD LAYOUT
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

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

LEGEND

APPROXIMATE WASTE LIMIT

AREA WHERE GROUNDWATER / SURFACE WATER PREVENTS GAS MIGRATION

figure 2.1

AERIAL PHOTO
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

74702-10(008)GIS-SP001 MAR 26/2012

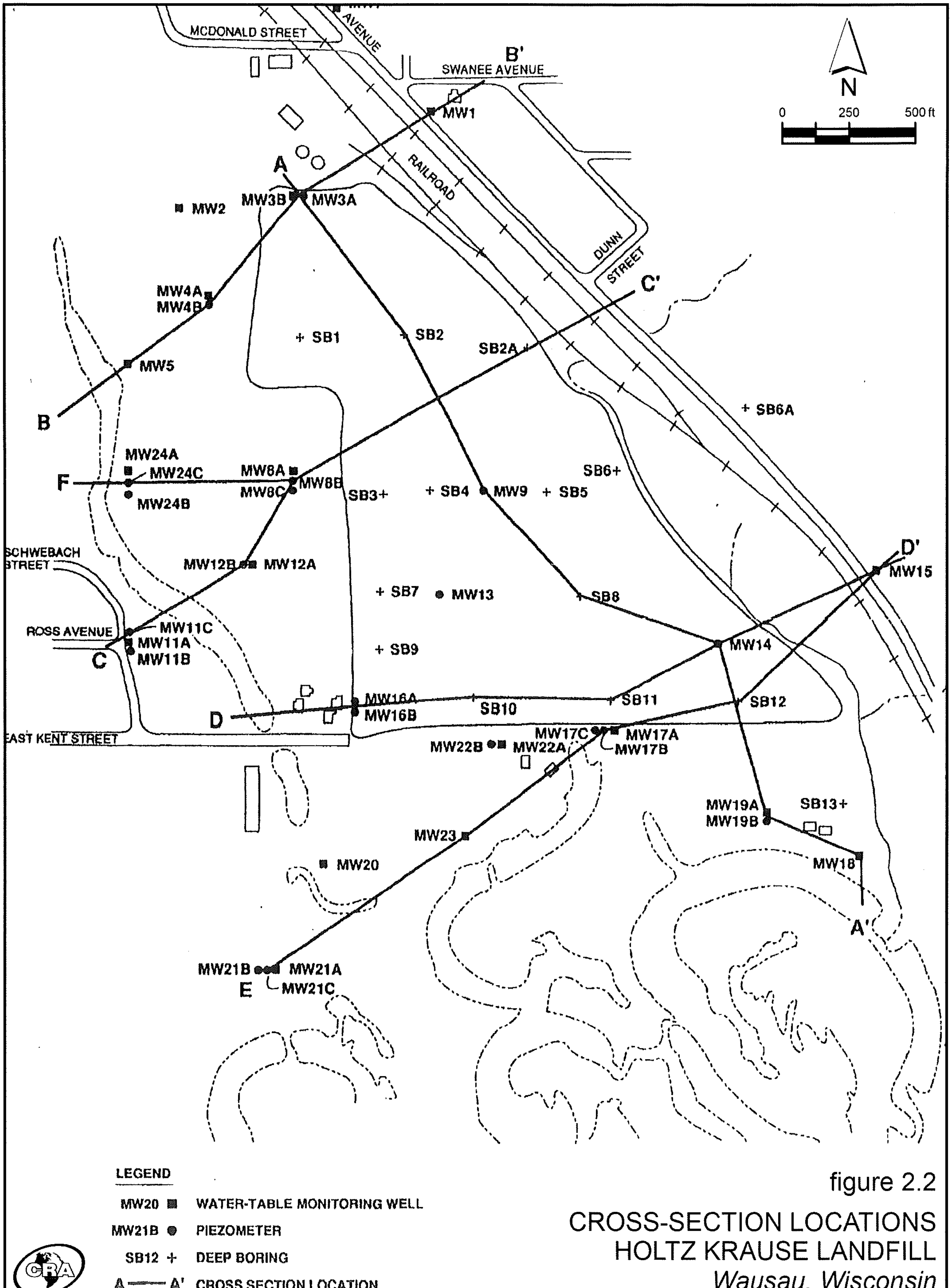
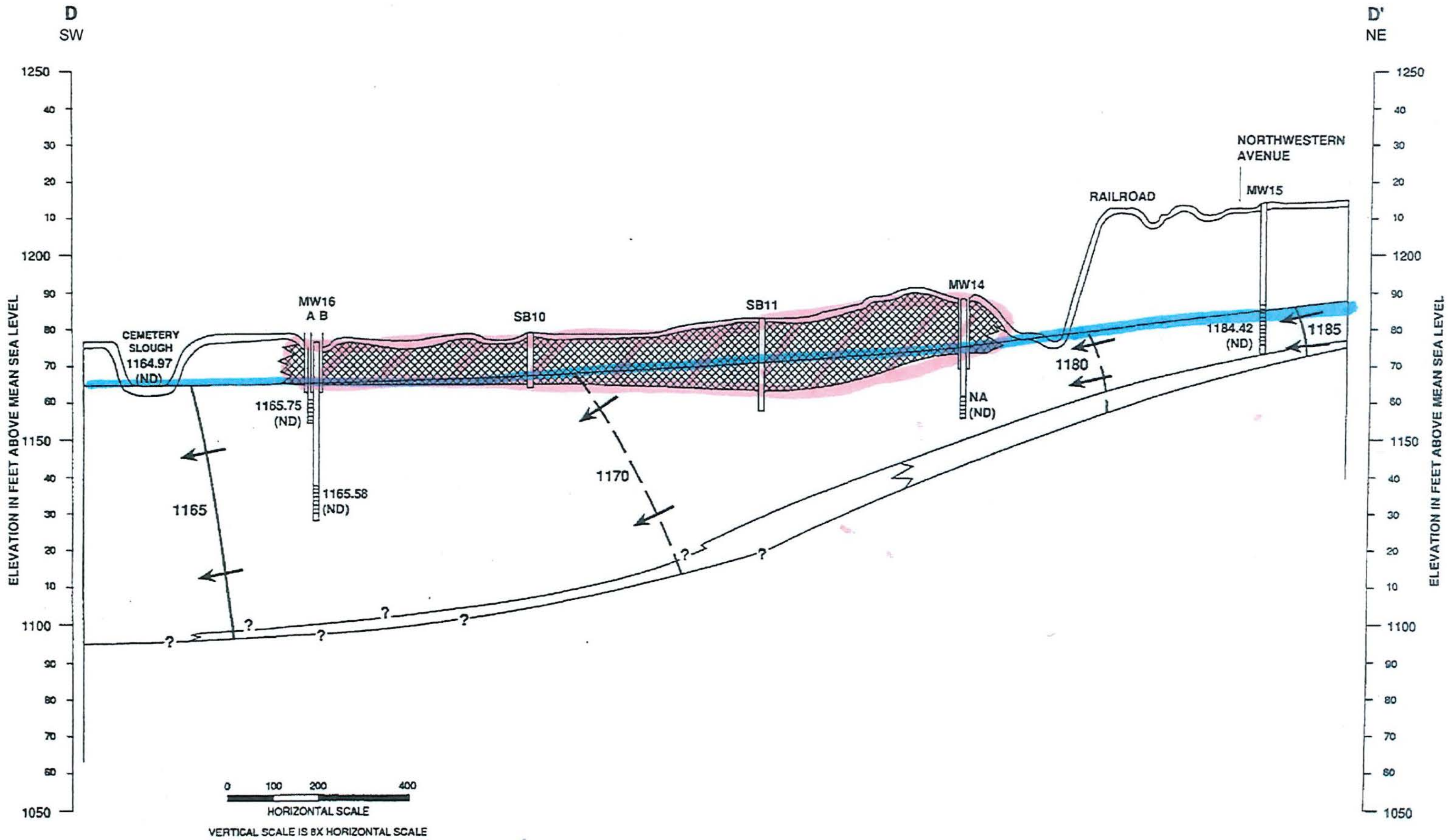


figure 2.2

CROSS-SECTION LOCATIONS
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

74702-10(008)GIS-SP002 MAR 01/2012



LEGEND

WATER-TABLE

EQUIPOTENTIAL LINE (Dashed Where Inferred) (Reference to Mean Sea Level)

DIRECTION OF GROUND WATER FLOW

(31) ESTIMATED LIMITS OF TOTAL AROMATICS CONCENTRATIONS PRESENTED IN PARENTHESES

(ND) CONCENTRATIONS OF TOTAL AROMATICS WERE NOT DETECTED IN SAMPLE

—?— GEOLOGIC CONTACT (Question Marks Where Inferred)

1163.84 GROUND-WATER ELEVATION MEASURED IN THE WELL

WASTE

CONTOUR INTERVAL = VARIABLE

SAMPLES WERE COLLECTED FROM JUNE 26 TO JUNE 28, 1990

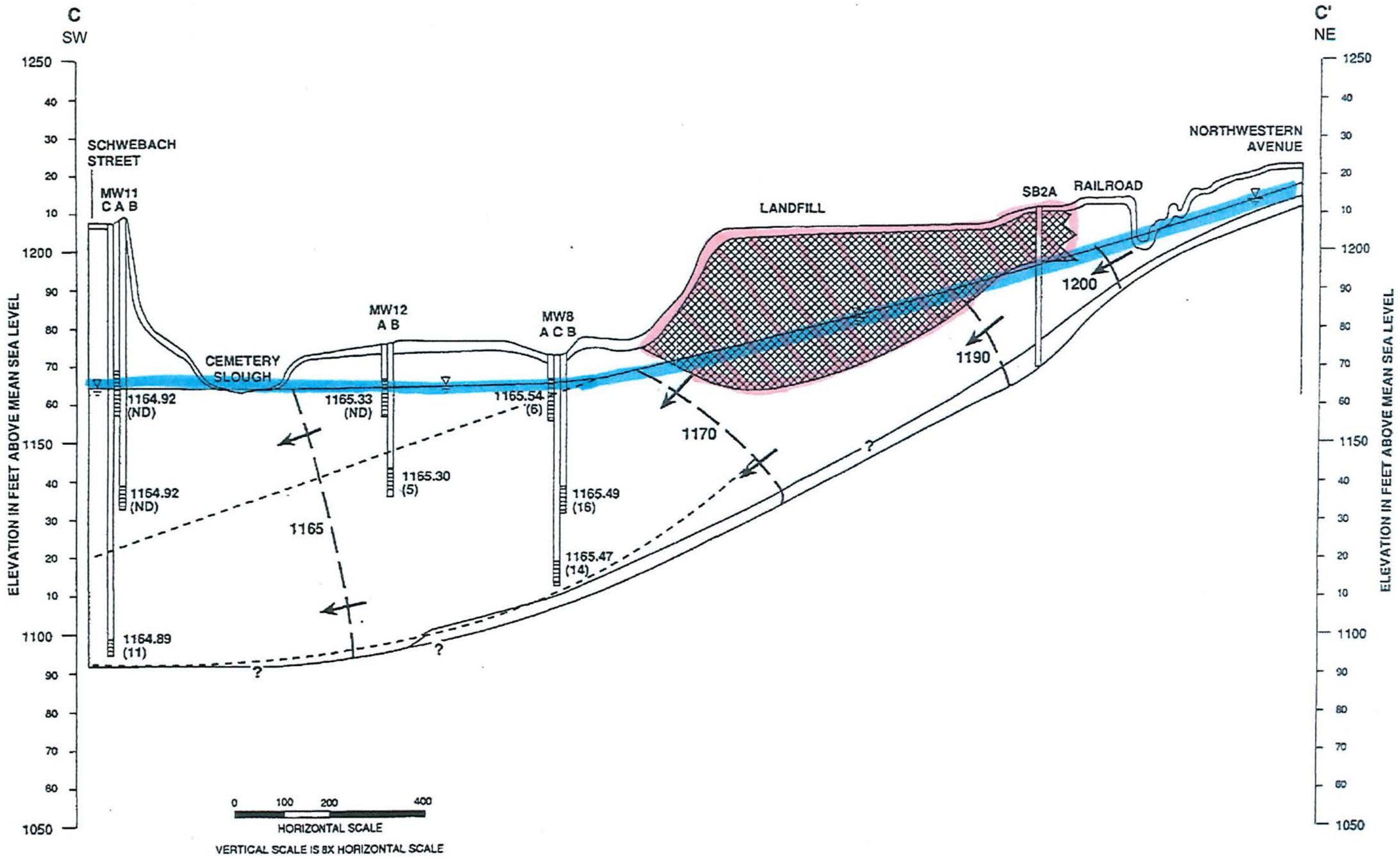
figure 2.3

DISTRIBUTION OF TOTAL AROMATICS DETECTED IN GROUNDWATER CROSS-SECTION D-D'

HOLTZ KRAUSE LANDFILL

Wausau, Wisconsin

74702-10(008)GIS-SP003 FEB 29/2012



LEGEND

- WATER-TABLE
- EQUIPOTENTIAL LINE (Dashed Where Inferred) (Reference to Mean Sea Level)
- DIRECTION OF GROUND WATER FLOW
- (31) ESTIMATED LIMITS OF TOTAL AROMATICS CONCENTRATIONS PRESENTED IN PARENTHESES
- (ND) CONCENTRATION OF TOTAL AROMATICS WERE NOT DETECTED IN SAMPLE
- ?— GEOLOGIC CONTACT (Question Marks Where Inferred)
- 1163.84 GROUND-WATER ELEVATION MEASURED IN THE WELL
- WASTE

CONTOUR INTERVAL = VARIABLE

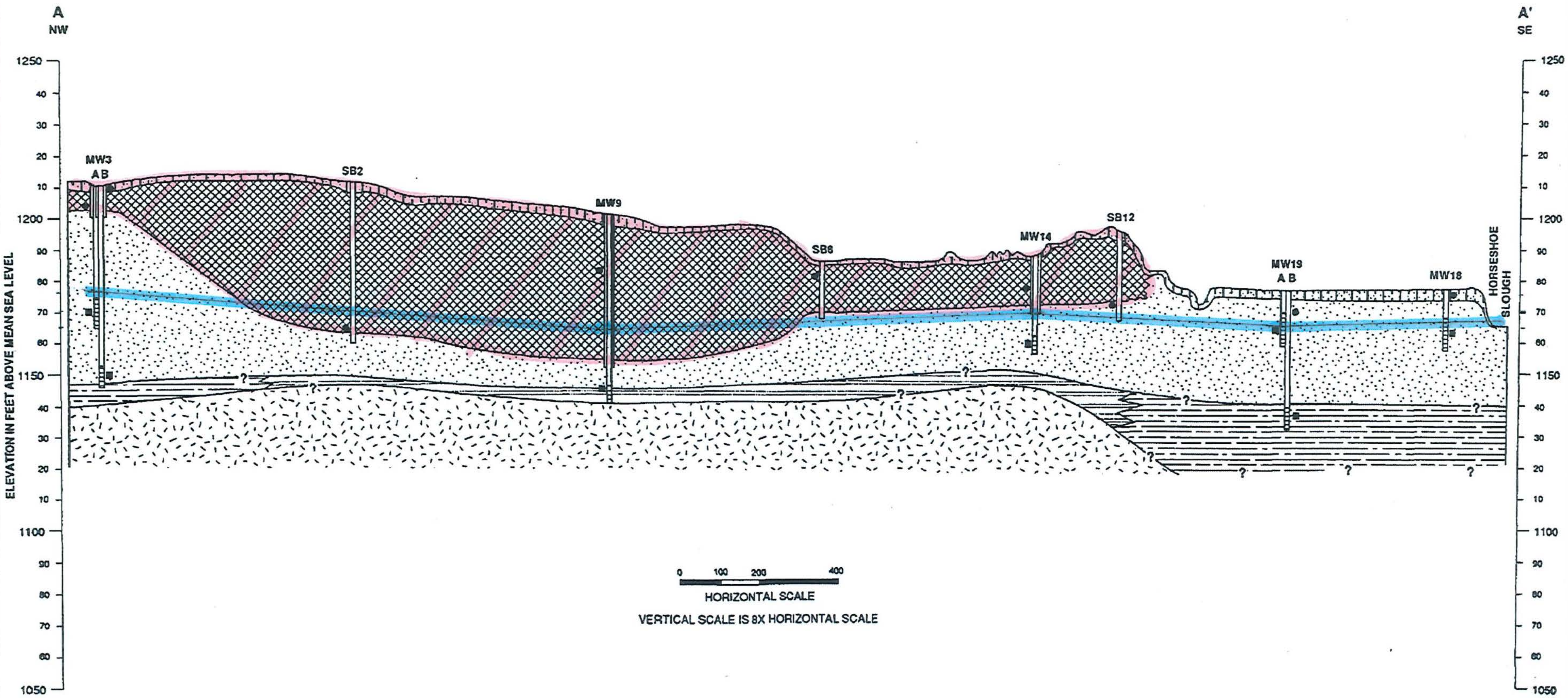
SAMPLES WERE COLLECTED FROM JUNE 26 TO JUNE 28, 1990

figure 2.4

DISTRIBUTION OF TOTAL AROMATICS DETECTED IN GROUNDWATER CROSS-SECTION C-C'
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

CRA

74702-10(008)GIS-SP004 FEB 29/2012



LEGEND — **Generalized Description**

- **TOPSOIL:** Black Topsoil or Brown Fine to Medium Sand
- **WASTE:** Miscellaneous Landfill Debris and Refuse
- **SAND:** Gray to Tan Fine to Coarse Poorly Sorted Sand
- **SILTY SAND:** Gray to Tan Silty Fine Sand with Granite Fragments
- **SILTY CLAY:** Red to Brown Very Stiff Clay with Trace Silt and Granite Fragments
- **BEDROCK:** Granite Bedrock Weathered at Surface
- —?— GEOLOGIC CONTACT (Question Marks Where Inferred From Other Site Specific and Regional Information)
- ● Sample from this Interval was Collected for Chemical Analyses
- ■ Sample from this Interval was Collected for Geotechnical Analyses

CRA

figure 2.5

GEOLOGIC CROSS-SECTION A-A'
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

74702-10(008)GIS-SP005 MAR 01/2012

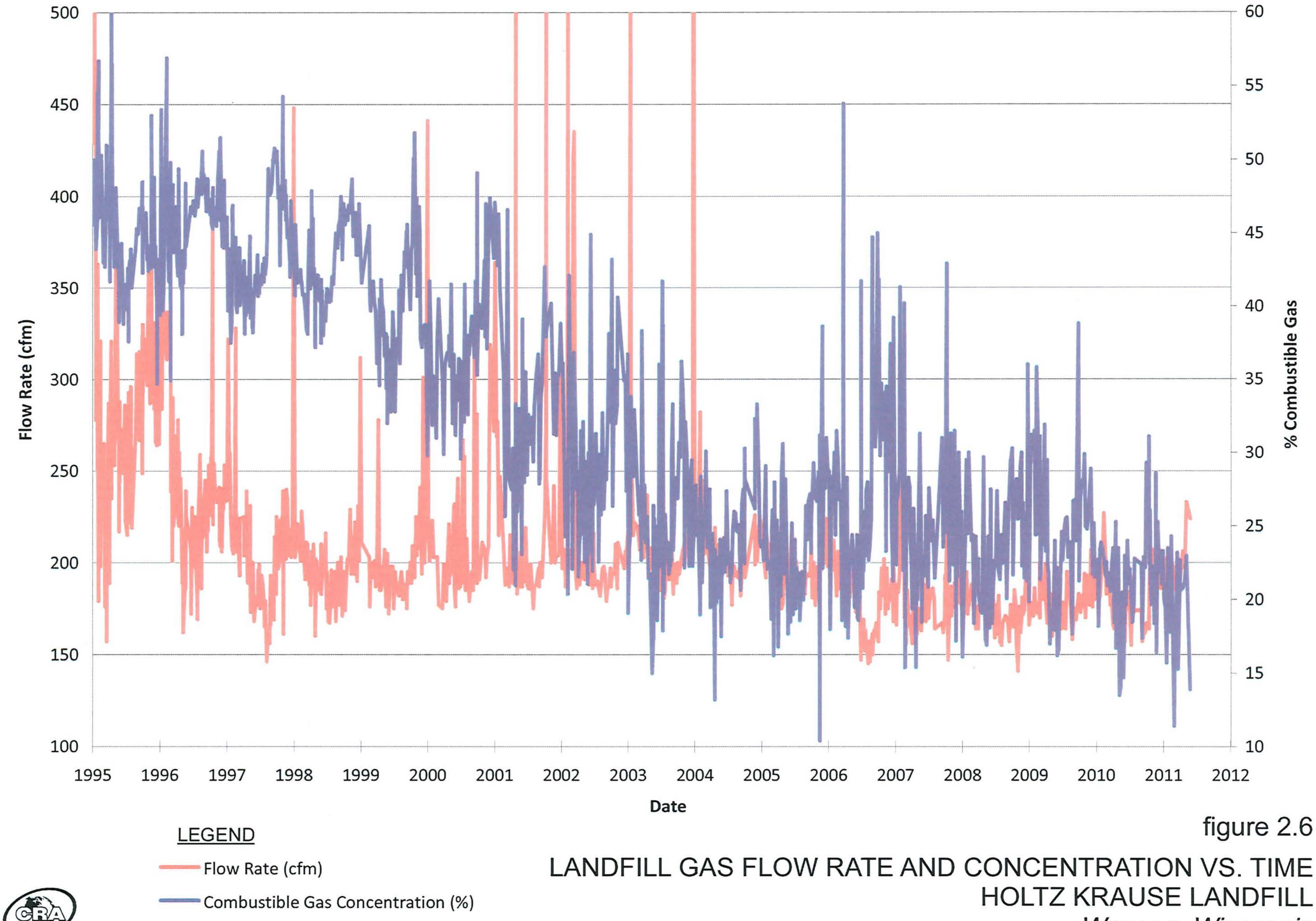


figure 2.6

LANDFILL GAS FLOW RATE AND CONCENTRATION VS. TIME
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

LEGEND

2.3% METHANE CONCENTRATION

▲ GAS PROBE LOCATION

■ GAS EXTRACTION WELL

APPROXIMATE WASTE LIMIT

CRA

figure 4.1

PRE-REMEDIATION METHANE RESULTS AT GAS PROBES (DECEMBER 1994)
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

74702-10(008)GIS-SP006 MAR 26/2012

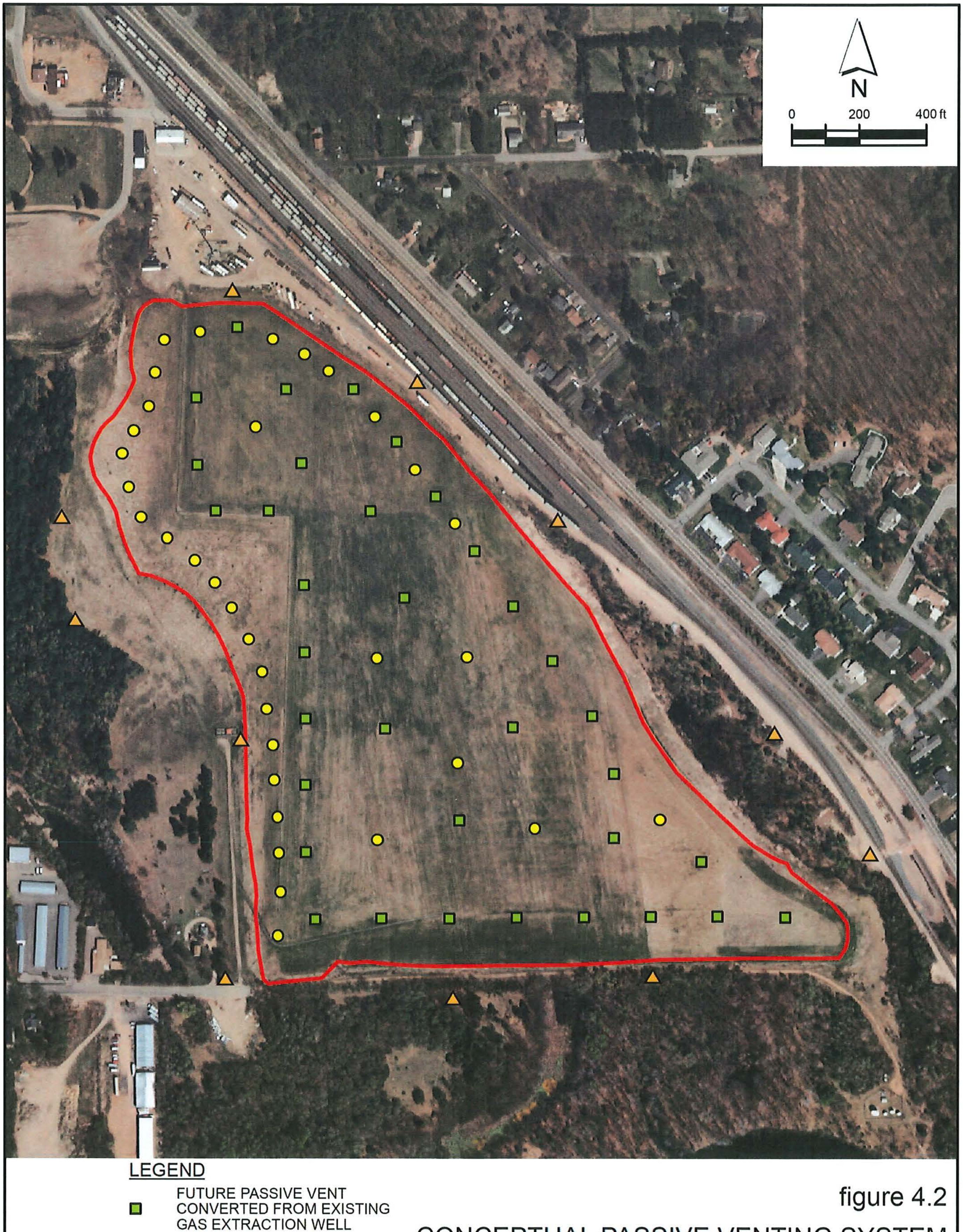


figure 4.2

CONCEPTUAL PASSIVE VENTING SYSTEM
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

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

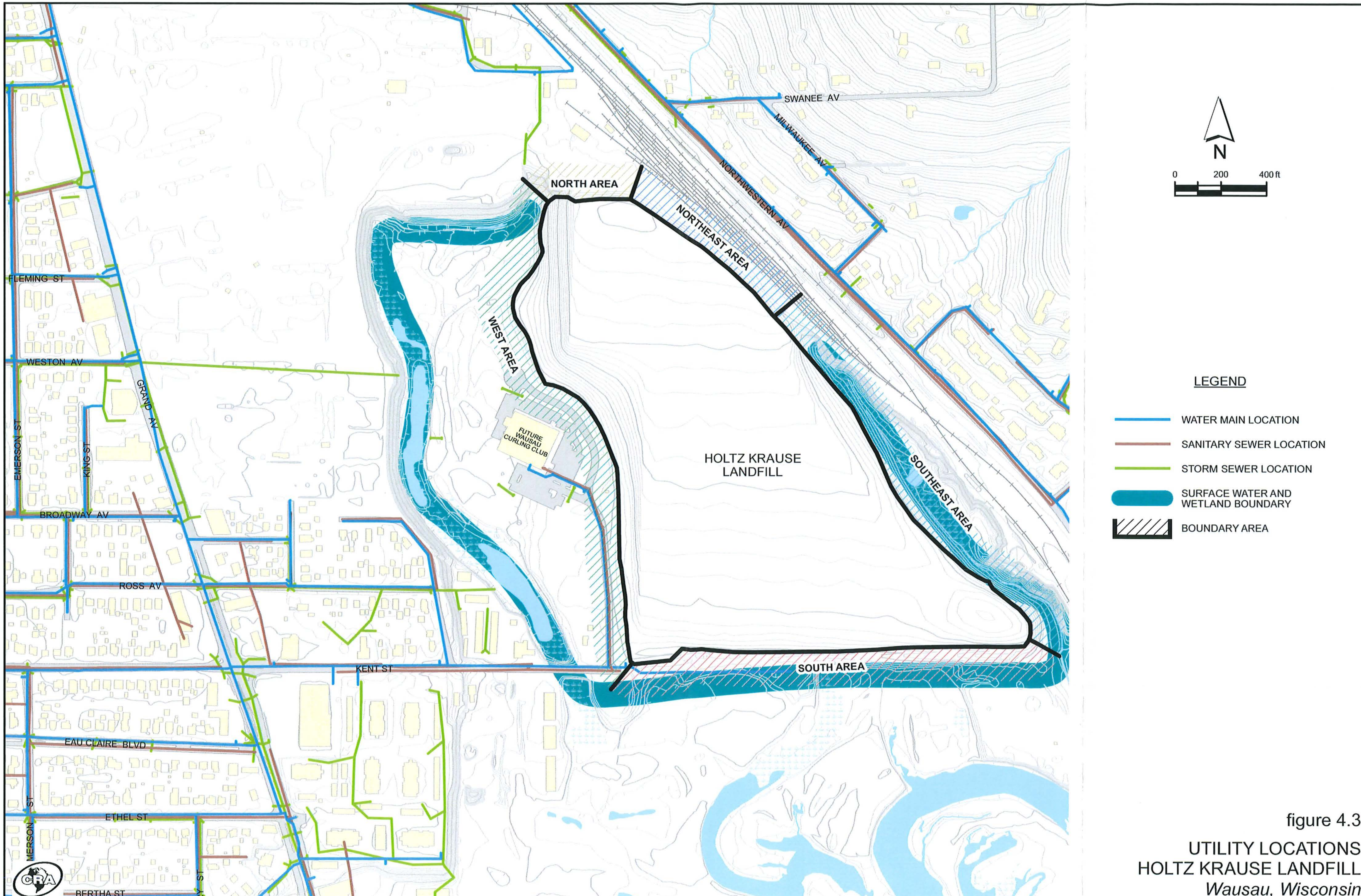
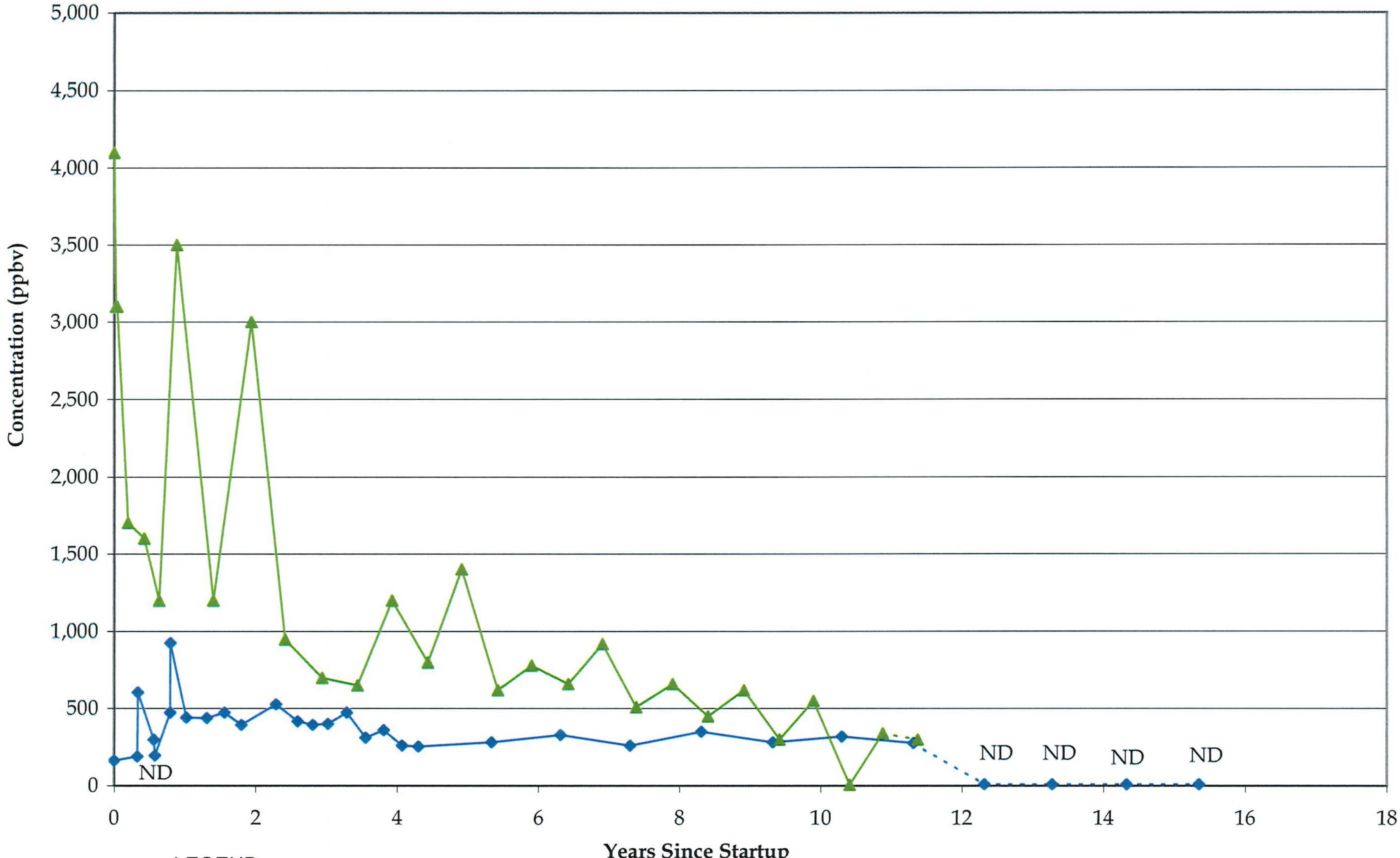


figure 4.3

UTILITY LOCATIONS
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

74702-10(008)GIS-SP014 MAR 26/2012



LEGEND

Holtz & Krause Landfill (Benzene)

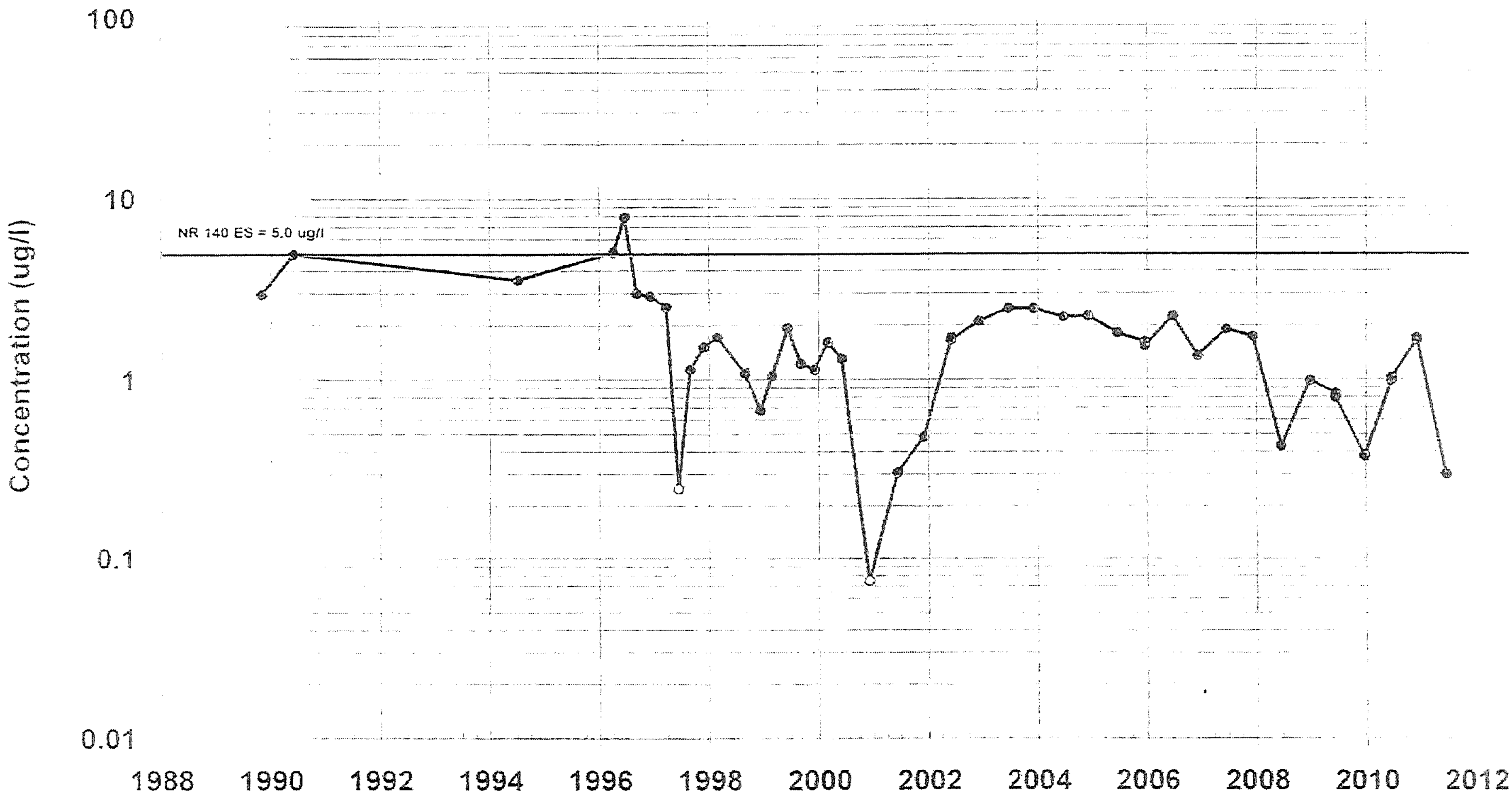
Tomah Sanitary Landfill (Vinyl Chloride)

NOTE: ND - NON DETECT

figure 4.4

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

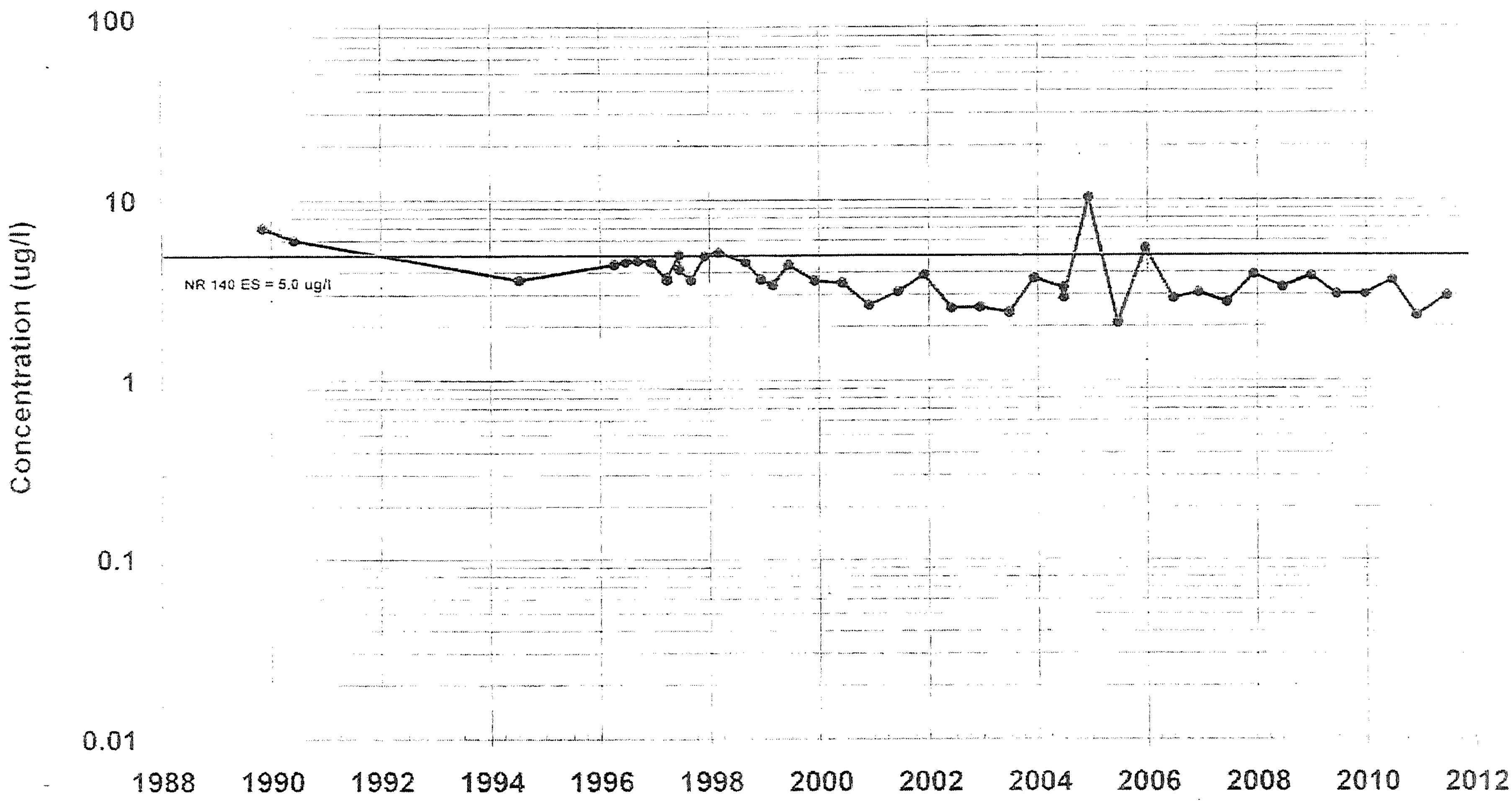
74702-10(008)GIS-SP011 APR 10/2012



NOTES:
- OPEN CIRCLE INDICATES THAT COMPOUND WAS NOT DETECTED
- NON-DETECTED DATA DISPLAYED AT ONE-HALF REPORTING LIMIT

figure 4.5

BENZENE CONCENTRATIONS
MONITORING WELL MW-4B
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin



NOTES:
- OPEN CIRCLE INDICATES THAT COMPOUND WAS NOT DETECTED
- NON-DETECTED DATA DISPLAYED AT ONE-HALF REPORTING LIMIT

figure 4.6

BENZENE CONCENTRATIONS
MONITORING WELL MW-8B
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

74702-10(008)GIS-SP010 APR 10/2012

LEGEND

- NEW GAS EXTRACTION WELL
- EXISTING GAS EXTRACTION WELL
- GAS EXTRACTION WELL TO BE ABANDONED
- NEW GAS EXTRACTION HEADER
- EXISTING GAS EXTRACTION HEADER
- PROPOSED FIELD
- FUTURE CURLING RINK

CRA

figure 5.1

CONCEPTUAL ACTIVE GAS EXTRACTION SYSTEM LAYOUT
HOLTZ KRAUSE LANDFILL
Wausau, Wisconsin

74702-10(008)GIS-SP015 MAR 26/2012

TABLES

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	

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*
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			

TABLE 4.2

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)*	*(lbs/yr)*	*Groundwater Contaminant?*	*WDNR Limit (lbs/hr)*	*(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 4.3

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

APPENDIX A

NUMERICAL SIMULATION OF PASSIVE VENTING

ELSEVIER

Journal of Hazardous Materials B100 (2003) 39–52

Journal of Hazardous Materials

www.elsevier.com/locate/jhazmat

Numerical simulation of gas flow around a passive vent in a sanitary landfill

Yen-Cho Chen [a], Kang-Shin Chen [b], Chung-Hsing Wu [c,d,*]

[a] *Department of Mechanical Engineering, Oriental Institute of Technology, Panchiao 220, Taiwan, ROC*
[b] *Institute of Environmental Engineering, National Sun Yat-Sen University, Kaohsiung 804, Taiwan, ROC*
[c] *Department of Bio-Industrial Mechatronics Engineering, National Taiwan University, Taipei 106, Taiwan, ROC*
[d] *College of Engineering and Science, National United University, Taiwan, ROC*

Received 7 June 1999; received in revised form 8 August 2000; accepted 12 December 2002

Abstract

A numerical model, based on the Darcy law, was used to simulate the two-dimensional gas flow around a passive vent in a sanitary landfill. We follow Findikakis and Leckie [ASCE J. Environ. Eng. 105 (1979) 927] in modeling the biodegradation of the solid waste and assume the first-order biodegradation kinetics. The numerical results from the Fresh Kills landfill, New York, show that the well's ability in extracting the landfill gas by the passive vent decays quickly with the increase of the radial distance from the well. The influence radius of the well is generally less than 20 m. The effects from the final soil thickness, well depth, and other parameters on the gas flow are also discussed.

Keywords: Numerical simulation; Gas flow; Sanitary landfill; Passive vent

1. Introduction

Sanitary landfilling is a common method for the disposal of solid waste. Concerns about the pollution and hazard problems it may bring have, however, increased with the use of such a disposal. Two major pollution issues associated with the landfill are the leachate and gases. The gases produced in the landfills are mainly the methane and carbon dioxide. Methane in volumetric concentration of 5–15% is explosive. In order to control the air pollution and hazard from the gases produced from the solid waste in the landfills, gas collection systems are installed. There are two kinds of gas collection systems, the passive venting system and the active gas pumping system [2]. The passive venting system is a system in which

* Corresponding author. Tel.: +886-2-2369-3159; fax: +886-2-2369-3159.
E-mail address: chwu@ccms.ntu.edu.tw (C.-H. Wu).

0304-3894/03/$ – see front matter
doi:10.1016/S0304-3894(03)00089-X

Nomenclature

a	thickness of the final soil cover (m)
A_i	fraction of waste component i
b	well depth (m)
C	mass of total gas produced per volume of waste (kg/m^3)
g	acceleration of gravity (m/s^2)
h	total landfill depth (m)
K	permeabilities of the final soil or refuse (m^2)
M	mean molecular weight of gas mixture (kg/mol)
P	gas pressure (Pa)
P_{atm}	atmosphere pressure (Pa)
Q_w	gas flow rate at well exit (m^3/s)
r	radical distance from the center of the well (m)
r_w	well radius (m)
R	computational domain in the r-direction (m)
R_u	universal gas constant (J/(kmol K))
t	time (year)
t_0	time elapsed after the closure of the landfill (year)
t_f	total time to fill the landfill (year)
T	gas absolute temperature (K)
u_r	gas velocity in the r-direction (m/s)
u_z	gas velocity in the z-direction (m/s)
z	vertical distance from the landfill surface

Greek symbols

α	overall gas generation rate of the waste (kg/m^3)
λ_i	reaction rate constant of the waste component i (per year)
μ	viscosity of gas mixture (Pa s)
ρ	gas density (kg/m^3)
ϕ	$=P - \rho g z - P_{atm}$ (Pa)

perforated venting pipes are installed within the landfill or the soil surrounding the landfill. The well depth ranges from 50 to 90% of the landfill depth. The wells collect gas by natural pressure difference and convection inside the landfill. In general, these wells are equipped with flares to burn off the gas. The advantages of the passive venting systems are simple to install, less expensive to operate, and easy to maintain, but its drawback is not effective in removing the landfill gas that may escape from landfill surface or from the underground soil surrounding the landfill into the nearby buildings. Another system is the active gas pumping system, which collects gas by using the vacuum pumps. A pipe network is built to the interconnect wells and blower equipment, which direct the collected gases to an energy recovery system. This system remove the landfill gas effectively but the installation and maintenance fees of such a system are pretty high.

In the modeling of the gas flow in the landfill, Esmaili [3] proposed a single-well model to analyze the gas flow rate from well in a landfill equipped with an active gas pumping system. The model assumed that: (1) the top surface of the soil formation is impermeable; and (2) the well is also located at the surrounding soil outside the landfill limits. His results, thus, cannot apply to the place inside the landfill. Lu and Kunz [4] developed a one-dimensional radial-flow model which calculates the landfill's methane production rate and gas-flow permeability by measuring of landfill gas pressures and pressure changes caused by the withdrawal of gas. Findikakis and Leckie [1] developed one-dimensional numerical model to simulate the gas pressure and concentration profiles in landfills. Arigala et al. [5] developed a model to describe the gas generation, transport, and extraction in a landfill. The wells are assumed to be one-dimensional line sinks with uniform gas extraction rates.

The well spacing is a critical issue in the passive venting system design. The influence radius is generally used in determining the well spacing. If the flow motion of gases produced from the solid waste is well understood for an influence radius, this may provide a useful information for the passive venting system design. The different influence radii (45–50 m for the Taipei Sanjuku landfill [6], and 30–35 m for the Taichung landfill [7]) were estimated in the designing of the passive venting system in Taiwan. It is also expensive to measure gas flow from a large area of landfill. These motivate the study of the gas-flow modeling in landfills.

2. Mathematical model

The sanitary landfill is composed of the solid waste and the final soil cover. The biodegradation of the solid waste is based on the approach by Findikakis and Leckie [1], in which the refuse is classified into three categories: readily biodegradable, moderately biodegradable and slowly biodegradable. Since the time scale of gas-flow dynamics within the landfill can be neglected, the gas flow can be approximated as a quasi-steady state, once the landfill gas is sufficiently mature. The landfill gas is assumed to be an equimolar mixture of CH_4 and CO_2. The variation of gas flow in the azimuthal direction is also neglected. A schematic of this flow system is given in Fig. 1. The governing equation of mass conservation can be written as:

$$\frac{1}{r}\frac{\partial}{\partial r}(r\rho u_r) + \frac{\partial}{\partial z}(\rho u_z) = \alpha, \tag{1}$$

where ρ is the gas density, r the radial distance from center of the well, z the vertical distance measured from top of the landfill, u_r and u_z the gas velocity in the r- and z-directions, respectively, and α the overall gas production rate for the solid waste layers. Gas production rate in the soil layers is zero. The gas production rate for all of the three components is assumed as follows [1,5]:

$$\alpha = C\sum_{i=1}^{3} A_i\lambda_i\,\mathrm{e}^{-\lambda_i t}, \tag{2a}$$

$$t = t_0 + \frac{z}{h}t_f, \tag{2b}$$

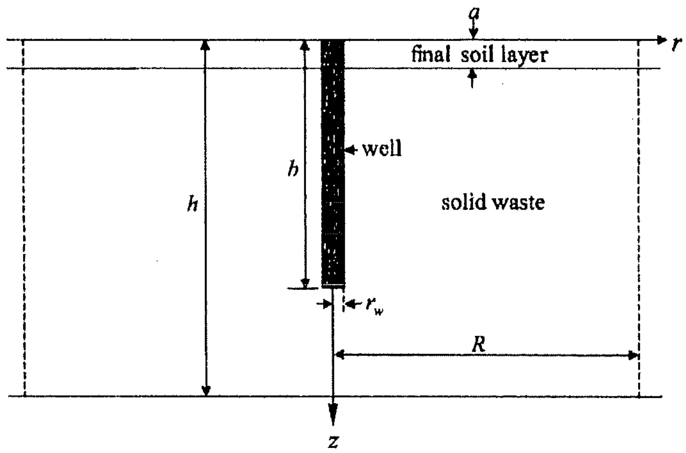


Fig. 1. The schematic of the landfill geometry and coordinate system.

where $C = \rho_{\text{refuse}}[\rho_{\text{CH}_4}(V_{\text{CH}_4})_{\text{refuse}} + \rho_{\text{CO}_2}(V_{\text{CO}_2})_{\text{refuse}}]$ is the mass of total gas produced per unit volume of refuse (ρ_{refuse}, ρ_{CH_4} and ρ_{CO_2} are the refuse, methane and carbon dioxide densities, respectively, and $(V_{\text{CH}_4})_{\text{refuse}}$ and $(V_{\text{CO}_2})_{\text{refuse}}$ the methane and carbon dioxide gas production potentials per unit mass of refuse (m^3/kg), respectively), A_i fraction of waste component i, λ_i the reaction rate constant of waste component i, t the time measured since the first layer of refuse was placed in the landfill, t_0 the time elapsed since the landfill was capped, t_f the total time to fill the landfill, and h the total landfill depth. The Dracy law is employed for the gas flow through the landfill including the soil and refuse layers. An ideal gas model is assumed for the gas mixtures:

$$u_r = -\frac{K_r}{\mu}\frac{\partial P}{\partial r}, \tag{3a}$$

$$u_z = -\frac{K_z}{\mu}\left(\frac{\partial P}{\partial z} - \rho g\right), \tag{3b}$$

$$\rho = \frac{PM}{R_u T}, \tag{3c}$$

where P is the gas pressure, μ the viscosity of gas mixture, g the acceleration of gravity, K_r and K_z the horizontal and vertical permeabilities of waste or soil layers, respectively, T the gas absolute temperature, M the mean molecular weight of gas mixture, and R_u the universal gas constant. In the waste layer, different horizontal and vertical permeabilities are used. In the final soil cover, the horizontal and vertical permeabilities are assumed to be the same. A new function can be defined as:

$$\phi = P - \rho g z - P_{\text{atm}}, \tag{4}$$

where P_{atm} is the atmosphere pressure. By substituting Eqs. (3) and (4) to Eq. (1), it yields:

$$\frac{1}{\mu}\frac{1}{r}\frac{\partial}{\partial r}\left(r\rho K_r\frac{\partial \phi}{\partial r}\right) + \frac{1}{\mu}\frac{\partial}{\partial z}\left(\rho K_z\frac{\partial \phi}{\partial z}\right) = -\alpha. \tag{5}$$

The associated boundary conditions are:

$$\phi = 0, \quad \text{at}\, z = 0, \quad r_w \le r \le R, \tag{6a}$$

$$\frac{\partial \phi}{\partial z} = 0, \quad \text{at}\, z = h, \quad 0 \le r \le R, \tag{6b}$$

$$\frac{\partial \phi}{\partial r} = 0, \quad \text{at}\, r = 0, \quad b \le z \le h, \tag{6c}$$

$$\frac{\partial \phi}{\partial r} = 0, \quad \text{at}\, r = R, \quad 0 \le z \le h, \tag{6d}$$

where r_w is the well radius, r the computational radius, b the well depth, and h the total depth of the landfill. The pressure on the top surface of the landfill is equal to the atmosphere pressure, P_{atm}. It is assumed that the bottom surface of the landfill is impermeable and the gas velocity in the radial direction is negligible at $r = R$. Boundary condition (6c) stands for the symmetric condition of the gas flow. The one-dimensional Bernoulli equation is assumed for the gas flow within the well, that is:

$$\phi_w + \tfrac{1}{2}\rho u_w^2 = \text{constant}, \quad \text{for}\, r < r_w, \quad 0 \le z \le b, \tag{7a}$$

where the subscript 'w' refers to the quantity within the well. The gas velocity distribution inside the well is obtained by using the mass conservation as shown in the following:

$$\frac{du_w}{dz} = 2\pi r_w u_r|_{r=r_w}, \tag{7b}$$

where $u_r|_{r=r_w}$ is the gas velocity at the well boundary and is calculated from the Eq. (3). It is noted that the pressure on the top of the well is also the atmosphere pressure as is shown in boundary condition (6a). The governing Eq. (5) and associated boundary conditions are solved by the finite-difference method. The Tri-Diagonal Matrix Algorithm is used to solve the discretized equations. The numerical details can be found in the book of Patankar [8]. In this study, the grid points in the r- and z-directions are 74 and 72, respectively. The criterion used for the iteration convergence is:

$$\max|\phi^{n+1} - \phi^n| \le 0.01, \tag{8}$$

where ϕ^n is the values at the iteration number n.

3. Result and discussion

The landfill side for this study is the Fresh Kills landfill, which is one of the world's largest landfill [9]. The Fresh Kills landfill is located at Staten Island, a borough of the city of New York. The total area covered by the municipal waste is 426.5 ha, and the mounds of waste extend up to 46 m or more in height. The landfill is divided into four sections designated as 3/4, 2/8, 6/7, and 1/9. Sections 3/4 and 2/8 no longer accepted trash. The northwest portion of the landfill is designated as Section 3/4 and covers approximately 57.2 ha (141 acres). The waste in this section dates from when the section was open in 1955 until it was closed in 1992. The details of the description of the landfill side can be found in the Report EPA902-R-95-001a [10].

A short-term intensive measurement on the landfill gas composition and pollutant emission rates was performed by the US Environmental Protection Agency Region II (assisted by the Radian Corporation). Hundred of gas samples were collected at the landfill over a 3-week period in June and July of 1995. In Section 3/4, most (119) of the passive vents had already been installed at the time of the field sampling. Only those vents above the 42.7 m elevation were not in place. The impermeable clay cap with thickness of 0.30–0.46 m on the toe covers approximately 9.1 ha. Approximately 8.2 ha were being capped with a PVC cover. The remaining 39.9 ha were capped with a soil cover. The details of the measurement data can be found in [10]. Since this report indicated that approximately 10% of the vents did not have flow, but it (Tables 4–8 of [10]) only had the flow rate records of 78 vents. The average of the flow rates of 78 vents is 52.8 m^3/h. Thus, we assume that the upper limit of the flow rate average is about 47.5 m^3/h and the lower limit (assuming the flow rates of the remaining vents are zero) is about $52.8 \times 78/119 = 34.6\ m^3/h$. The mean value of the upper limit and the lower limit of the flow rate for passive vent is 41 m^3/h.

Table 1 lists all input landfill parameters for the numerical model, including the soil and refuse permeabilities and other refuse properties used by Findikakis and Leckie [1] and Arigala et al. [5]. Since the final soil thickness generally ranges between 0.5 and 2 m, and the well depth generally ranges from 50 to 90% of the landfill depth [2], the final soil thickness

Table 1
Values of landfill parameters (data adopted from [1,5,10])

Landfill data	Value
Well diameter (m)	0.1
Landfill depth (m)	46
Final soil thickness (m)	1
Well depth (about 70% of landfill depth) (m)	32.5
Fill period (year)	37
Time elapsed since closure of landfill (per year)	3
Refuse density (kg/m^3)	880
Gas temperature (K)	310
Viscosity of gas mixture (Pa s)	1.54×10^{-5}
Permeability of final soil cover (m^2)	1.0×10^{-13}
Horizontal permeability of refuse (m^2)	3.0×10^{-12}
Vertical permeability of refuse (m^2)	1.0×10^{-12}
Methane gas generation potential per unit mass of refuse (m^3/kg)	0.178
Carbon dioxide gas generation potential per unit mass of refuse (m^3/kg)	0.178
Refuse composition	
Readily biodegradable (%)	15
Moderately biodegradable (%)	55
Slowly biodegradable (%)	30
Reaction rate constant of refuse	
Readily biodegradable (per year)	0.1386
Moderately biodegradable (per year)	0.0231
Slowly biodegradable (per year)	0.017328

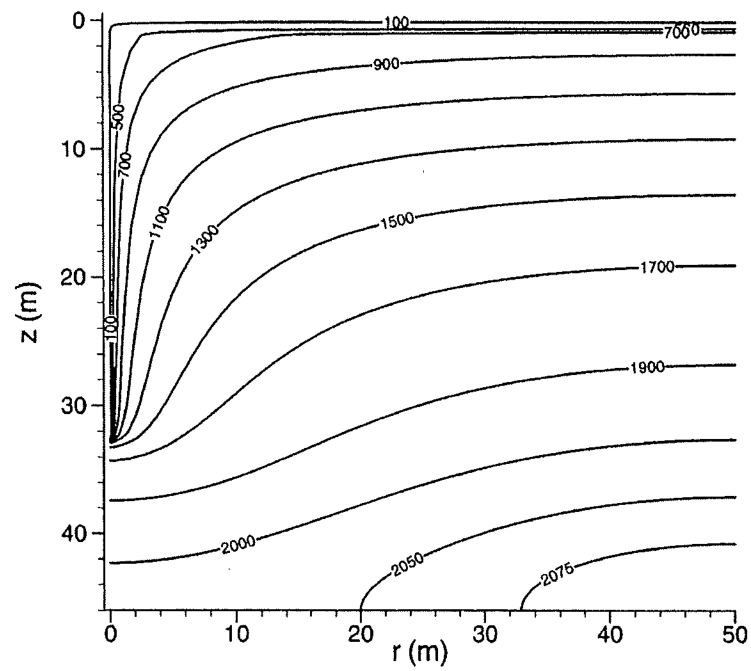


Fig. 2. The pressure contour, ϕ, with the input landfill parameters shown in Table 1.

of 1 m and the well depth with 70% of the landfill depth are also assumed in Table 1. The numerical result of the flow rate from a passive vent is 36.0 m^3/h. This indicates that the computed flow rate is in the reasonable range as compared with the landfill experimental data.

The pressure field, ϕ $(=P - \rho gz - P_{atm})$, for the above landfill parameters (Table 1) is plotted in Fig. 2. The results show that the constant pressure lines near the well are close to each other and the curves stand almost vertically. This indicates that the gas moves almost horizontally and will be collected by the well. But if the radial distance from the well is increased, the interval between two curves will increase quickly and the slope of the curve decline quickly. This implies that the well's ability in capturing the far-away landfill gas decays quickly with the increase of the radial distance from the well in the passive venting system. When the distance from the well is greater than 20 m, the constant pressure lines are close horizontal. It suggests that a high proportion of the landfill gas produced by the waste for $r \geq 20$ m could not be collected by the well and could emit out from the landfill surface. It can also be seen that the slope of the constant pressure line is smaller, when the curve is closer to the top surface. This indicates that the gases produced by the top refuse layers are easy to escape from the landfill surface. From the above discussions, it indicates that the well's ability in collecting the landfill gas by the passive vent is limited to a small area around the vent.

Fig. 3 shows the effect of the final soil cover thickness, a, on the gas flow rate at the well exit, Q_W (m^3/h). It is noted that, except the final soil thickness, all other input landfill parameters are the same with those listed in Table 1. Fig. 3 indicates that the gas flow rate from the well increases with increasing final soil thickness. This is because the permeability of final soil is much smaller than that of the refuse, the increase of the final soil thickness will

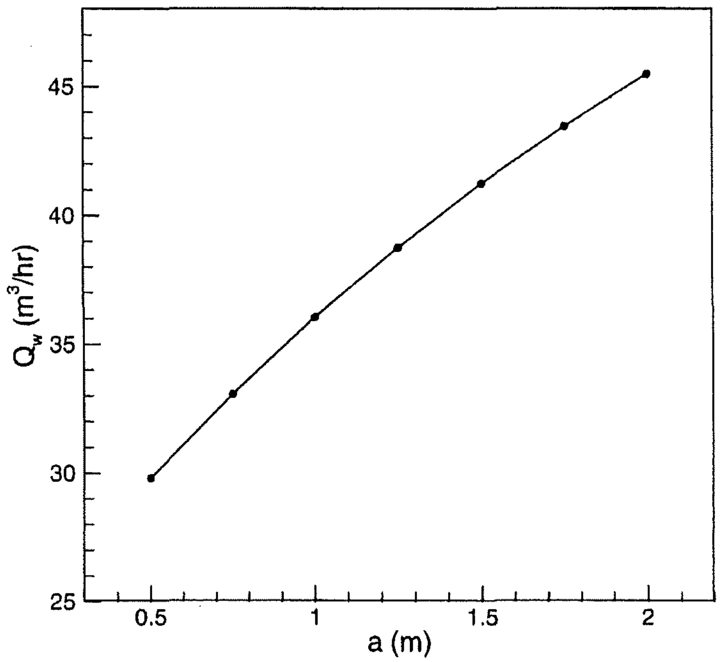


Fig. 3. The variation of flow rate, Q_w, with the final soil thickness, a (except the final soil thickness, all other input landfill parameters are the same with those in Table 1).

increase the flow resistance for the gas to go through the final soil layer. Thus, the landfill gas will move along the refuse layers with less flow resistance and is easy to be captured by the well. The flow rate for $a = 2$ m is 45.5 m^3/h, which is 53% higher than that (29.8 m^3/h) for $a = 0.5$ m. To show the effect on the flow pattern for the thicker final soil layer, the pressure contour, ϕ, for $a = 2$ m is plotted in Fig. 4. When it compares to the pressure contours in Fig. 2, the density of the curves near the well region in Fig. 4 is much higher than that in Fig. 2. This means that more landfill gas will move towards the well direction and will consequently be collected by the well. The curve inside the final soil in Fig. 4 is crowded, meaning that the final soil cover acts to retard the gas flow toward the landfill surface.

The effect of well depth, b, on the gas flow rate at well exit, Q_w, is plotted in Fig. 5. The well depth generally ranges from 50 to 90% of the landfill depth [2]. The Q_w increases with increasing well depth. The Q_w for the $b = 41.5$ m (90% of the landfill depth) is 44.6 m^3/h, which is 77% higher than that (25.2 m^3/h) for the $b = 23$ m (50% of the landfill depth). This indicates that the well depth has an important effect on the flow rate. Fig. 6 presents the pressure contour, ϕ, for a shorter well depth of 23 m. It shows that the flow pattern is affected by the well depth. The curves for the depth $z \geq 27$ m or for the radius $r \geq 18$ m are almost horizontal. This indicates that the well's ability in extracting on those gases, which are produced in the refuse for the regions of $z \geq 27$ m or for the radius $r \geq 18$ m, is rather limited. Thus, large amount of the landfill gases produced in these regions could escape from the landfill surface. From the above results, it is suggested that the well depth should be deeper as possible as it can be.

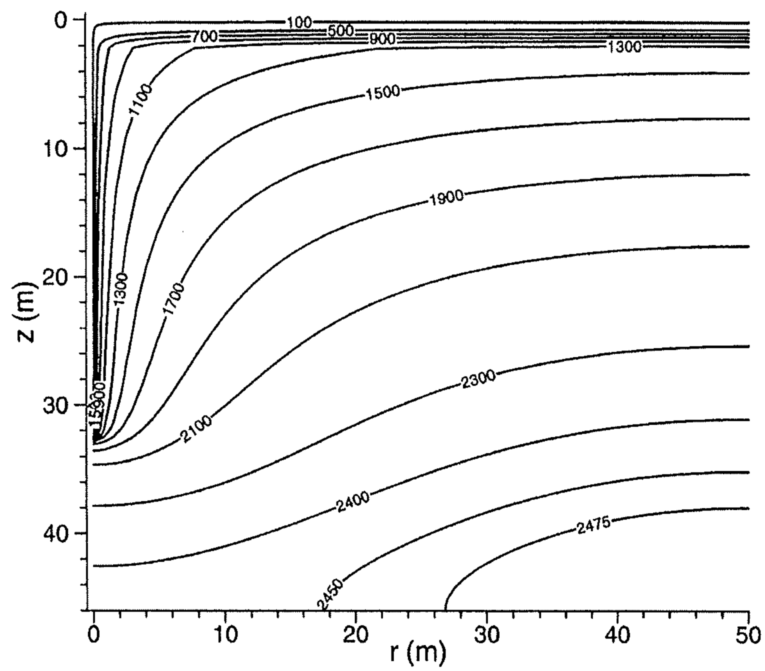


Fig. 4. The pressure contour, ϕ, for the final soil thickness, $a = 2$ m.

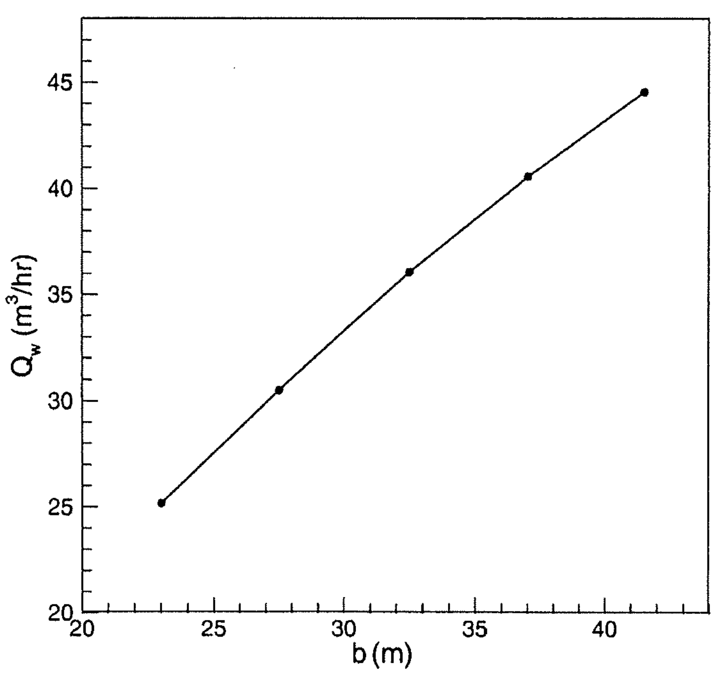


Fig. 5. The variation of flow rate, Q_w, with the well depth, b.

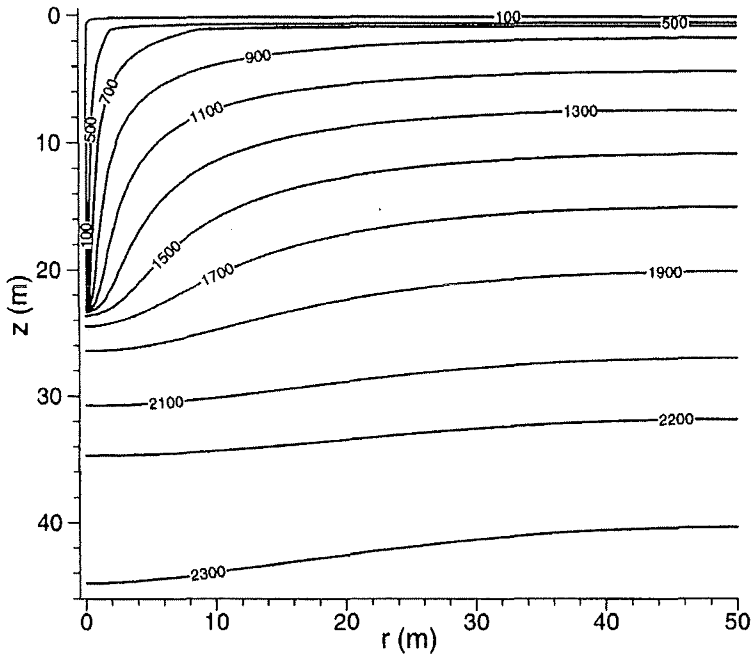


Fig. 6. The pressure contour, ϕ, for the well depth, $b = 23$ m.

The effect of the final soil permeability, K_f, on the gas flow rate from well, Q_w, is plotted in Fig. 7. The Q_w increases with the decreasing final soil permeability and its increases more quickly when the permeability of the final soil is small. The gas flow rate Q_w for $K_f = 6 \times 10^{-14}$ m^2 is 44.8 m^3/h, which is 72% higher than that (26 m^3/h) for $K_f = 30 \times 10^{-14}$ m^2. The pressure contour, ϕ, for small final soil permeability of 6×10^{-14} m^2 is shown in Fig. 8, and it shows that the curves in the final soil layer are close to each other, indicating that the flow resistance for the gas to go through the final soil layer is high. The above results show that the mechanisms on the flow patterns by increasing the final soil thickness or by choosing a lower permeability for the final soil are basically the same; that is, they increase the gas flow resistance through the final soil layer so that the landfill gas is difficult to penetrate this layer.

A sensitivity analysis of time, t_0 (year), elapsed since the landfill was capped is plotted in Fig. 9. It is reminded that, except the parameter of t_0, all other input landfill parameters are the same with those listed in Table 1. It shows that the flow rate gradually decays when time, t_0, is longer. Fig. 10 plots the pressure contour for $t_0 = 10$ years. As compared with Fig. 3 for $t_0 = 3$ years, both pressure patterns are similar, but the curves of Fig. 3 are more crowded. The flow rate (28.6 m^3/h) for $t_0 = 10$ years is 79% of that (36.1 m^3/h) for $t_0 = 3$ years. It is seen that most portions of the curve of $\phi = 1650$ in Fig. 10 coincide with those of the curve of $\phi = 2050$ in Fig. 3. Its ratio is 1650/2050 = 80%, which is very close to 79%. Thus, the magnitude of flow velocity in Fig. 3 is about 79% of that in Fig. 3. This indicates that the time age of t_0 has limited effect on the flow pattern, but it affects the magnitude of flow velocity in the landfill.

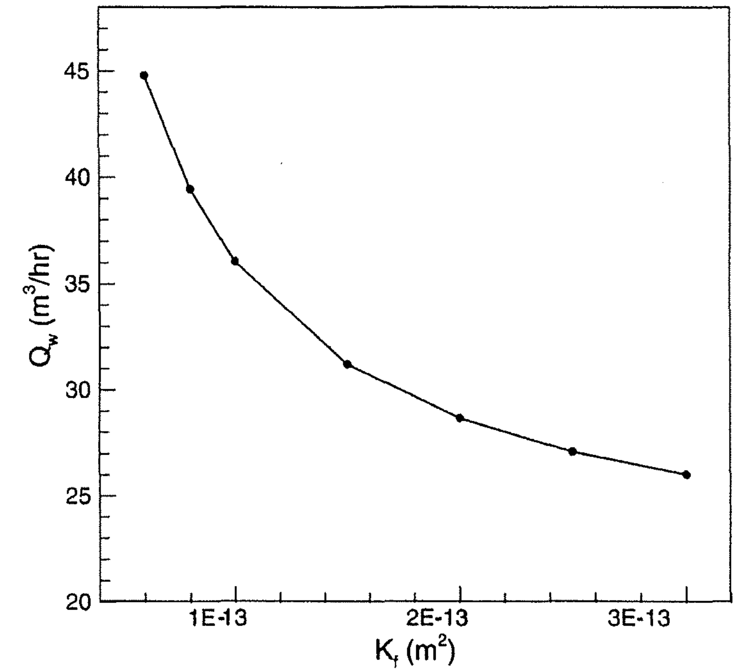


Fig. 7. The variation of flow rate, Q_w, with the final soil permeability, K_f.

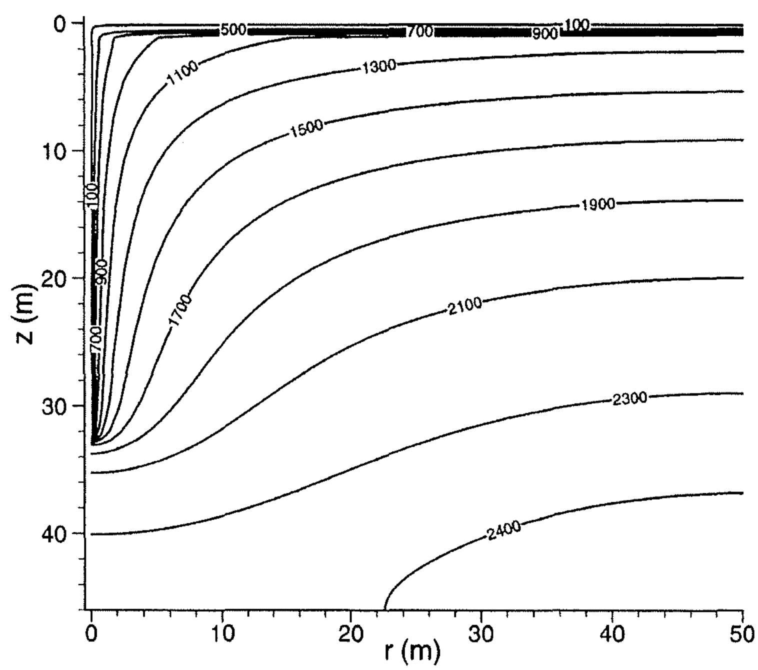


Fig. 8. The pressure contour, ϕ, for the final soil permeability, $K_f = 6 \times 10^{-14}$ m².

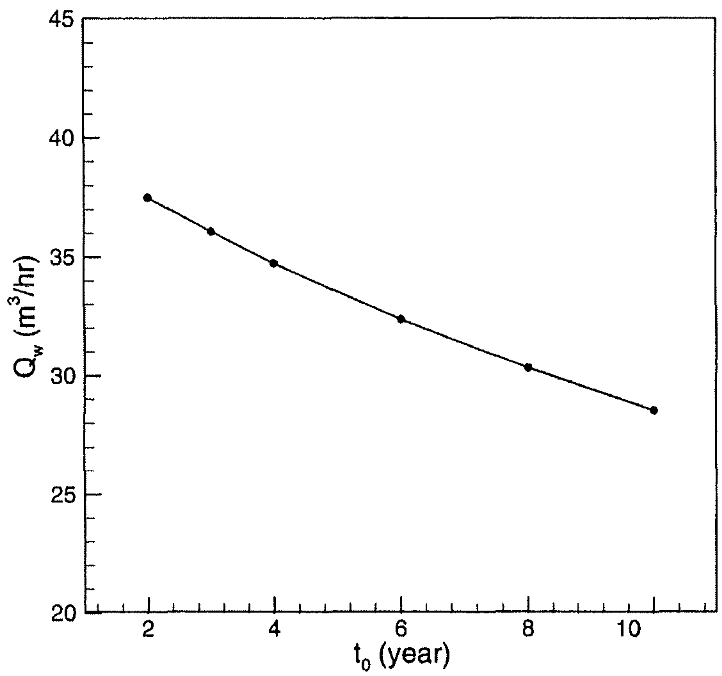


Fig. 9. The variation of flow rate, Q_w, with time elapsed since landfill was capped, t_0.

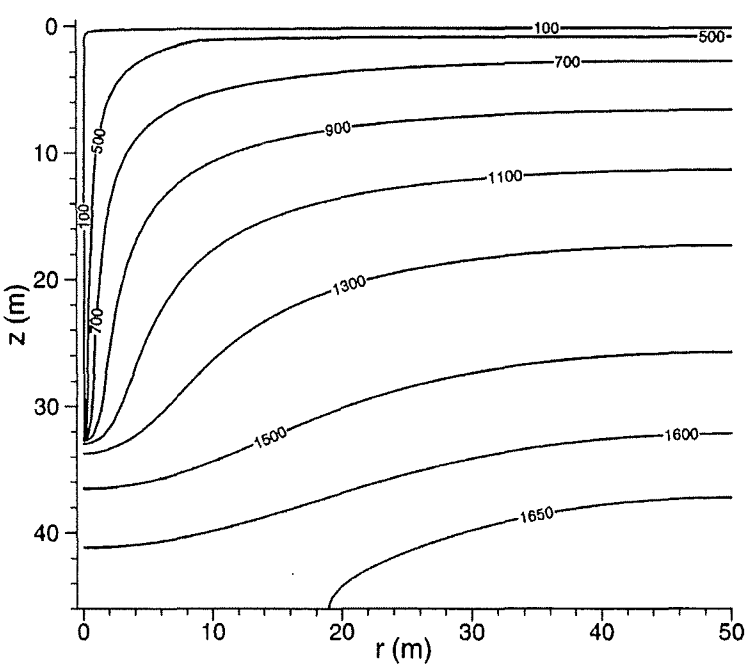


Fig. 10. The pressure contour, ϕ, for time, $t_0 = 10$ years.

4. Conclusion

The two-dimensional gas flow around a passive vent in a landfill was investigated numerically. The Darcy law was employed in modeling the flow motion. The one-dimensional Bernoulli equation was assumed for the gas flow within the well. The field data from the Fresh Kills landfill, New York, was used for the numerical model verification and the studies of the different landfill parameter effects on the gas flow. The numerical results show that the well's ability in extracting the landfill gas in the passive venting system is limited to a small area around the well and its gas collection ability decays quickly with the increase of the radial distance from the well. The result from the Fresh Kills landfill also shows that when the distance from the well is greater than 20 m, the slopes of constant pressure curves are generally small. It suggests that a high proportion of the landfill gas in the region with its radial distance from the well greater than 20 m may emit out from the landfill surface. This indicates that the influence radius of the passive vent is generally less than 20 m.

The landfill parameter studies also show that the flow rate from the well increases with increasing the final soil thickness or by choosing final soil with lower permeability. This is due to the fact that they increase the flow resistance through the final soil layer so that gas is difficult to penetrate it. The flow rate from the well is increased 53%, when the final soil thickness is increased from 0.5 to 2.0 m. The flow rate is increased 72%, when the final soil permeability is reduced from 30×10^{-14} to $6 \times 10^{-14}\,m^2$. The flow rate also increases for the deeper well depth. When the well depth is 90% of the landfill depth, its flow rate is 77% higher than that for the well depth equal to 50% of the landfill depth. The time age, elapsed since the closure of the landfill, has a limited effect on the flow pattern, but it affects the magnitude of flow velocity and the flow rate. Those imply that the gas flow can be significantly effected by the final soil thickness and its permeability, and the well depth.

Acknowledgements

This work was supported by the National Science Council, Taiwan, ROC, under the grant NSC 88-2621-B-161-001 (Y.-C. Chen as Principal Investigator). The computing resource was provided by National Center for High-Performance Computing. We are thankful for the buildup of the computer code by Mrs. H.Y. Hu. The authors are gratefully thankful to one of reviewers, who kindly provided us the information of the field experimental data of Fresh Kills landfill [10] for the numerical model verification.

References

[1] A.N. Findikakis, J.O. Leckie, Numerical simulation of gas flow in sanitary landfills, ASCE J. Environ. Eng. 105 (1979) 927–945.
[2] P. O'Leary, P. Walsh, Landfill gas movement, control, and uses, Waste Age 114 (1991) 114–124.
[3] H. Esmaili, Control of gas flow from sanitary landfills, ASCE J. Environ. Eng. 101 (1975) 555–566.
[4] A.H. Lu, C.O. Kunz, Gas-flow model to determine methane production at sanitary landfills, Environ. Sci. Technol. 15 (1981) 436–440.
[5] S.G. Arigala, T.T. Tsotsis, I.A. Webster, Y.C. Yortsos, J.J. Kattapuram, Gas generation, transport, and extraction in landfills, ASCE J. Environ. Eng. 121 (1995) 33–44.

[6] Chung-Hsing Engineering Consulting Corp., Planning Report of Sanjuku Sanitary Landfill of Taipei City, 1992.
[7] Hwan-Chi Engineering Consulting Corp., The Planning Project of Gas and Leachate Pollution Prevention for the Taichung City Sanitary Landfill, 1994.
[8] S.V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere, New York, 1989.
[9] J.M. Suflita, C.P. Gerba, R.K. Ham, A.C. Palmisano, W.L. Rathje, J.A. Robinson, The world's largest landfill, Environ. Sci. Technol. 26 (1992) 1486–1495.
[10] Radian Corporation, Determination of landfill gas composition and pollutant emissions rates at Fresh Kills landfill, USEPA Project Report No. EPA902-R-95-001a, 1995.

APPENDIX B

UTILITY EVALUATION

APPENDIX B

UTILITY EVALUATION

This appendix presents the evaluation of existing and proposed utilities as potential migration pathways for landfill gas migration. Figure 4.3 (shown in text) presents the existing utilities in the vicinity of the Holtz Krause landfill as well as the proposed utilities to be installed during the new road construction of the Curling Club. Each area of the landfill perimeter is discussed below and for ease of reference, are highlighted and labeled on Figure 4.3. Figure 2.1 of Section 2.0 show the water features which prevent landfill gas migration.

SOUTHEAST AREA

This area represents approximately 1,800 feet along the east landfill perimeter. Surface water and wetland features are present here and also match the groundwater table. As such, landfill gas cannot migrate to the east. Northwestern Avenue, located approximately 400 feet northeast of the landfill has a watermain and sanitary sewer. These utilities lie northeast of the surface water/wetland features and, as such, do not represent a preferential pathway for landfill gas migration.

SOUTH AREA

This area represents approximately 1,800 feet along the south landfill boundary. The area south of the landfill has surface water and wetland features present. The groundwater table is present at ground surface. As such, landfill gas cannot migrate to the south.

As shown on Figure 4.3, East Kent Street terminates at the landfill. There is an existing, 800-foot long access road that currently services the blower building. Also, the City of Wausau is planning to construct a new street (Curling Way), sanitary sewer and watermain for the future curling club. The 90 percent design drawings for Curling Way as designed by the City are attached to this Appendix.

The existing and proposed sanitary sewers lie at a depth of 16 to 18 feet below ground and are within the water table.

The backfill for the sanitary sewer trench is, or will be, sand or finer-grained soils. The native soil is sand. As such, the backfill does not represent a preferential pathway to landfill gas migration.

The existing and proposed watermains are/will be approximately 4 to 5 feet below ground and the watermain trench backfill will not be more permeable than the native sand. As such, there is no preferential pathway for landfill gas migration.

Electrical and telephone are also proposed approximately 50 feet west of the landfill along the access road. These utilities would be buried in native sand at a shallow depth of 2 to 3 feet below ground and will likely be trenched in. Hence, electrical and telephone lines do not represent a preferential pathway to landfill gas migration.

A north-south fiber optic line and natural gas line are also proposed and would be located approximately 120 feet west of the landfill. These utilities would be buried 3 to 4 feet below ground in native soil and do not represent a preferential pathway to landfill gas migration.

The northern half of the west side represents 1,200 feet of landfill perimeter. There are no utilities between the landfill and Cemetery Slough. As such, there are no preferential utility pathways for landfill gas migration.

NORTH AREA

The north area represents only 400 feet of landfill perimeter. There is an existing north-south storm sewer likely buried at a depth of 3 to 4 feet below ground. The storm sewer lies 400 feet or greater from the landfill. Given its distance and shallow depth, the storm sewer does not represent a preferential migration pathway for landfill gas migration.

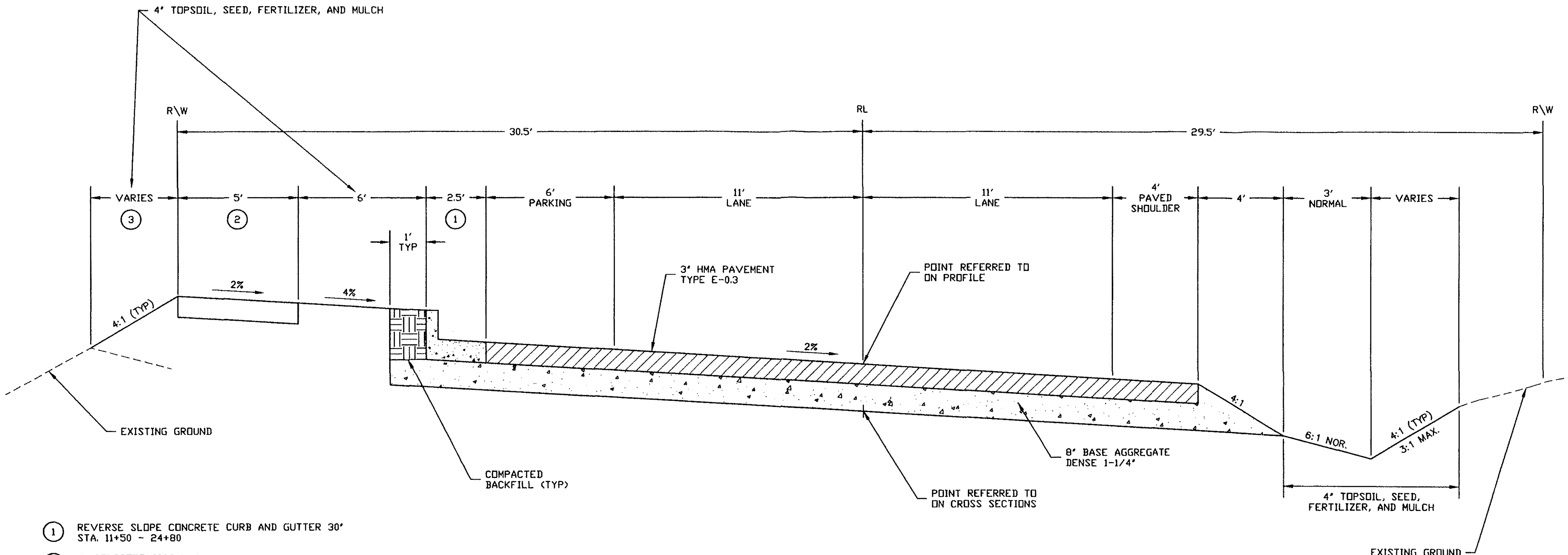
A watermain is located approximately 600 feet north of the landfill at a depth of 4 to 5feet below ground. Given this distance, the watermain trench is not likely to be a preferential migration pathway to landfill gas migration.

NORTHEAST AREA

The northeast area represents 800 feet of landfill perimeter. Northwestern Avenue is located 300 to 400 feet northeast of the landfill and has an existing water main and sanitary sewer. These utilities were installed in native sandy soils and the utility trench backfill is likely similar or less permeable than the native soil. As such, there is not a preferential migration pathway to the northeast of the landfill.

SUMMARY

The existing and proposed utilities surrounding the Holtz Krause landfill have been identified and evaluated. Based on this evaluation, there are no preferential migration pathways for landfill gas migration along the utility corridors.



1. REVERSE SLOPE CONCRETE CURB AND GUTTER 30" STA. 11+50 - 24+80
2. 4" CONCRETE SIDEWALK STA. 11+50 - 24+80
3. SLOPE RESTORATION FROM STA. 18+80 - 24+75 OUTSIDE OF R/W BY OTHERS.

TYPICAL FINISHED SECTION - CURLING WAY

STA. 10+62.60 - 25+37.89

NOTE: NOT TO SCALE

CITY OF WAUSAU
Engineering Department
407 GRANT STREET WAUSAU, WI. 54403-4783
(715) 261-6740 FAX (715) 261-6759

SURVEYED BY:
FIELD BOOK NO. PG.
DESIGNED BY: S.J.GEHIN
DRAWN BY: J.D.VANBOXEL
APPROVED BY: A.M.WESOLOWSKI
POINT FILE:

REVISIONS

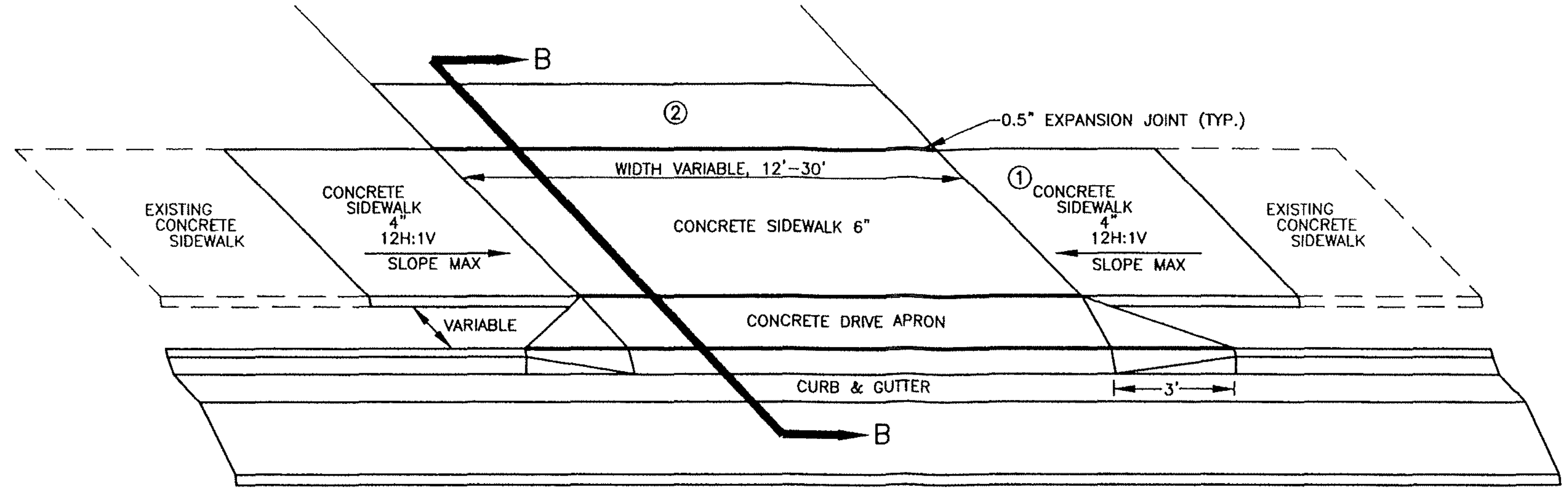
DATE 02/03/12

ISSUED FOR
PRELIMINARY
REVIEW/APPROVAL
BIDDING/CONST.
REC. REF. DWG.
OFFICE USE

TYPICAL SECTION
PROPOSED SECTION
CURLING WAY

SHEET NO. 1 OF 1 SHEETS
FILE NUMBER 12-01-30

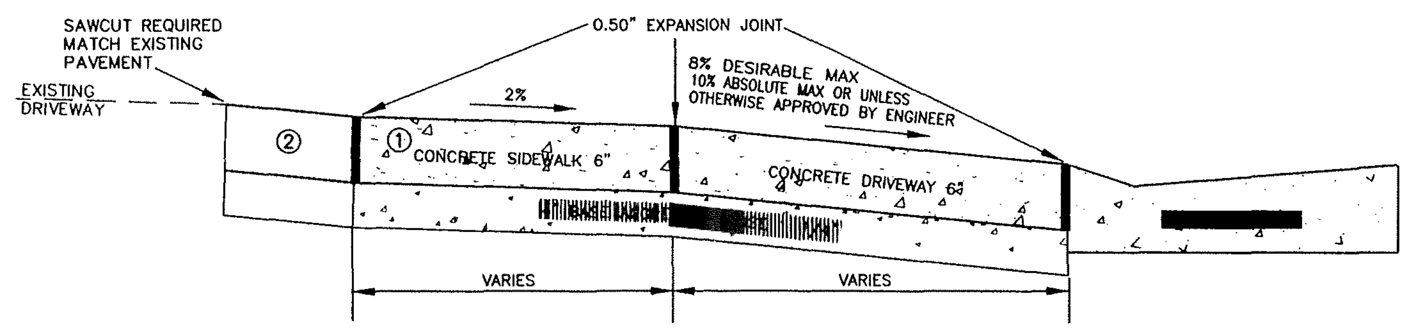
DWG FILE NAME: O:\Engineering\DWG\PROJ\0839\0839_Details.dwg, 3/2/2012 11:38:43 AM, City of Wausau - Engineering Department, Plotted by: J.D. VanBoxel



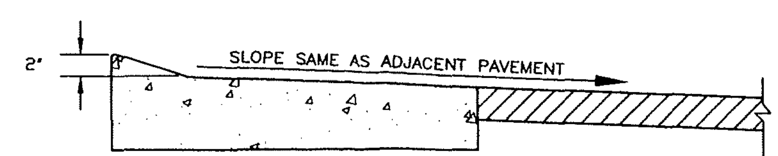
TYPICAL DRIVEWAY DETAIL

①REMOVE AND REPLACE EXISTING CONCRETE SIDEWALK 6" AT LOCATIONS SHOWN ON PLANS.

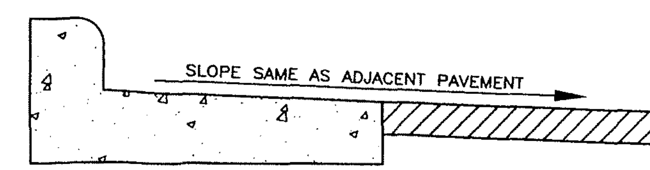
②CONCRETE DRIVES: CONCRETE DRIVEWAY 6" OVER 4" BASE AGGREGATE DENSE 1 1/4"
ASPHALT DRIVES: 2" ASPHALTIC SURFACE DRIVEWAYS (E-0.3) OVER 6" BASE AGGREGATE DENSE 1 1/4"
GRAVEL DRIVES: 6" CRUSHED RED GRANITE 1"



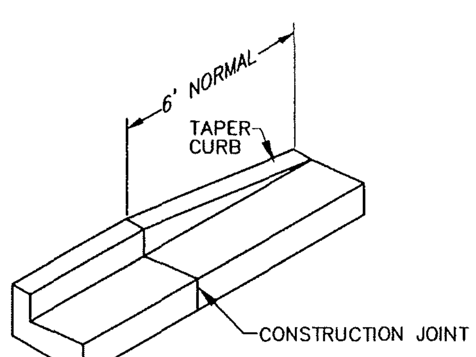
TYPICAL DRIVEWAY SECTION
SECTION B-B



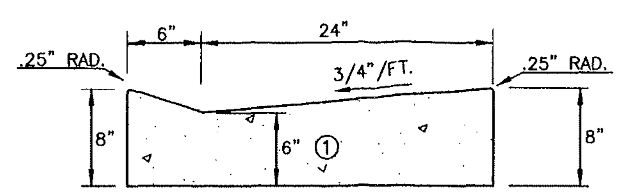
REVERSE SLOPE GUTTER
AT DRIVE APPROACHES



REVERSE SLOPE GUTTER
(TYPICAL FOR ALL CURB AND GUTTER TYPES)

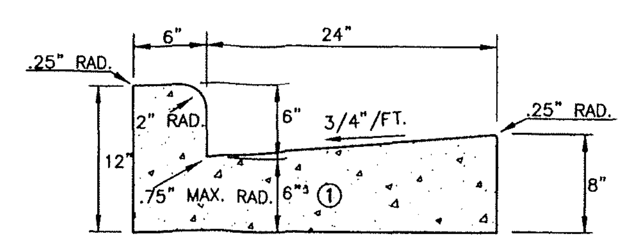


DETAIL OF CURB & GUTTER TERMINI



CONCRETE CURB & GUTTER 30"
AT DRIVE APPROACHES

① THE BOTTOM OF CURB AND GUTTER MAY BE CONSTRUCTED EITHER LEVEL OR PARALLEL TO THE SLOPE OF SUBGRADE OR BASE AGGREGATE PROVIDED A 6" MINIMUM GUTTER THICKNESS IS MAINTAINED.



CONCRETE CURB & GUTTER 30"

NOTE: NOT TO SCALE

CITY OF WAUSAU
Engineering Department
407 GRANT STREET WAUSAU, WI. 54403-4783
(715) 261-6740 FAX (715) 261-6759

SURVEYED BY:
FIELD BOOK NO. PG.
DESIGNED BY: S.J.GEHIN
DRAWN BY: J.D.VANBOXEL
APPROVED BY: A.M.WESOLOWSKI
POINT FILE:

REVISIONS

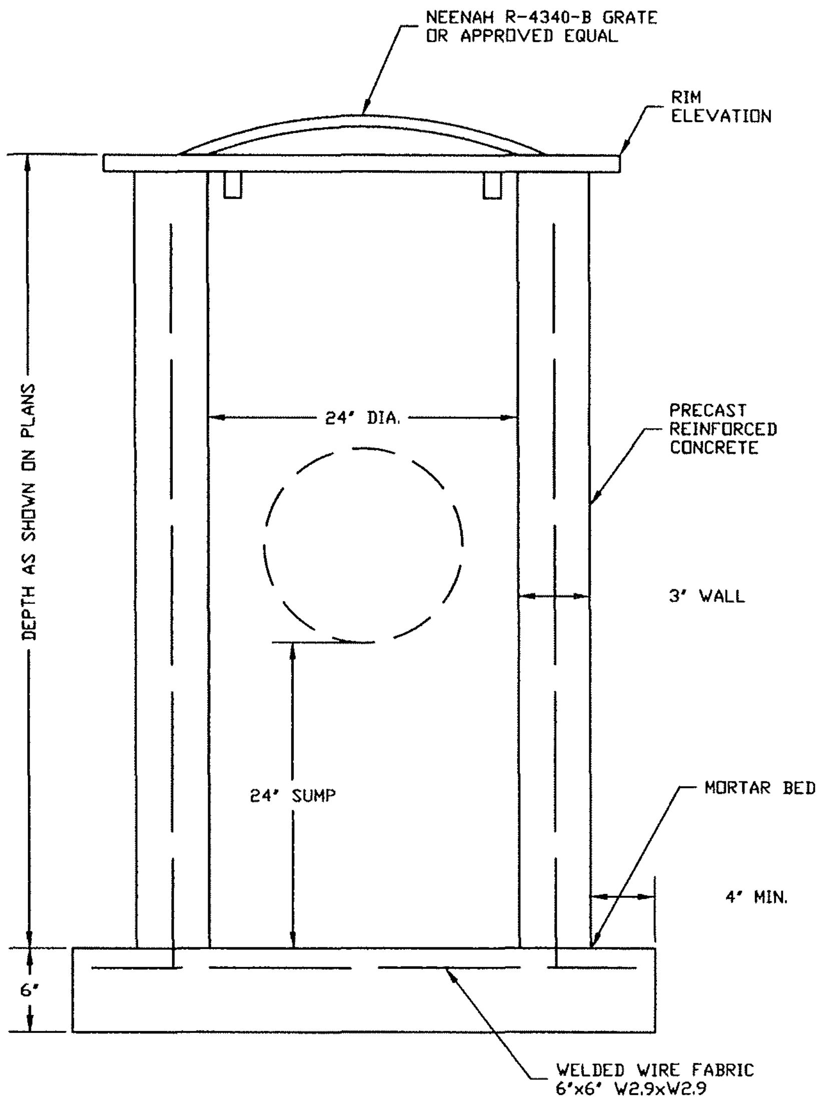
DATE 02/03/12

ISSUED FOR
PRELIMINARY ■
REVIEW/APPROVAL □
BIDDING/CONST. □
REC. REF. DWG. □
OFFICE USE □

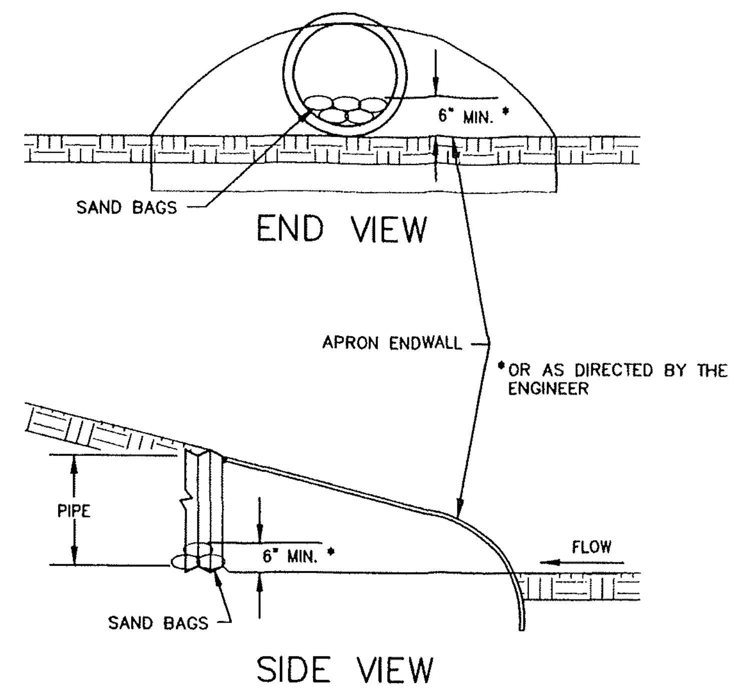
GENERAL DETAILS
STRUCTURES, GENERAL DETAILS, AND SPECIFICATIONS
2012 STREET IMPROVEMENTS PROJECT "C"

SHEET NO. 1 OF 2 SHEETS
FILE NUMBER 12-01-30

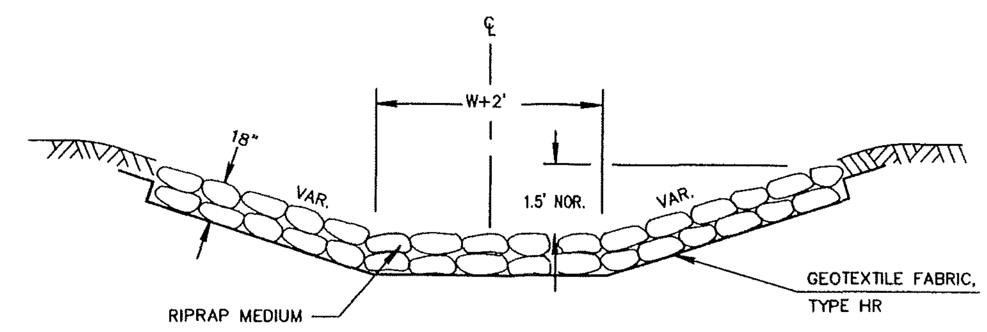
DWG FILE NAME: C:\Engineering\DWG\PROJ\0839\0839_Details.dwg, 3/2/2012 11:39:07 AM, City of Wausau - Engineering Department, Plotted by: J.D. VanBoxel



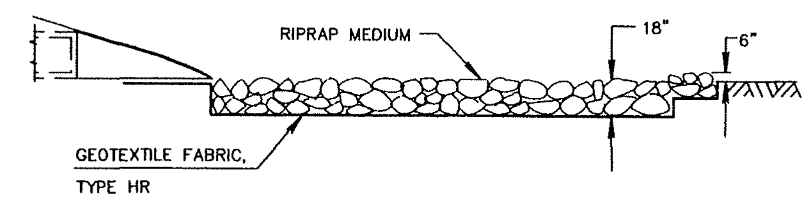
24" CATCH BASIN



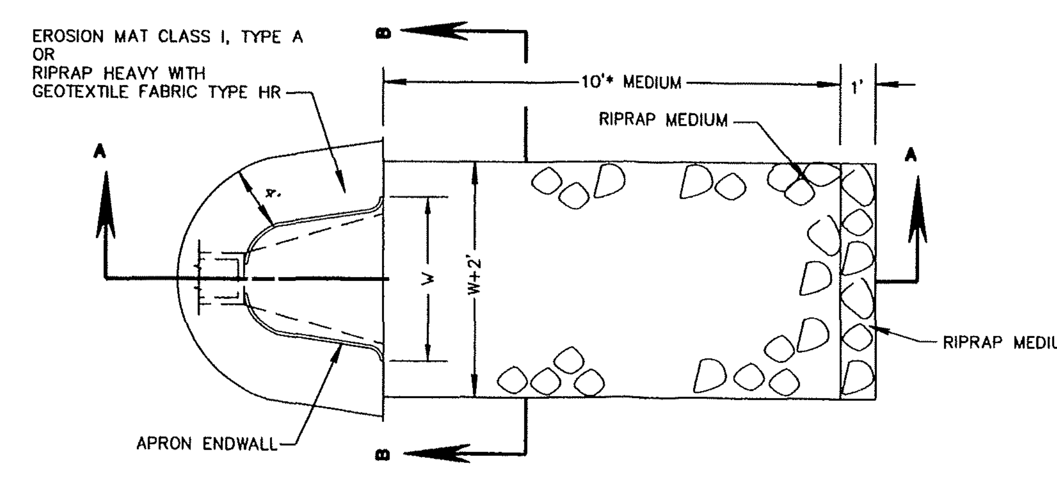
CULVERT PIPE DITCH CHECK



SECTION B–B



SECTION A–A



RIPRAP MEDIUM

*OR AS DIRECTED BY THE ENGINEER

NOTE: NOT TO SCALE

CITY OF WAUSAU
Engineering Department
407 GRANT STREET WAUSAU, WI. 54403-4783
(715) 261-6740 FAX (715) 261-6759

SURVEYED BY:
FIELD BOOK NO. PG.
DESIGNED BY: S.J.GEHIN
DRAWN BY: J.D.VANBOXEL
APPROVED BY: A.M.WESOLOWSKI
POINT FILE:

REVISIONS

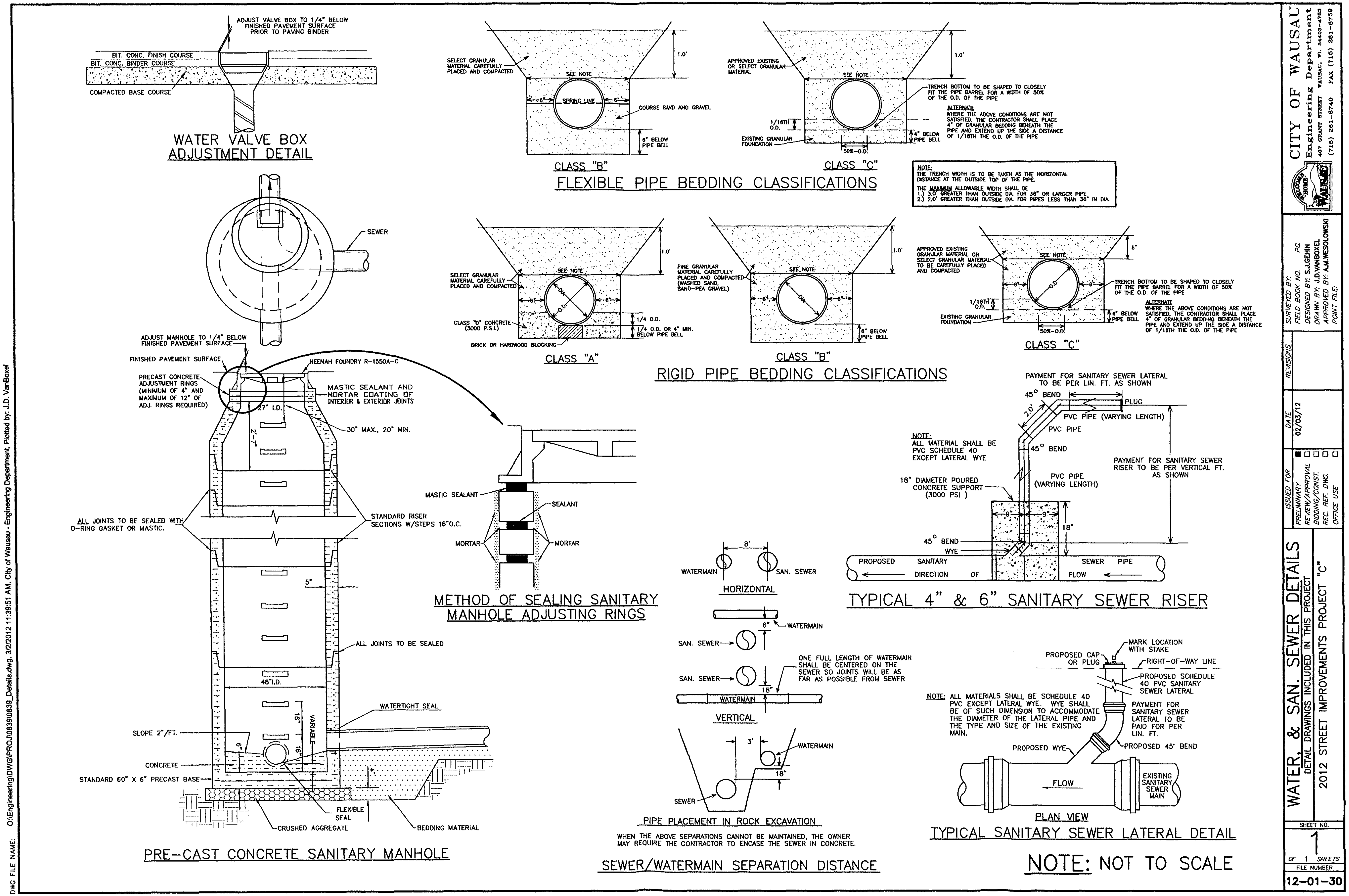
DATE 02/03/12

ISSUED FOR
PRELIMINARY ■
REVIEW/APPROVAL □
BIDDING/CONST. □
REC. REF. DWG. □
OFFICE USE □

GENERAL DETAILS

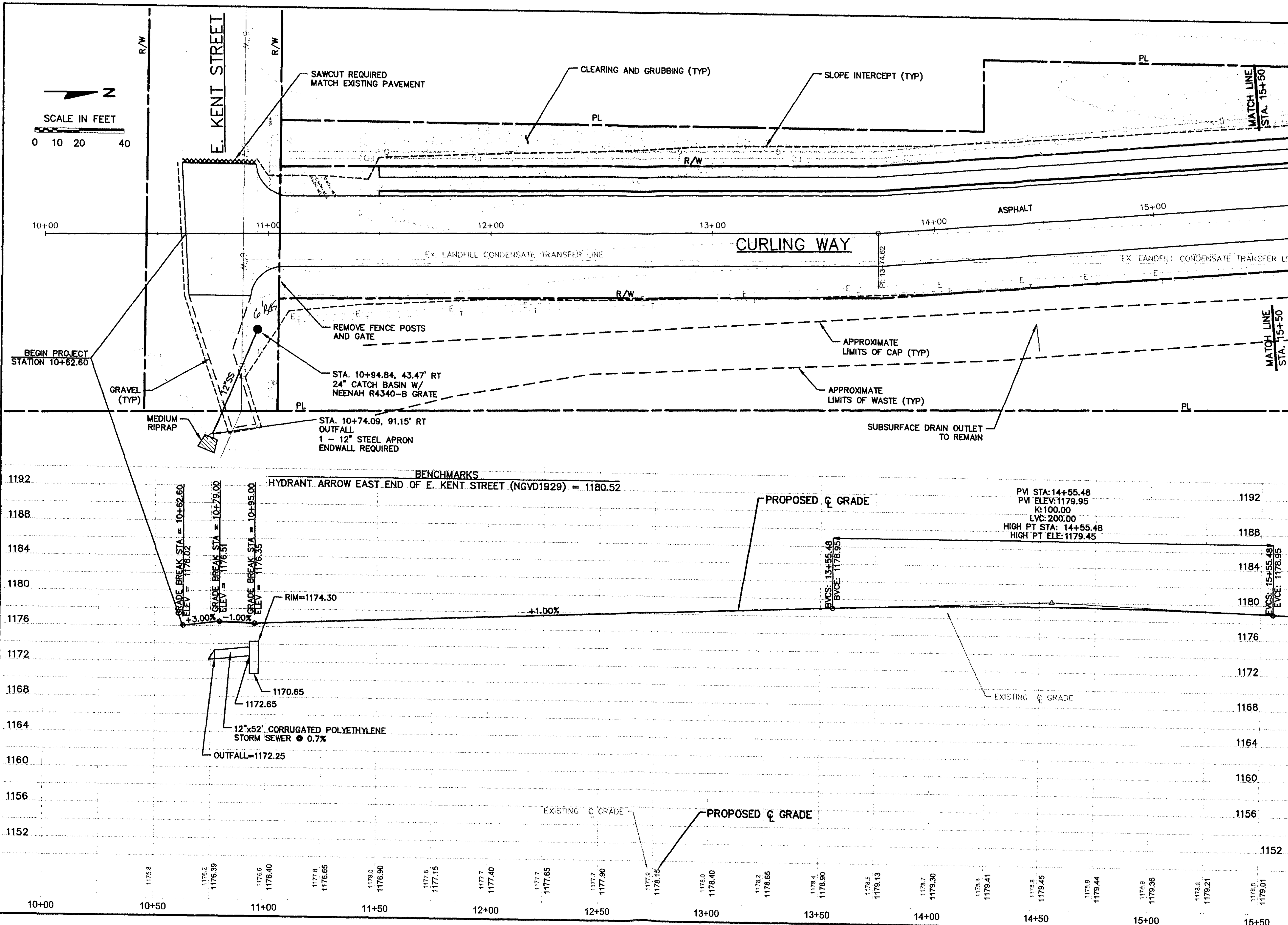
STRUCTURES, GENERAL DETAILS, AND SPECIFICATIONS
2012 STREET IMPROVEMENTS PROJECT "C"

SHEET NO. 2 OF 2 SHEETS
FILE NUMBER 12-01-30



DWG FILE NAME: O:\Engineering\DWG\PROJ\0839\0839_Details.dwg, 3/2/2012 11:39:51 AM, City of Wausau - Engineering Department, Plotted by: J.D. VanBoxel

DWG FILE NAME: O:\Engineering\DWG\PROJ0839\0839-022112-CurlingClubDesign-CoW.dwg, 3/2/2012 11:26:33 AM, City of Wausau - Engineering Department, Plotted by: J.D. VanBoxel



CITY OF WAUSAU
Engineering Department
407 GRANT STREET WAUSAU, WI. 54403-4783
(715) 261-6740 FAX (715) 261-6759

SURVEYED BY: CWE
FIELD BOOK NO. PG.
DESIGNED BY: S.J.GEHIN
DRAWN BY: J.D.VANBOXEL
APPROVED BY: A.M.WESOLOWSKI
POINT FILE:

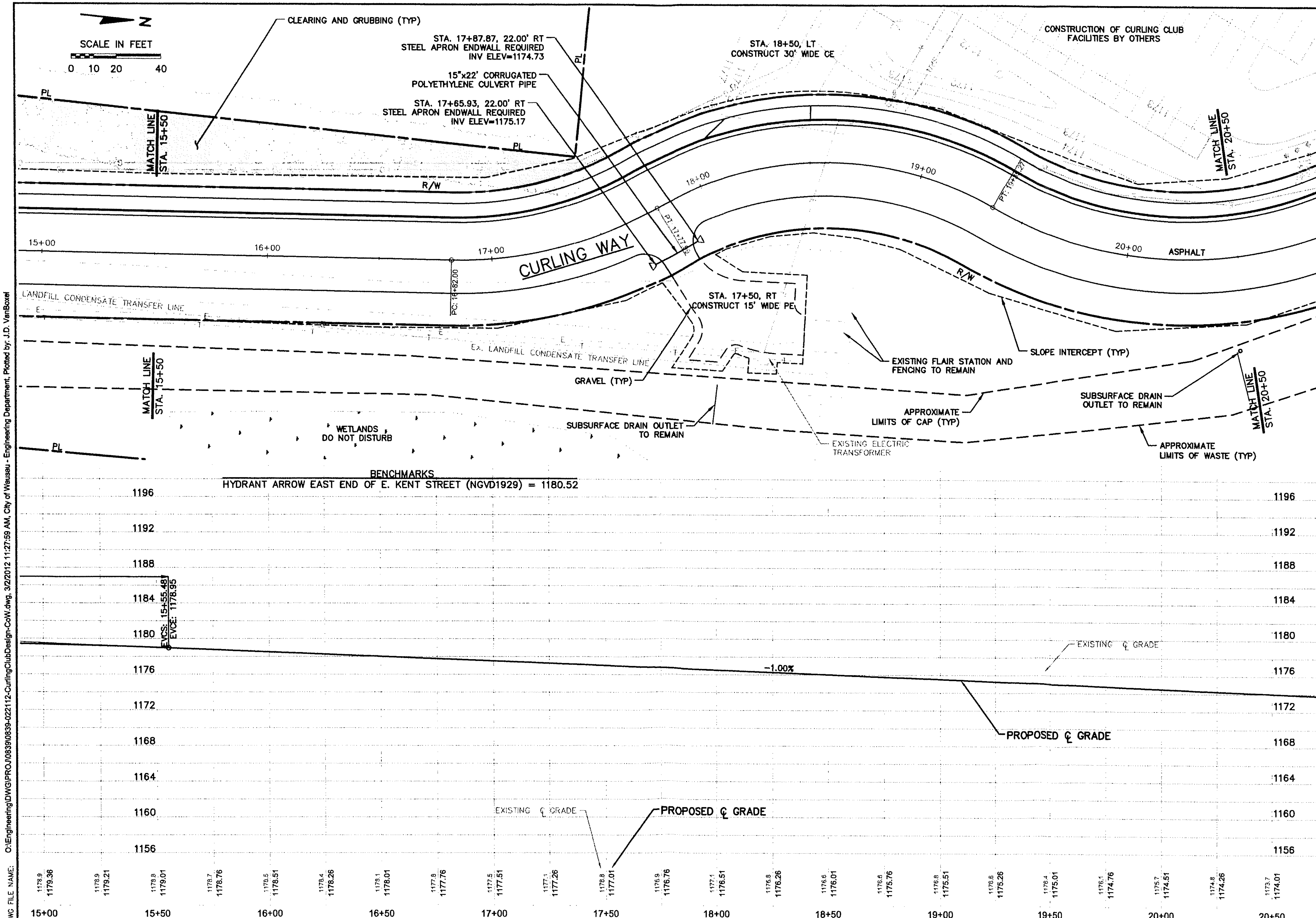
REVISIONS: P.R.NIKOLAI

DATE: 01/30/2012

ISSUED FOR: PRELIMINARY / REVIEW/APPROVAL / BIDDING/CONST. / REC. REF. DWG. / OFFICE USE

CURLING WAY
E. KENT STREET TO CURLING CLUB
PLAN & PROFILE
2012 STREET IMPROVEMENT PROJECT "C"

SHEET NO. 1 OF 3 SHEETS
FILE NUMBER 12-01-30



DWG FILE NAME: O:\Engineering\DWG\PROJ\0839\0839-022112-CurlingClubDesign-CoW.dwg, 3/2/2012 11:27:59 AM, City of Wausau - Engineering Department, Plotted by: J.D. VanBoxel

CITY OF WAUSAU
Engineering Department
407 GRANT STREET WAUSAU, WI 54403-4783
(715) 261-6740 FAX (715) 261-6759

SURVEYED BY: CWE
FIELD BOOK NO. PG.
DESIGNED BY: S.J.GEHIN
DRAWN BY: J.D.VANBOXEL
APPROVED BY: A.M.WESOLOWSKI
POINT FILE:

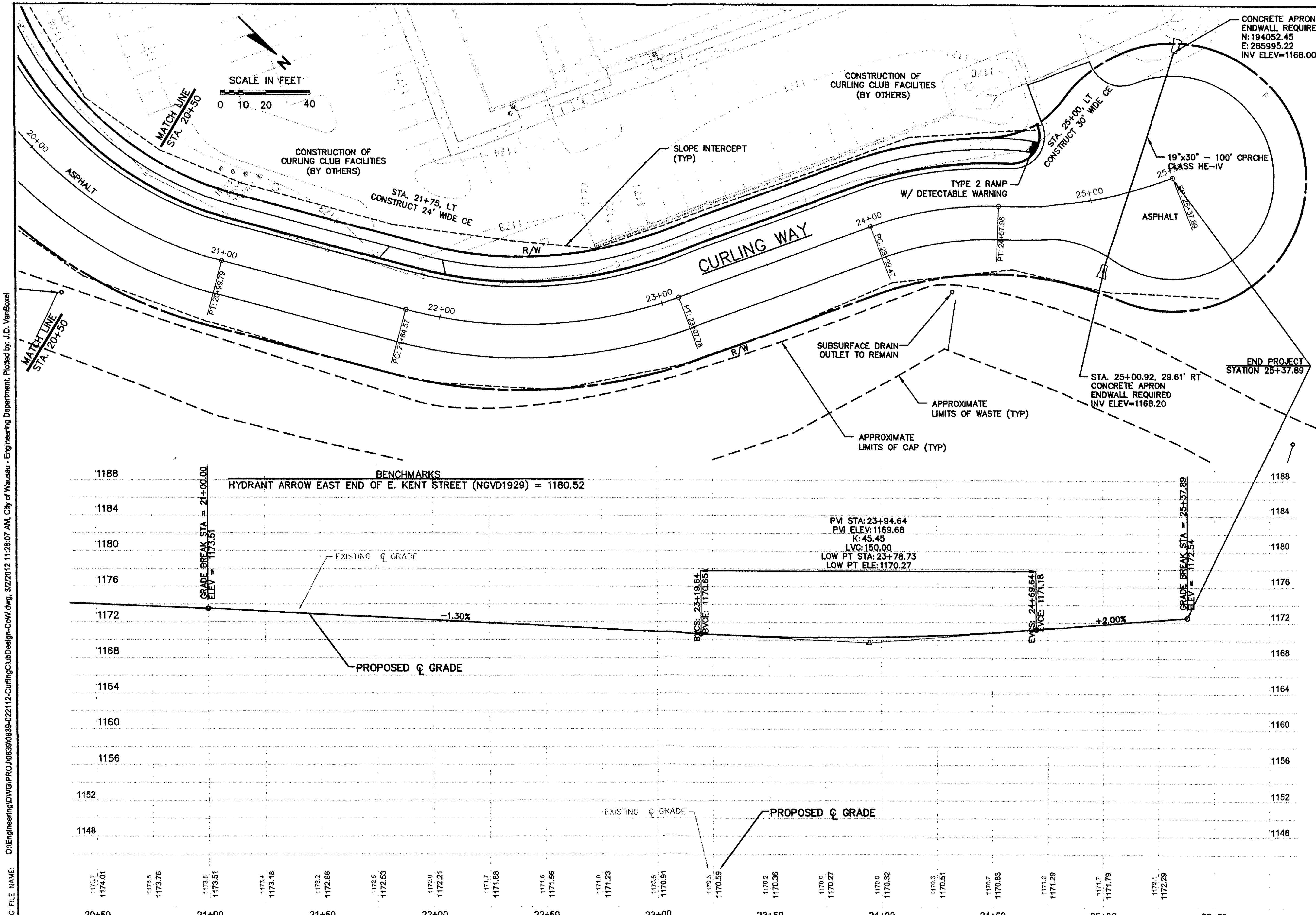
REVISIONS: P.R.NIKOLAI

DATE: 01/30/2012

ISSUED FOR: PRELIMINARY / REVIEW/APPROVAL / BIDDING/CONST. / REC. REF. DWG. / OFFICE USE

CURLING WAY
E. KENT STREET TO CURLING CLUB
PLAN & PROFILE
2012 STREET IMPROVEMENT PROJECT "C"

SHEET NO. 2 OF 3 SHEETS
FILE NUMBER 12-01-30



CITY OF WAUSAU
Engineering Department
407 GRANT STREET WAUSAU, WI. 54403-4783
(715) 261-6740 FAX (715) 261-6759

SURVEYED BY: CWE
FIELD BOOK NO. PG.
DESIGNED BY: S.J.GEHIN
DRAWN BY: J.D.VANBOXEL
APPROVED BY: A.M.WESOLOWSKI
POINT FILE:

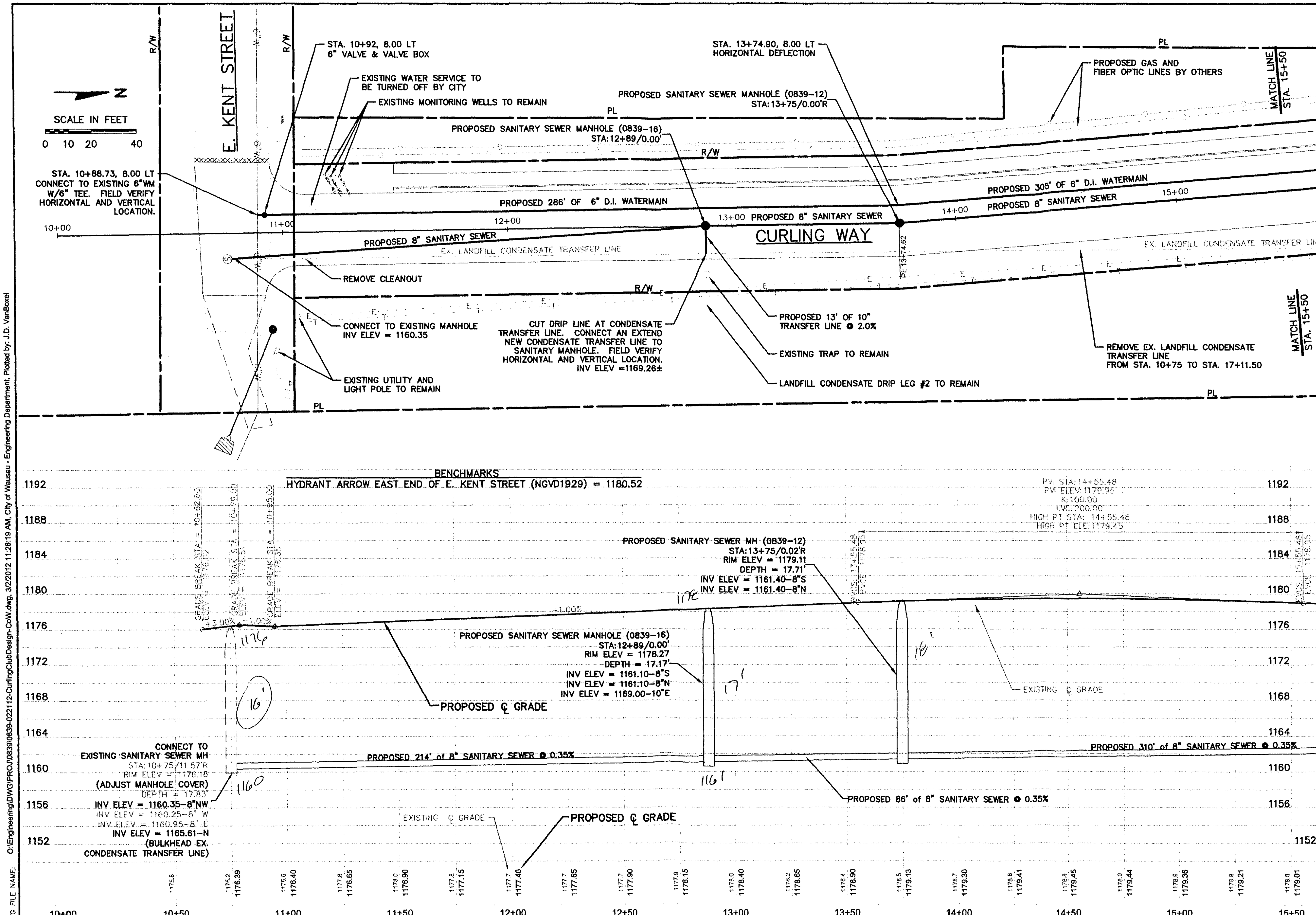
REVISIONS P.R.NIKOLAI
DATE 01/30/2012

ISSUED FOR
■ PRELIMINARY
□ REVIEW/APPROVAL
□ BIDDING/CONST.
□ REC. REF. DWG.
□ OFFICE USE

CURLING WAY
E. KENT STREET TO CURLING CLUB
PLAN & PROFILE
2012 STREET IMPROVEMENT PROJECT "C"

SHEET NO. 3 OF 3 SHEETS
FILE NUMBER 12-01-30

DWG FILE NAME: O:\Engineering\DWG\PROJ\0839\0839-022112-CurlingClubDesign-CoW.dwg, 3/2/2012 11:28:07 AM, City of Wausau - Engineering Department, Plotted by: J.D. VanBoxel



DWG FILE NAME: O:\Engineering\DWG\PROJ\0839\0839-022112-CurlingClubDesign-CoW.dwg, 3/2/2012 11:28:19 AM, City of Wausau - Engineering Department, Plotted by: J.D. VanBoxel

CITY OF WAUSAU
Engineering Department
407 GRANT STREET WAUSAU, WI. 54403-4783
(715) 261-6740 FAX (715) 261-6759

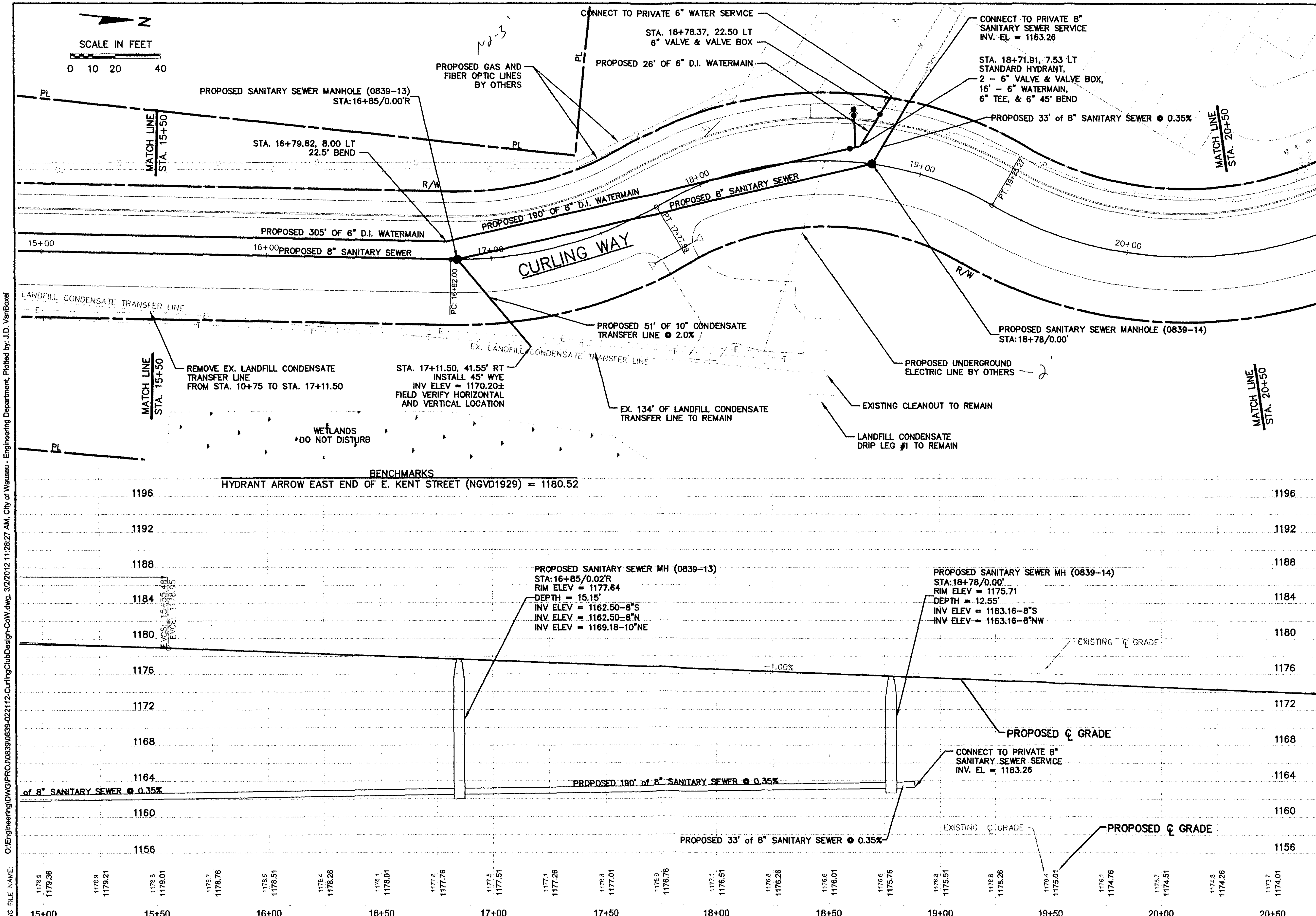
SURVEYED BY: CWE
FIELD BOOK NO. PG.
DESIGNED BY: S.J.GEHIN
DRAWN BY: J.D.VANBOXEL
APPROVED BY: A.M.WESOLOWSKI
POINT FILE:

REVISIONS P.R.NIKOLAI
DATE 01/30/2012

ISSUED FOR
PRELIMINARY
REVIEW/APPROVAL
BIDDING/CONST.
REC. REF. DWG.
OFFICE USE

CURLING WAY
E. KENT STREET TO CURLING CLUB
UTILITIES
2012 STREET IMPROVEMENT PROJECT "C"

SHEET NO. 1 OF 2 SHEETS
FILE NUMBER 12-01-30



DWG FILE NAME: O:\Engineering\DWG\PROJ\0839\0839-022112-CurlingClubDesign-CoW.dwg, 3/2/2012 11:28:27 AM, City of Wausau - Engineering Department, Plotted by: J.D. VanBoxel

CITY OF WAUSAU
Engineering Department
407 GRANT STREET WAUSAU, WI. 54403-4783
(715) 261-6740 FAX (715) 261-6759

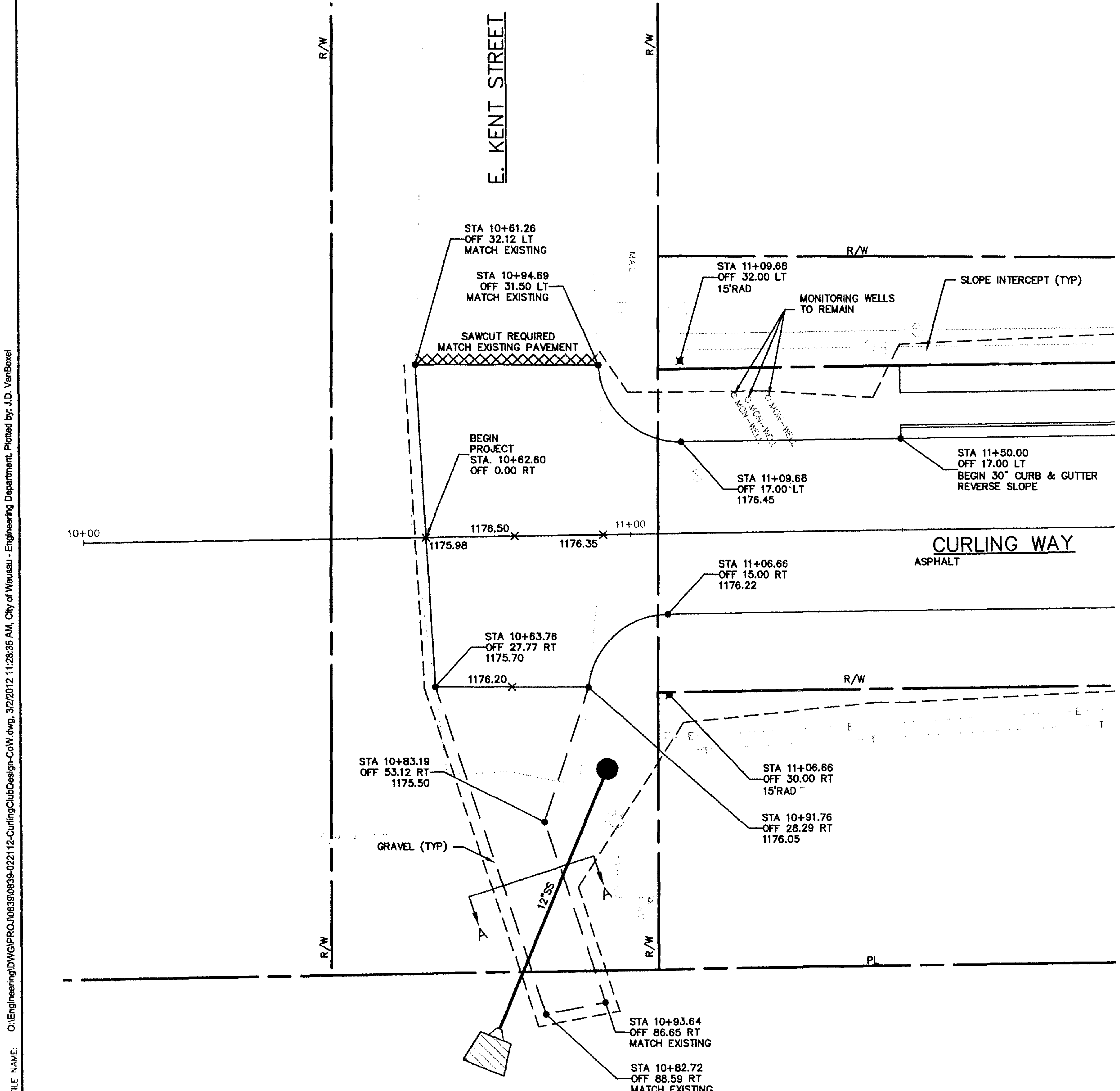
SURVEYED BY: CWE
FIELD BOOK NO. PG.
DESIGNED BY: S.J.GEHIN
DRAWN BY: J.D.VANBOXEL
APPROVED BY: A.M.WESOLOWSKI
POINT FILE:

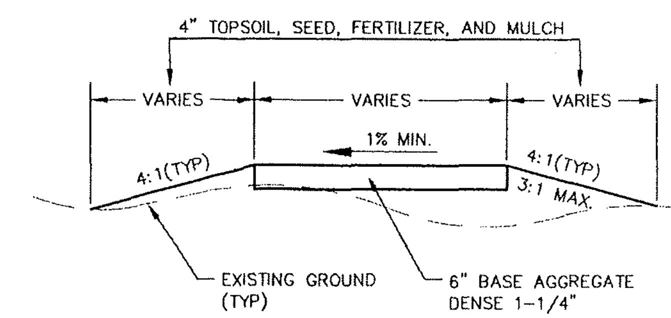
REVISIONS: P.R.NIKOLAI
DATE: 01/30/2012

ISSUED FOR: PRELIMINARY / REVIEW/APPROVAL / BIDDING/CONST. / REC. REF. DWG. / OFFICE USE

CURLING WAY
E. KENT STREET TO CURLING CLUB
UTILITIES
2012 STREET IMPROVEMENT PROJECT "C"

SHEET NO. 2 OF 2 SHEETS
FILE NUMBER 12-01-30





TYPICAL FINISHED SECTION - GRAVEL DRIVE

SECTION A-A
LOOKING EAST

CITY OF WAUSAU
Engineering Department
407 GRANT STREET WAUSAU, WI. 54403-4783
(715) 261-6740 FAX (715) 261-6759

SURVEYED BY: CWE
FIELD BOOK NO. PG.
DESIGNED BY: S.J.GEHIN
DRAWN BY: J.D.VANBOXEL
APPROVED BY: A.M.WESOLOWSKI
POINT FILE:

REVISIONS: P.R.NIKOLAI

DATE: 01/30/2012

ISSUED FOR
■ PRELIMINARY
□ REVIEW/APPROVAL
□ BIDDING/CONST.
□ REC. REF. DWG.
□ OFFICE USE

CURLING WAY

CURLING WAY & KENT STREET INTERSECTION
LAYOUT AND GRADES
2012 STREET IMPROVEMENT PROJECT "C"

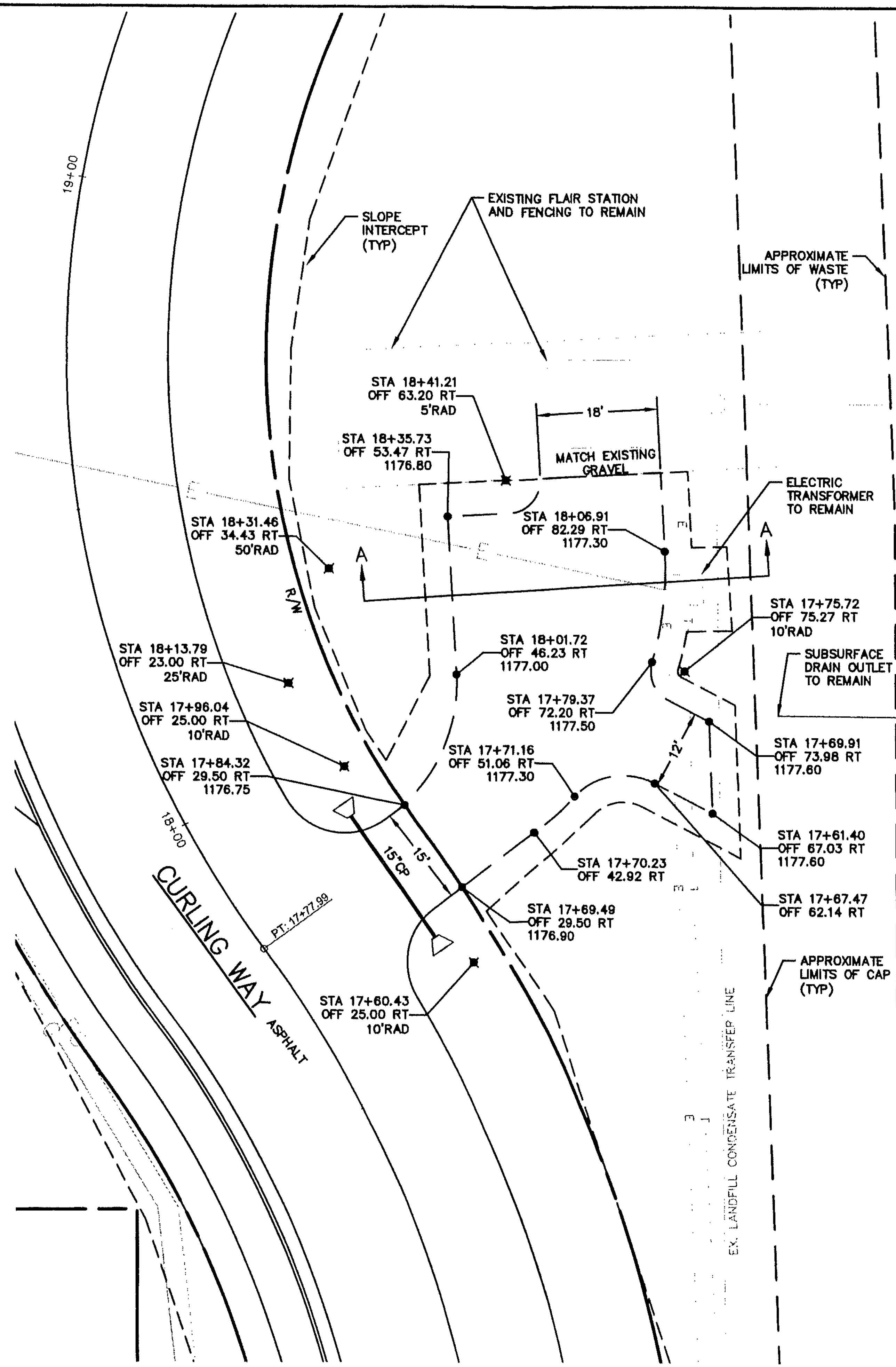
SHEET NO. 1 OF 1 SHEETS

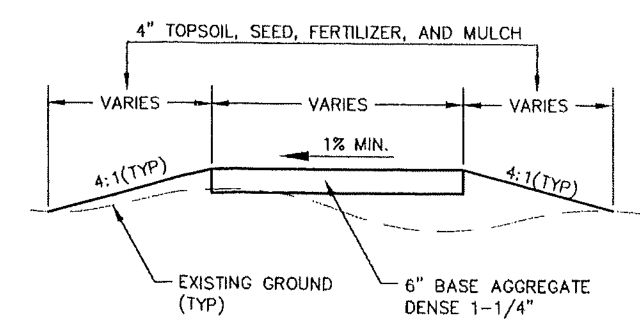
FILE NUMBER 12-01-30

SCALE IN FEET

0 5 10 20

N





TYPICAL FINISHED SECTION – GRAVEL LOT

SECTION A–A

LOOKING NORTH

CITY OF WAUSAU

Engineering Department

407 GRANT STREET WAUSAU, WI. 54403-4783

(715) 261-6740 FAX (715) 261-6759

SURVEYED BY: CWE
FIELD BOOK NO. PG.
DESIGNED BY: S.J.GEHIN
DRAWN BY: J.D.VANBOXEL
APPROVED BY: A.M.WESOLOWSKI
POINT FILE:

ISSUED FOR		DATE	REVISIONS
PRELIMINARY	■	01/30/2012	P.R.NIKOLAI
REVIEW/APPROVAL	□		
BIDDING/CONST.	□		
REC. REF. DWG.	□		
OFFICE USE	□		

CURLING WAY

ELECTRICAL AREA GRAVEL DRIVE

LAYOUT AND GRADES

2012 STREET IMPROVEMENT PROJECT "C"

SHEET NO.

1

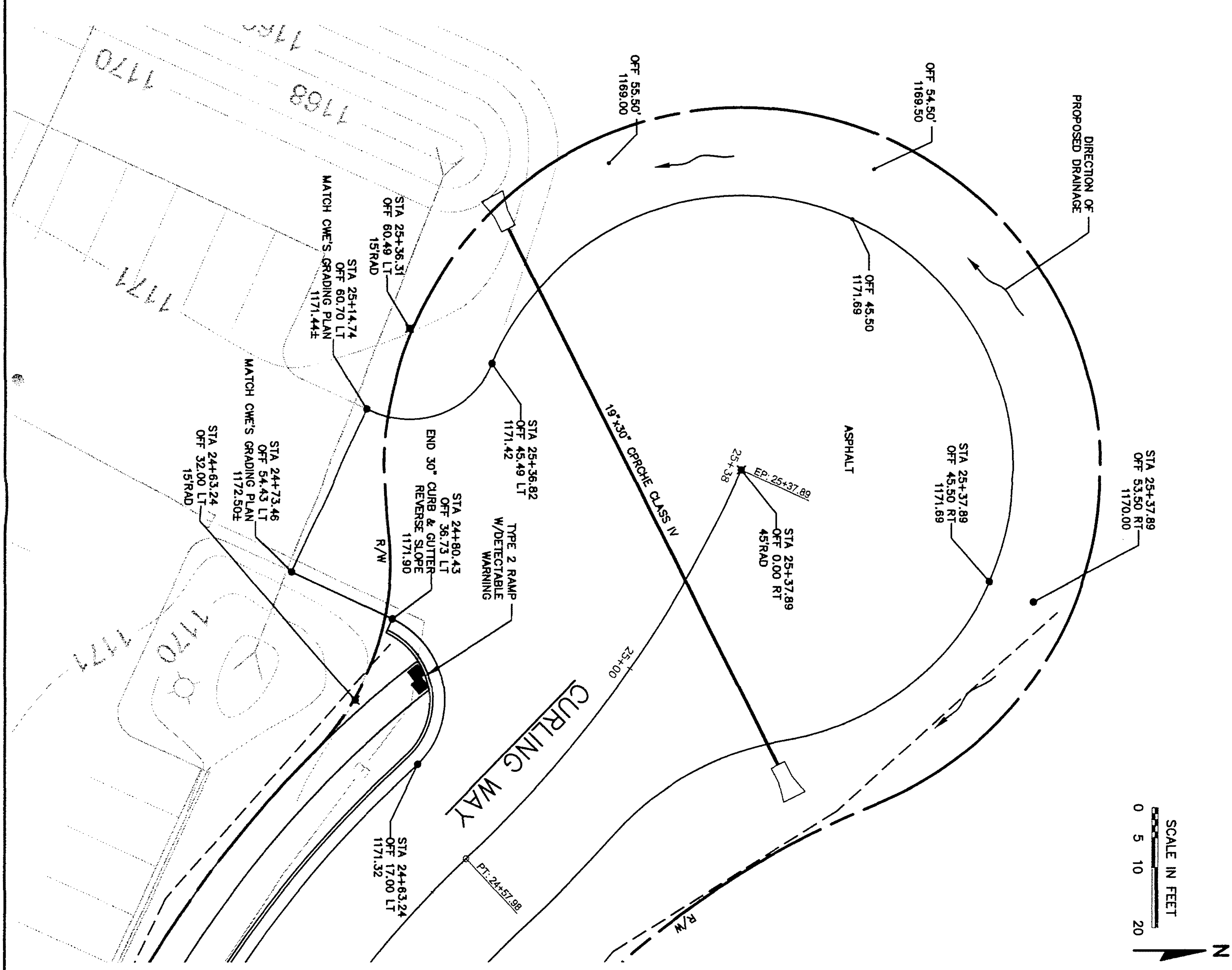
OF 1 SHEETS

FILE NUMBER

12-01-30

DWG FILE NAME: O:\Engineering\DWG\PROJ\0839\0839-022112-CurlingClubDesign-CoW.dwg, 3/2/2012 11:28:39 AM, City of Wausau - Engineering Department, Plotted by: J.D. VanBoxel

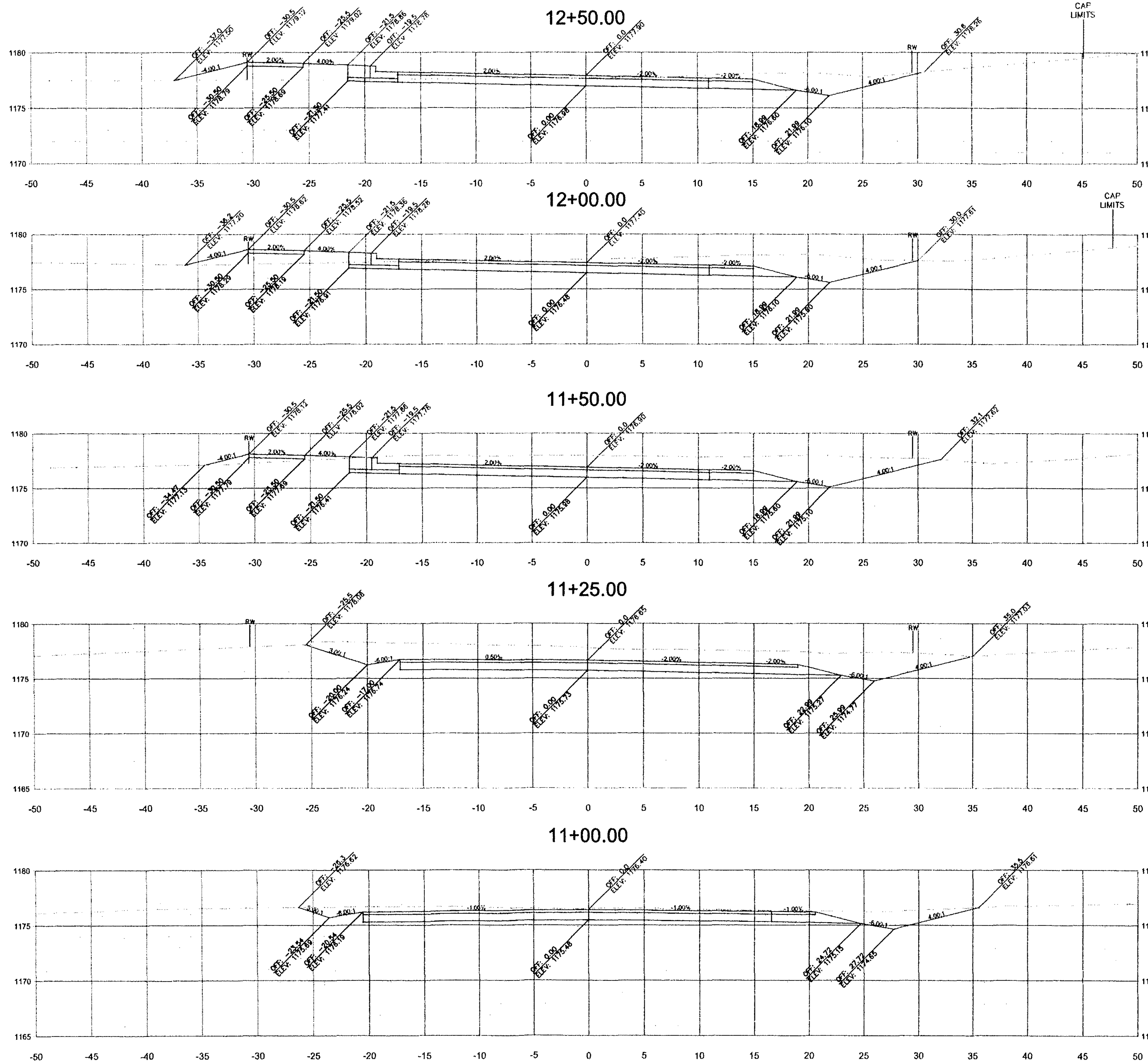
DWG FILE NAME: O:\Engineering\DWG\PROJ\0839\0839-022112-CurlingClubDesign-CoW.dwg, 3/2/2012 11:28:44 AM, City of Wausau - Engineering Department, Plotted by: J.D. VanBoxel

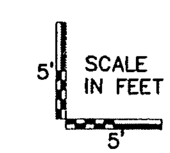


CURLING WAY CURLING WAY CUL-DE-SAC LAYOUT AND GRADES 2012 STREET IMPROVEMENT PROJECT "C"	ISSUED FOR PRELIMINARY ■ REVIEW/APPROVAL □ BIDDING/CONST. □ REC. REF. DWG. □ OFFICE USE □	DATE 01/30/2012	REVISIONS P.R.NIKOLAI	SURVEYED BY: CWE FIELD BOOK NO. PG. DESIGNED BY: S.J.GEHIN DRAWN BY: J.D.VANBOXEL APPROVED BY: A.M.WESOLOWSKI POINT FILE:

CITY OF WAUSAU
Engineering Department
407 GRANT STREET WAUSAU, WI. 54403-4783
(715) 261-6740 FAX (715) 261-6759

SHEET NO. 1 OF 1 SHEETS
FILE NUMBER 12-01-30



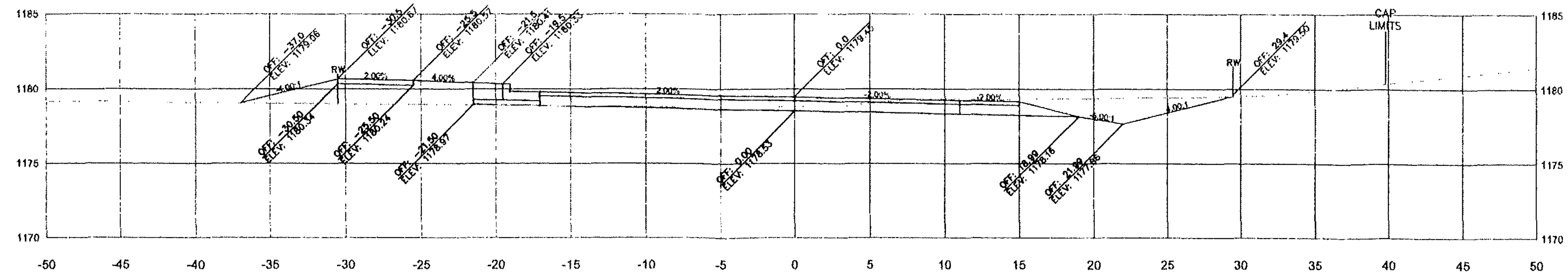


BEGIN PROJECT 10+62.60

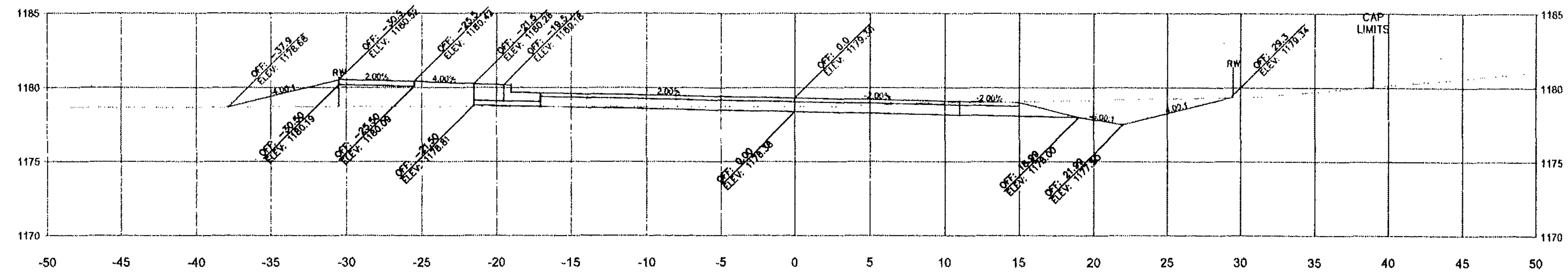
CURLING WAY CROSS–SECTIONS STA. 11+00 – 12+50

DWG FILE NAME: O:\Engineering\DWG\PROJ\0839\0839-022112-CurlingClubDesign-CoW.dwg, 3/2/2012 11:32:52 AM, City of Wausau - Engineering Department, Plotted by: P.R.Nikolai

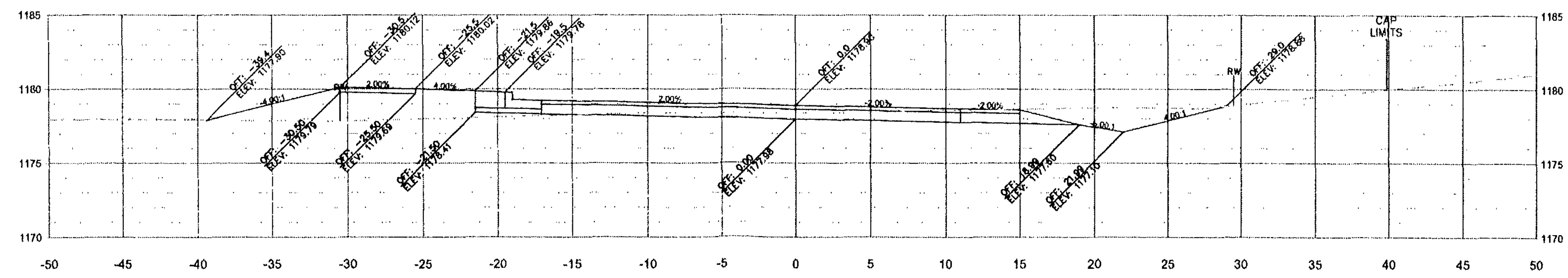
14+50.00



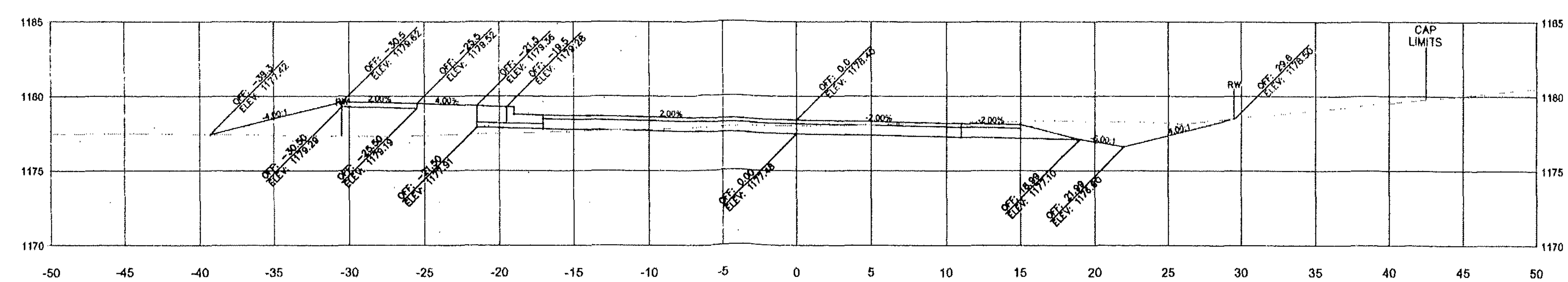
14+00.00



13+50.00



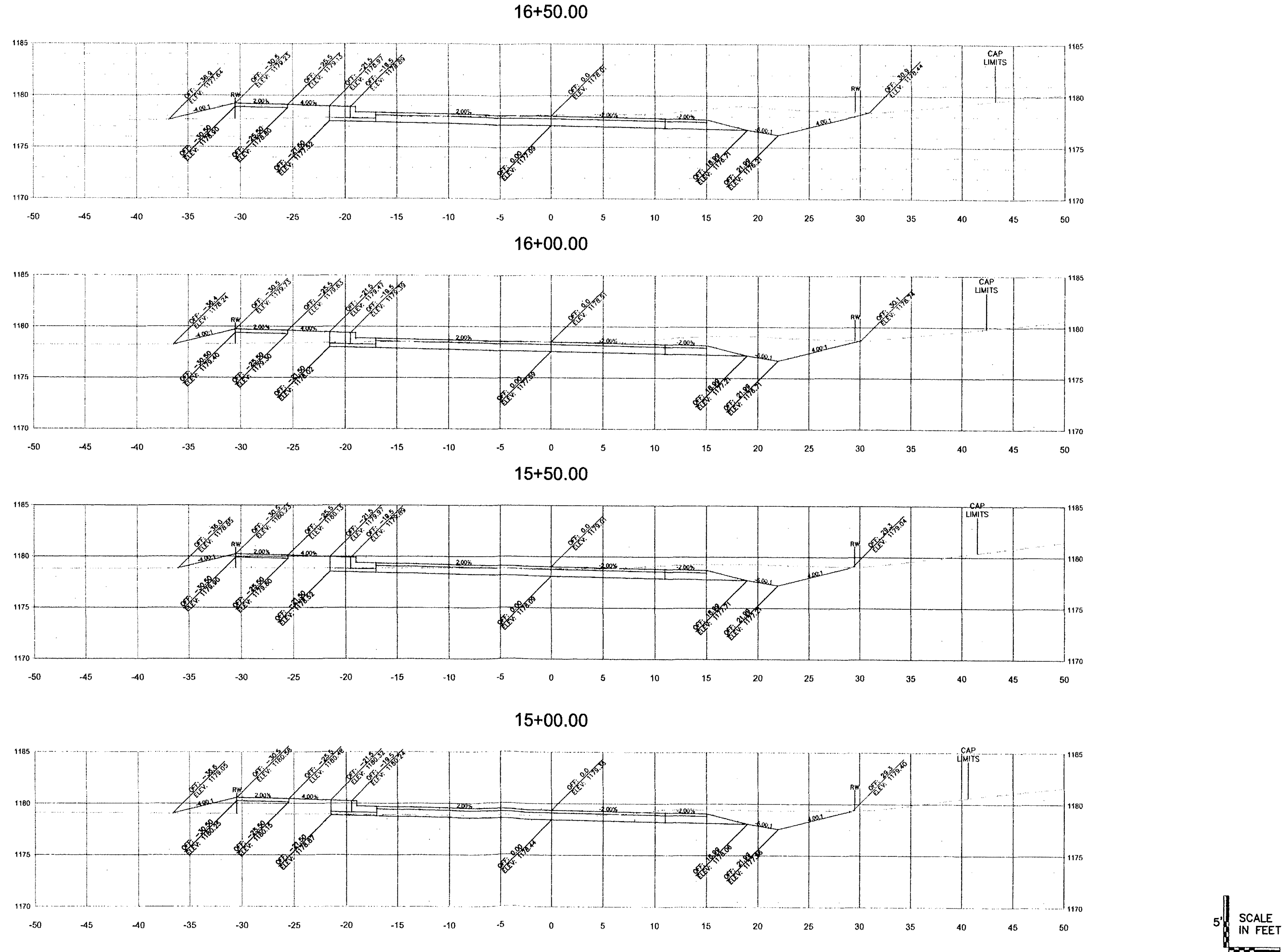
13+00.00



5' SCALE IN FEET 5'

CURLING WAY CROSS-SECTIONS STA. 13+00 – 14+50

DWG FILE NAME: O:\Engineering\DWG\PROJ\0839\0839-022112-CurlingClubDesign-CoW.dwg, 3/2/2012 11:33:40 AM, City of Wausau - Engineering Department, Plotted by: P.R.Nikolai

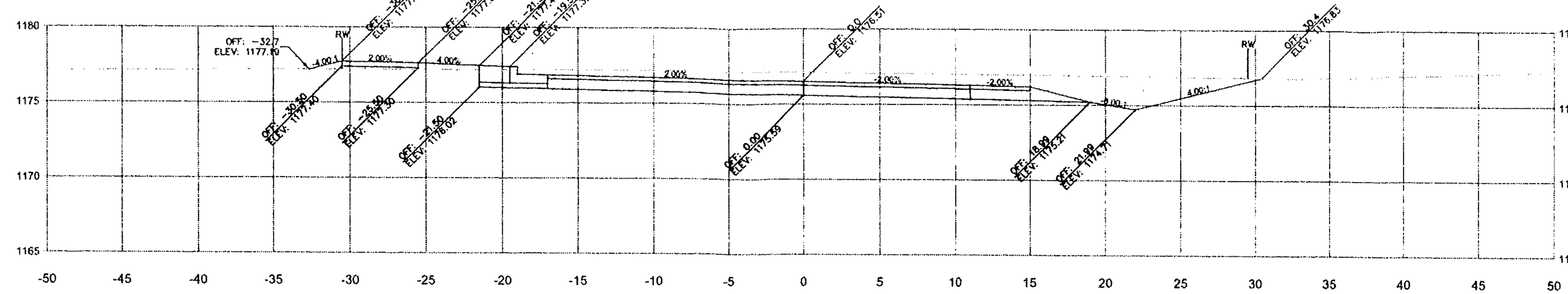


DWG FILE NAME: O:\Engineering\DWG\PROJ\0839\0839-022112-CurlingClubDesign-CoW.dwg, 3/2/2012 11:34:18 AM, City of Wausau - Engineering Department, Plotted by: P.R.Nikolai

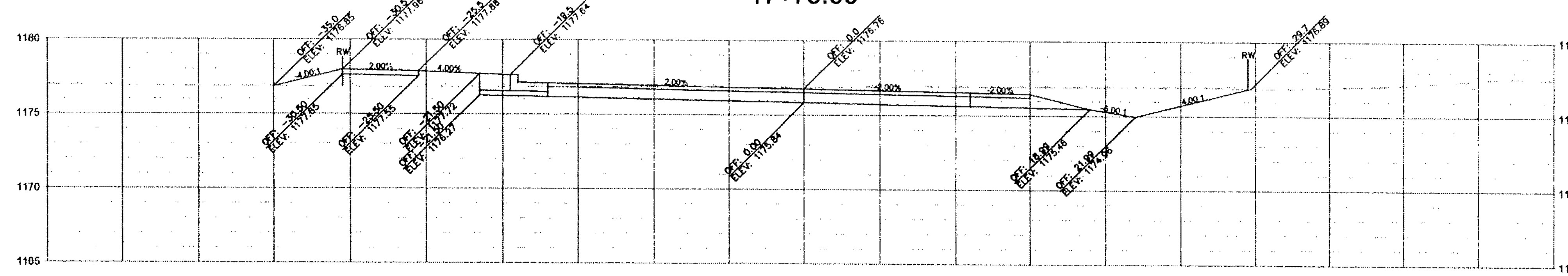
CURLING WAY CROSS-SECTIONS STA. 15+00 – 16+50

DWG FILE NAME: O:\Engineering\DWG\PROJ\0839\0839-022112-CurlingClubDesign-CoW.dwg, 3/2/2012 11:34:49 AM, City of Wausau - Engineering Department, Plotted by: P.R.Nikolai

18+00.00

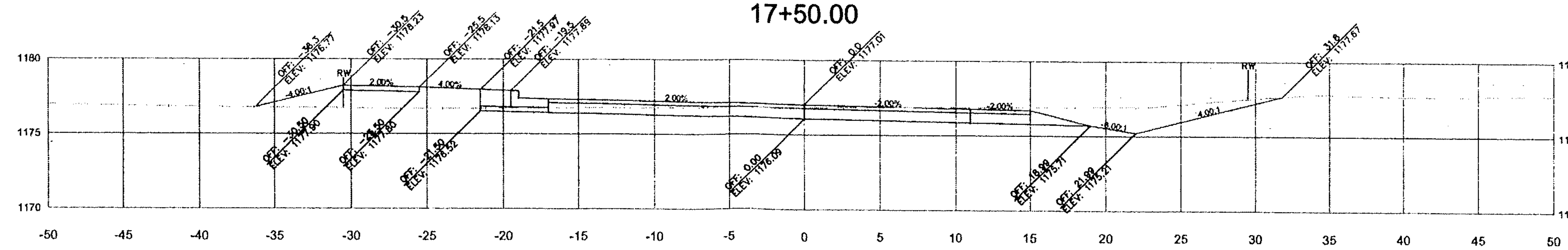


17+75.00

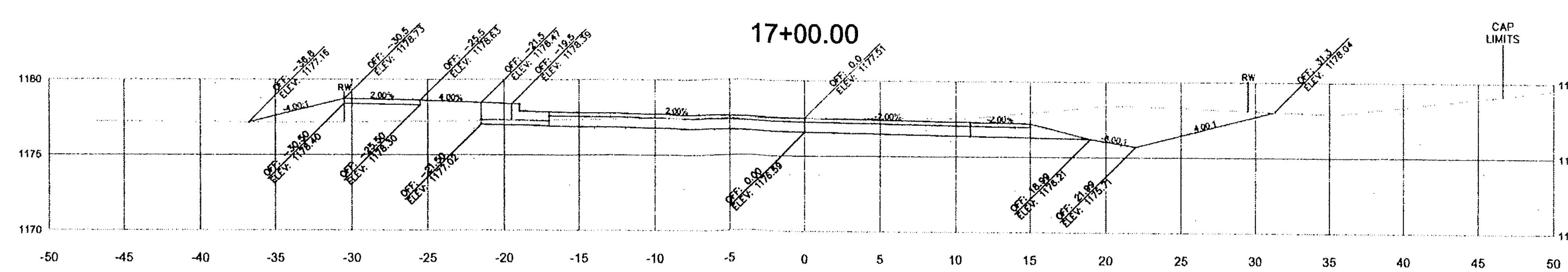


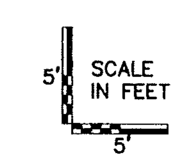
STA. 17+75 RT
CONSTRUCT 15' WIDE PE
1 – 15"x22' CORRUGATED POLYETHYLENE CULVERT PIPE W/ STEEL APRON ENDWALLS REQUIRED
INV. (S) = 1175.17
INV (N) = 1174.73

17+50.00

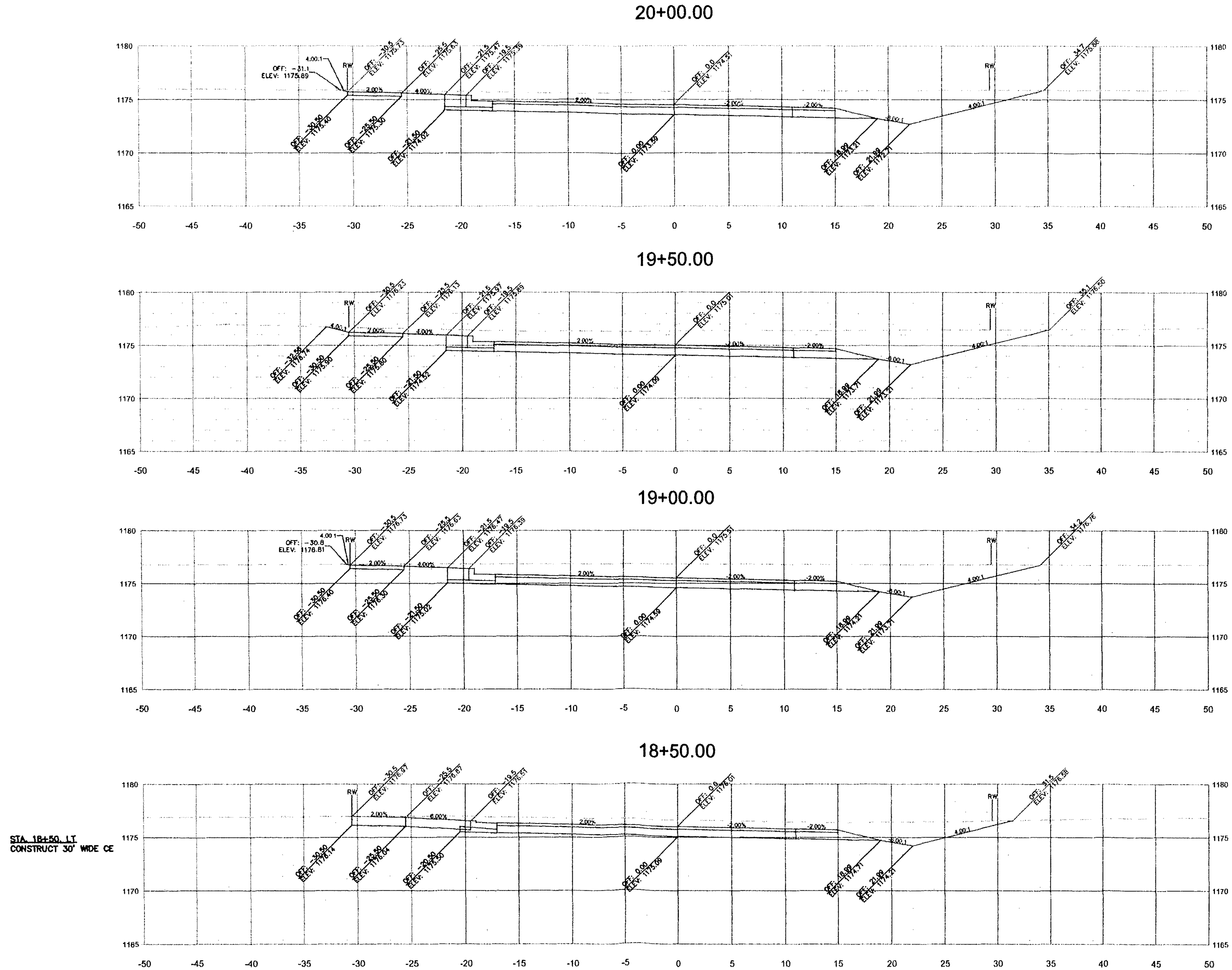


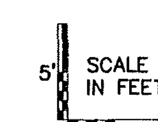
17+00.00





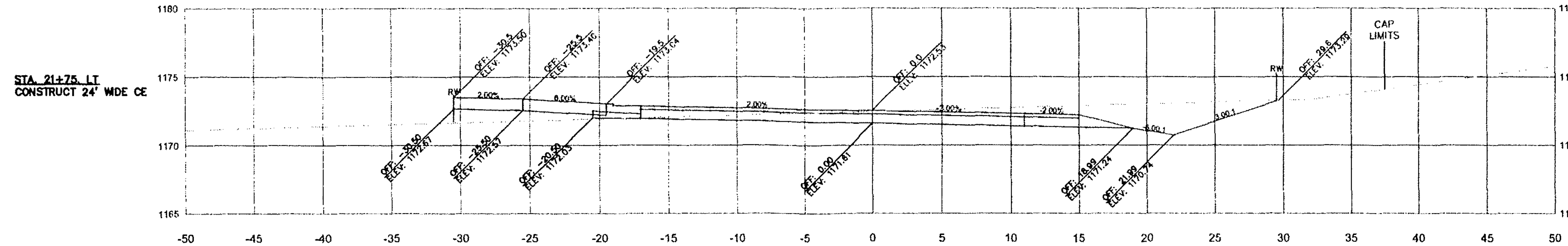
CURLING WAY CROSS–SECTIONS STA. 17+00 – 18+00



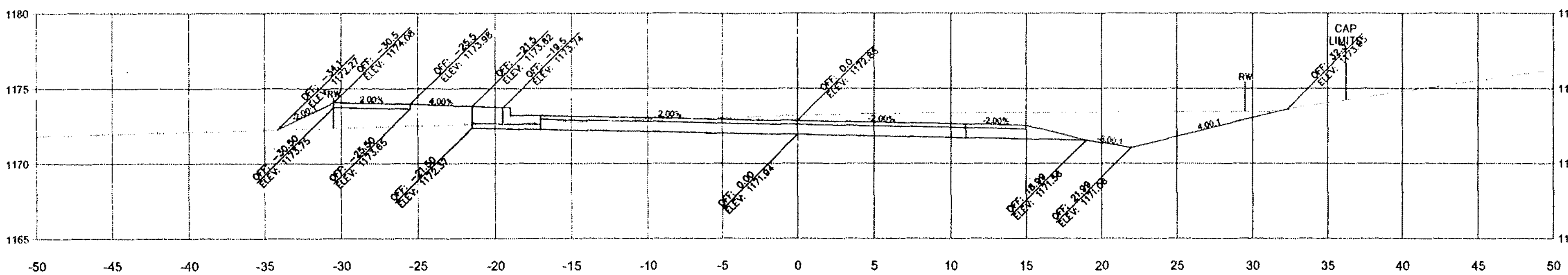


CURLING WAY CROSS–SECTIONS STA. 18+50 – 20+00

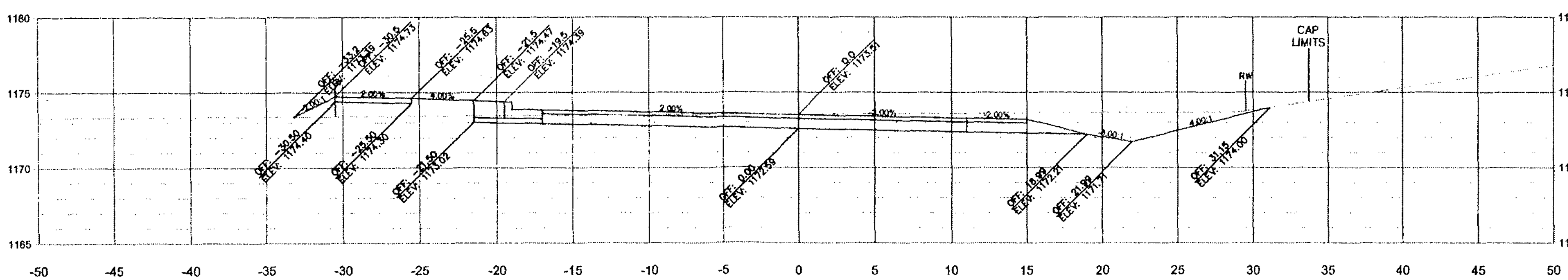
21+75.00



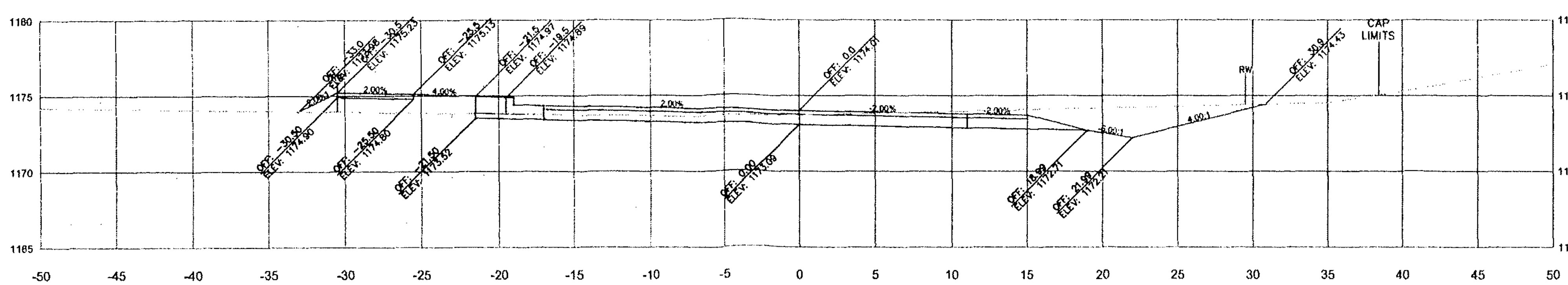
21+50.00



21+00.00



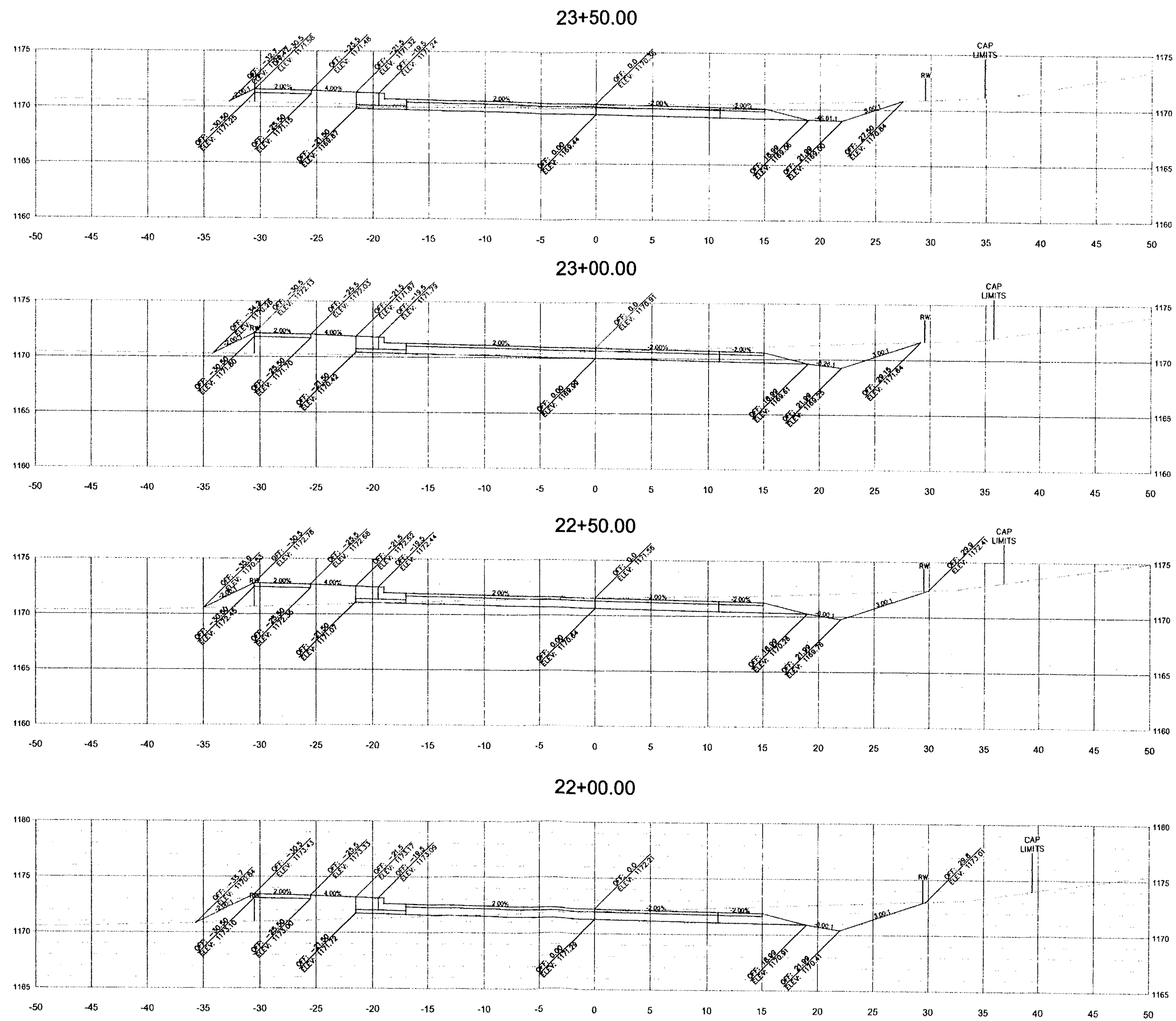
20+50.00



5' SCALE IN FEET 5'

CURLING WAY CROSS-SECTIONS STA. 20+50 – 21+75

DWG FILE NAME: O:\Engineering\DWG\PROJ\0839\0839-022112-CurlingClubDesign-CoW.dwg, 3/2/2012 11:35:59 AM, City of Wausau - Engineering Department, Plotted by: P.R.Nikolai

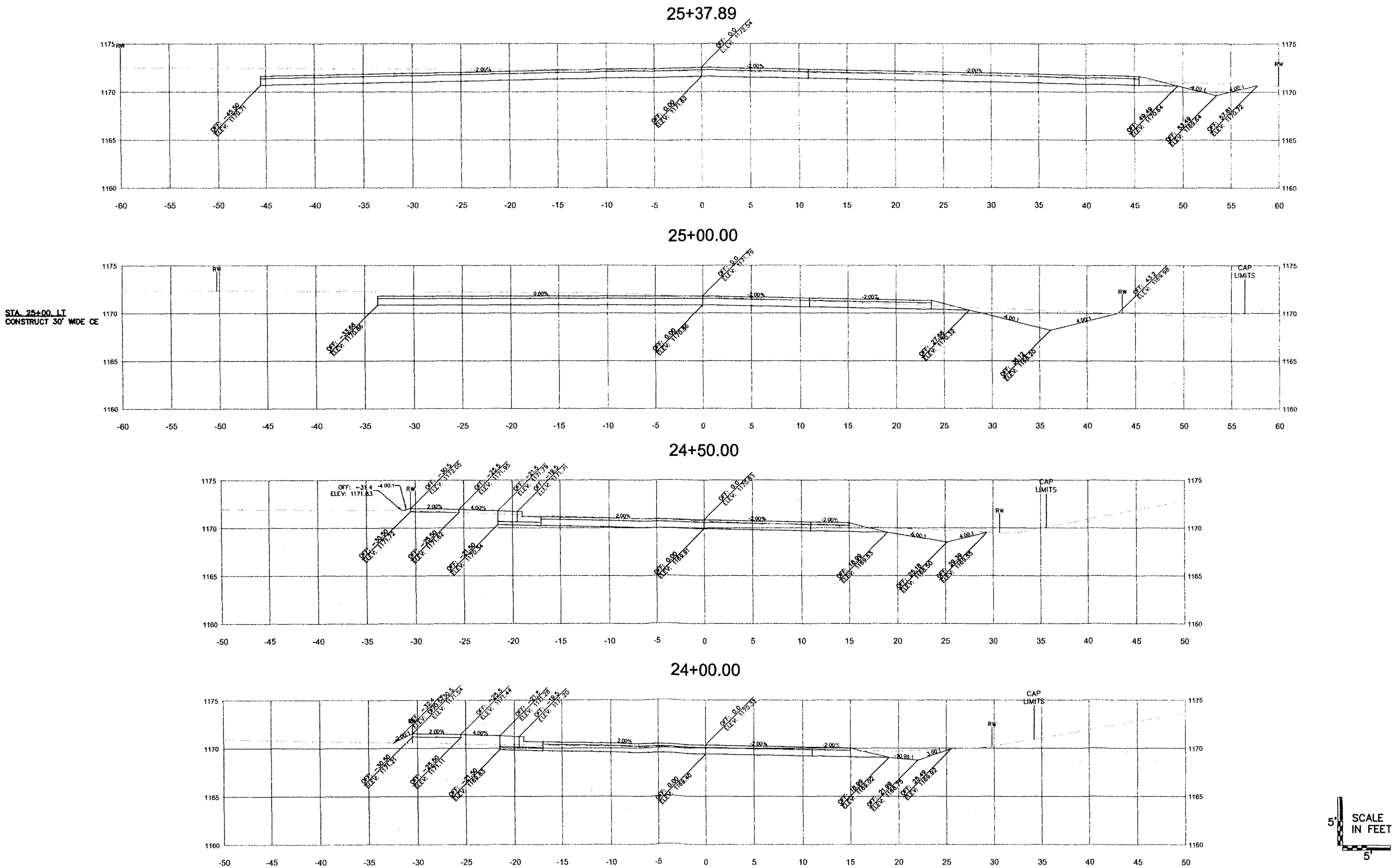


5' SCALE IN FEET 5'

CURLING WAY CROSS-SECTIONS STA. 22+00 – 23+50

DWG FILE NAME: O:\Engineering\DWG\PROJ\0839\0839-022112-CurlingClubDesign-CoW.dwg, 3/2/2012 11:36:28 AM, City of Wausau - Engineering Department, Plotted by: P.R.Nikolai

END PROJECT 25+37.89



CURLING WAY CROSS-SECTIONS STA. 24+00 – 25+37.89

DWG FILE NAME: O:\Engineering\DWG\PROJ\0839\0839-022112-CurlingClubDesign-CoW.dwg, 3/2/2012 11:37:01 AM, City of Wausau - Engineering Department, Plotted by: P.R.Nikolai

APPENDIX C

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*		
				Maximum VOC				
	Molecular Weight	*mol/kg-bar*	*mol/kg-atm*	*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

APPENDIX D

PROJECT SUMMARY 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.

APPENDIX E

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

MW5 VINYL CHLORIDE
FORMER RIVER FALLS LF

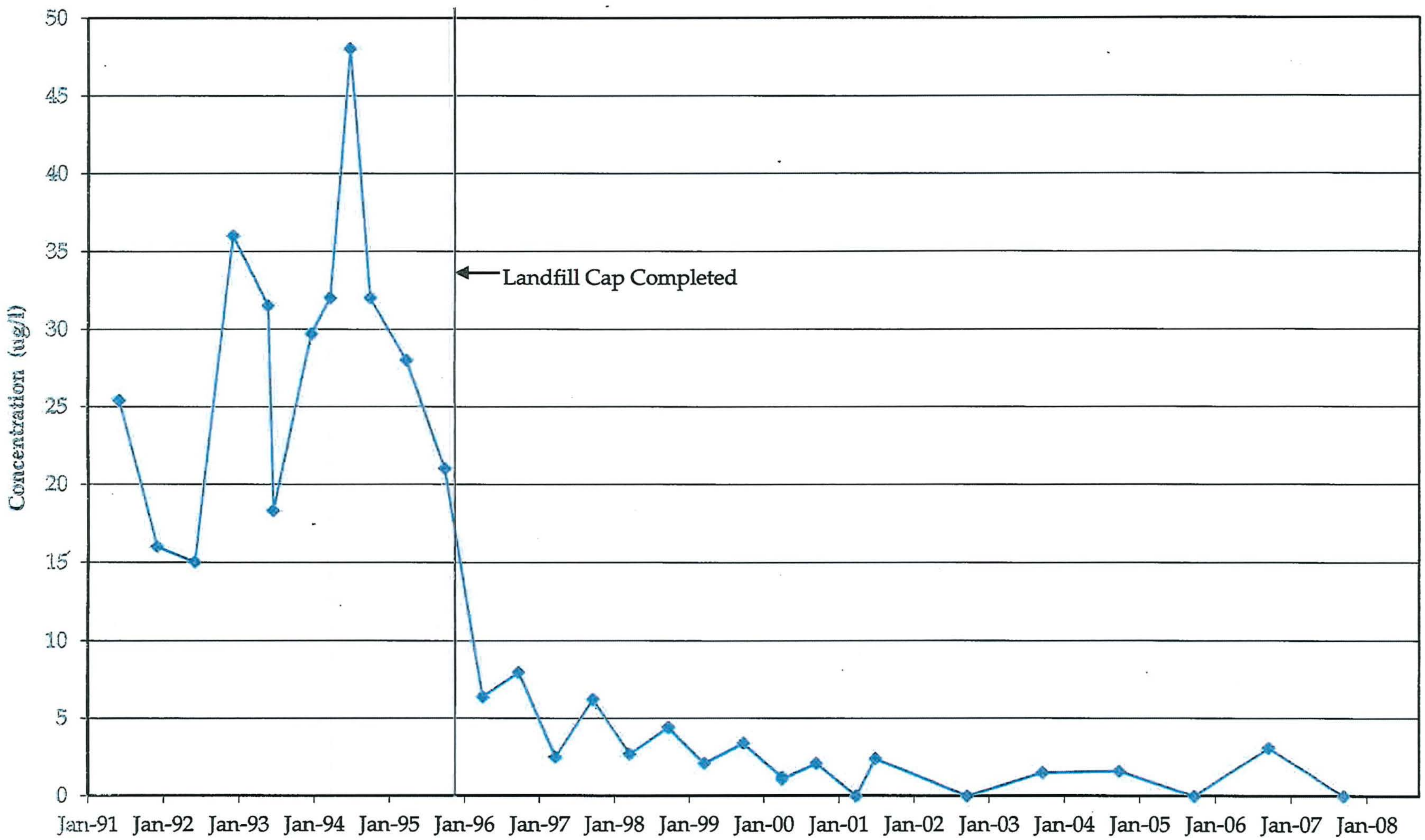
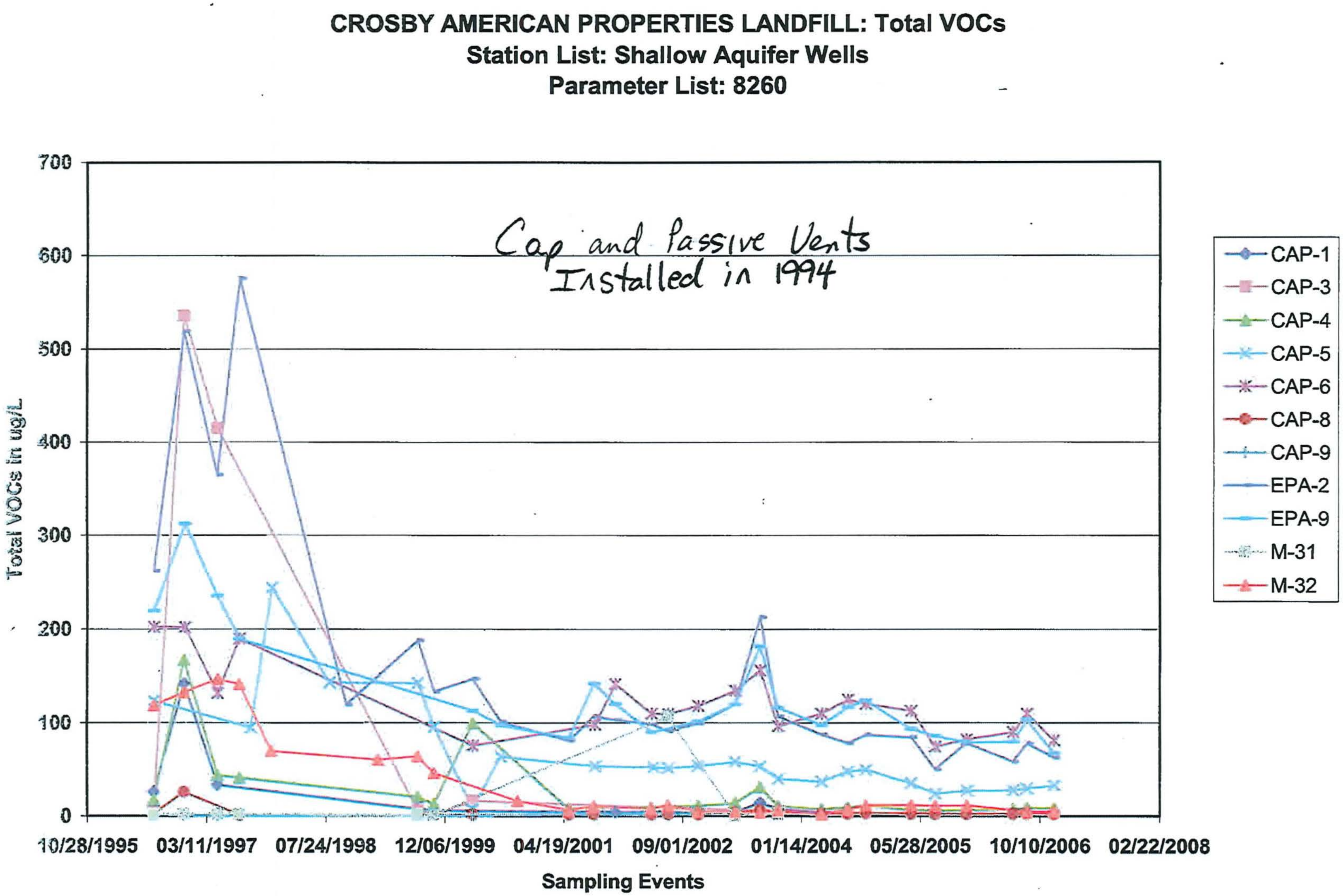
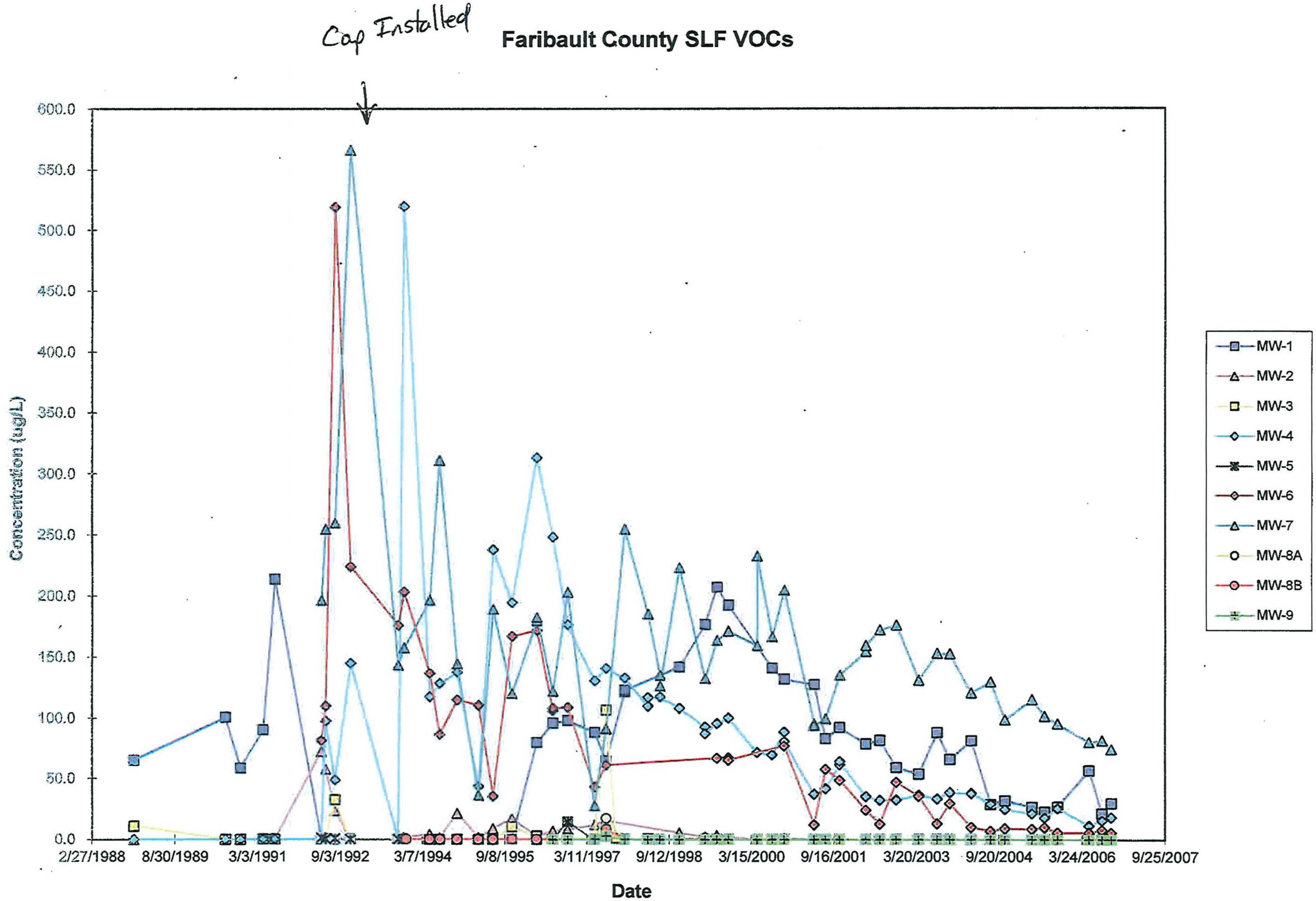


Figure 7

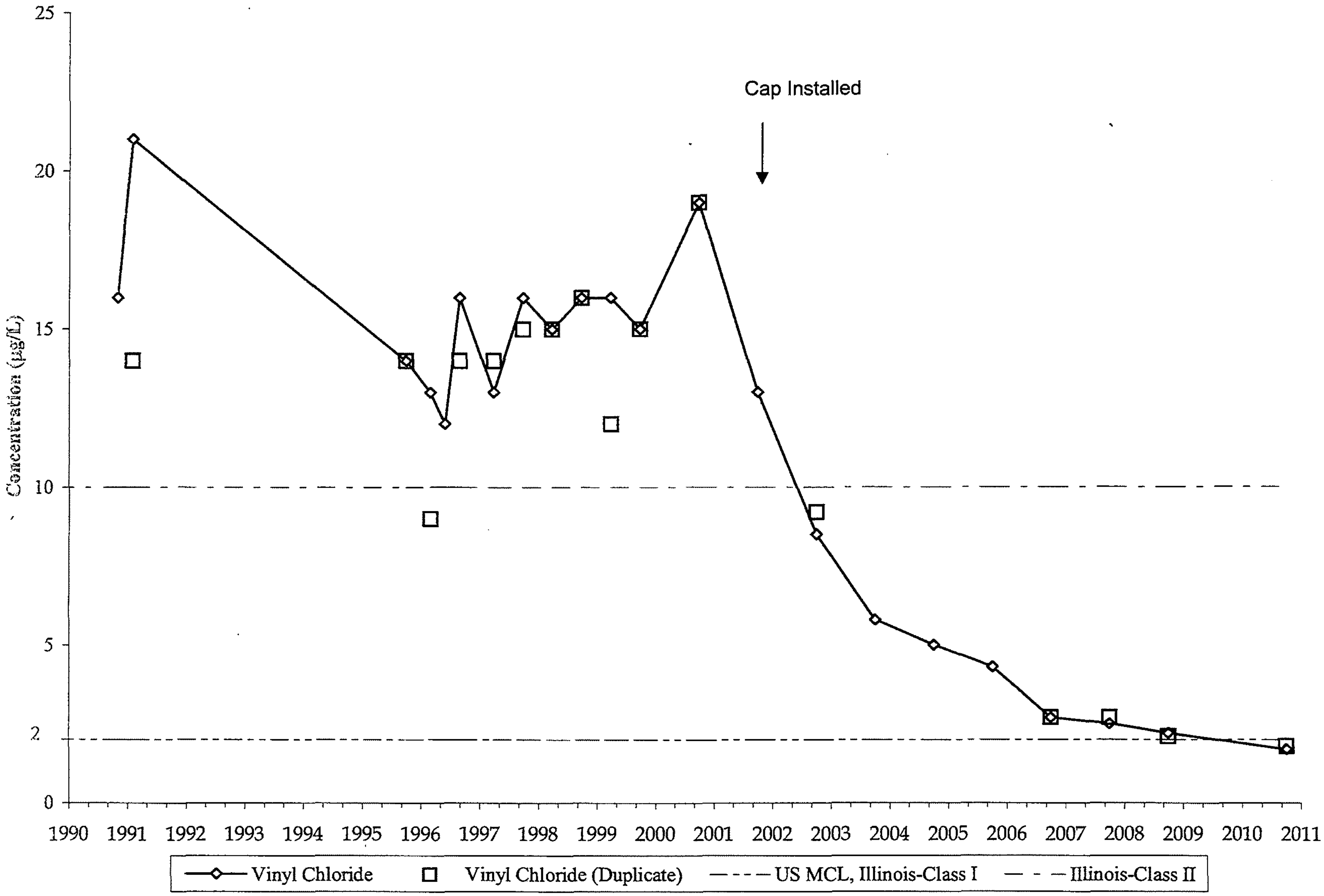


KLL1\K:\03M043\CAP 2002 Report\R-CAP.doc\10000



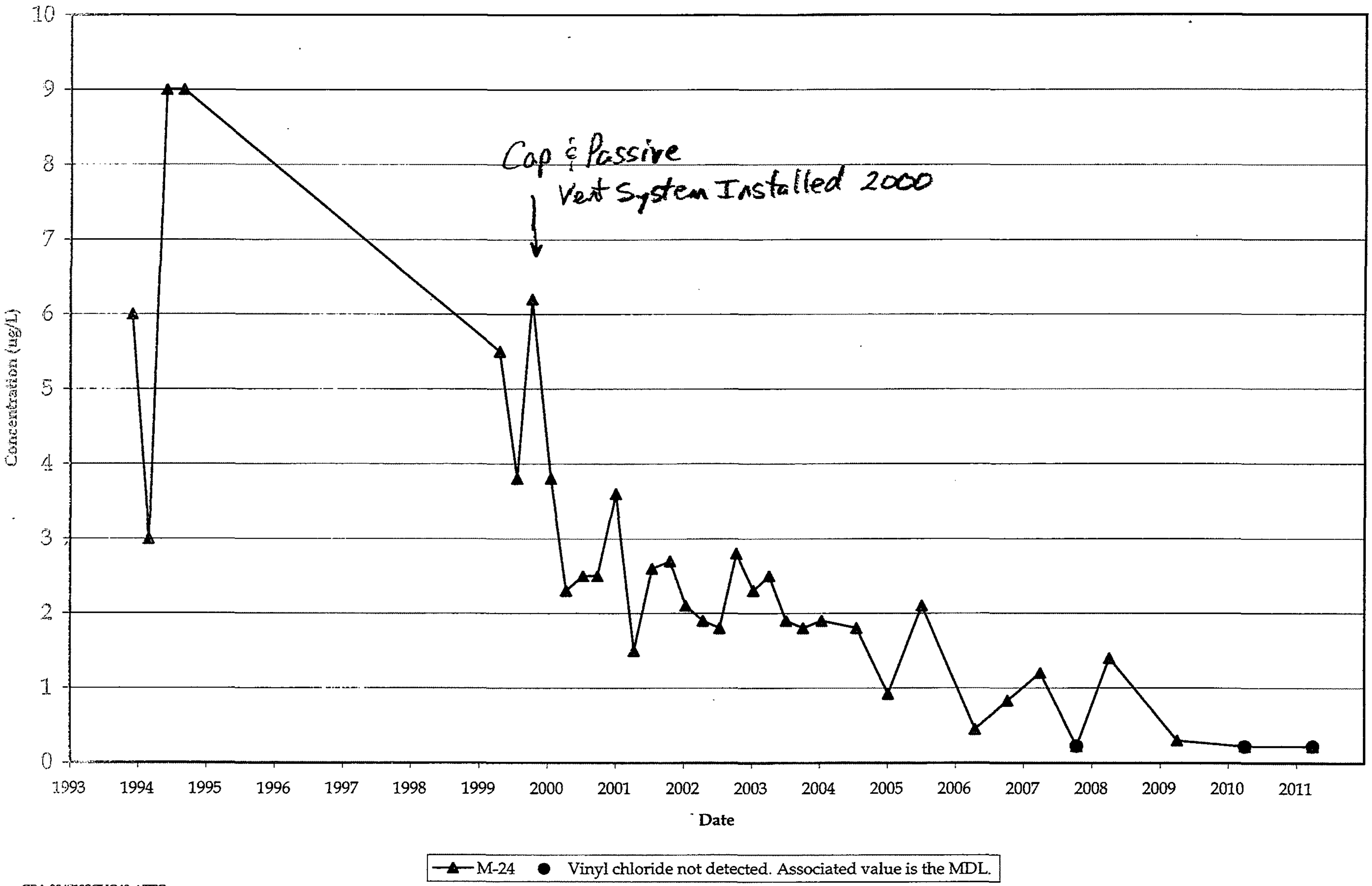
Cap Installed
Faribault County SLF VOCs
600.0
550.0
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Concentration (ug/L)
2/27/1988
8/30/1989
3/3/1991
9/3/1992
3/7/1994
9/8/1995
3/11/1997
9/12/1998
3/15/2000
9/16/2001
3/20/2003
9/20/2004
3/24/2006
9/25/2007
Date
MW-1
MW-2
MW-3
MW-4
MW-5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



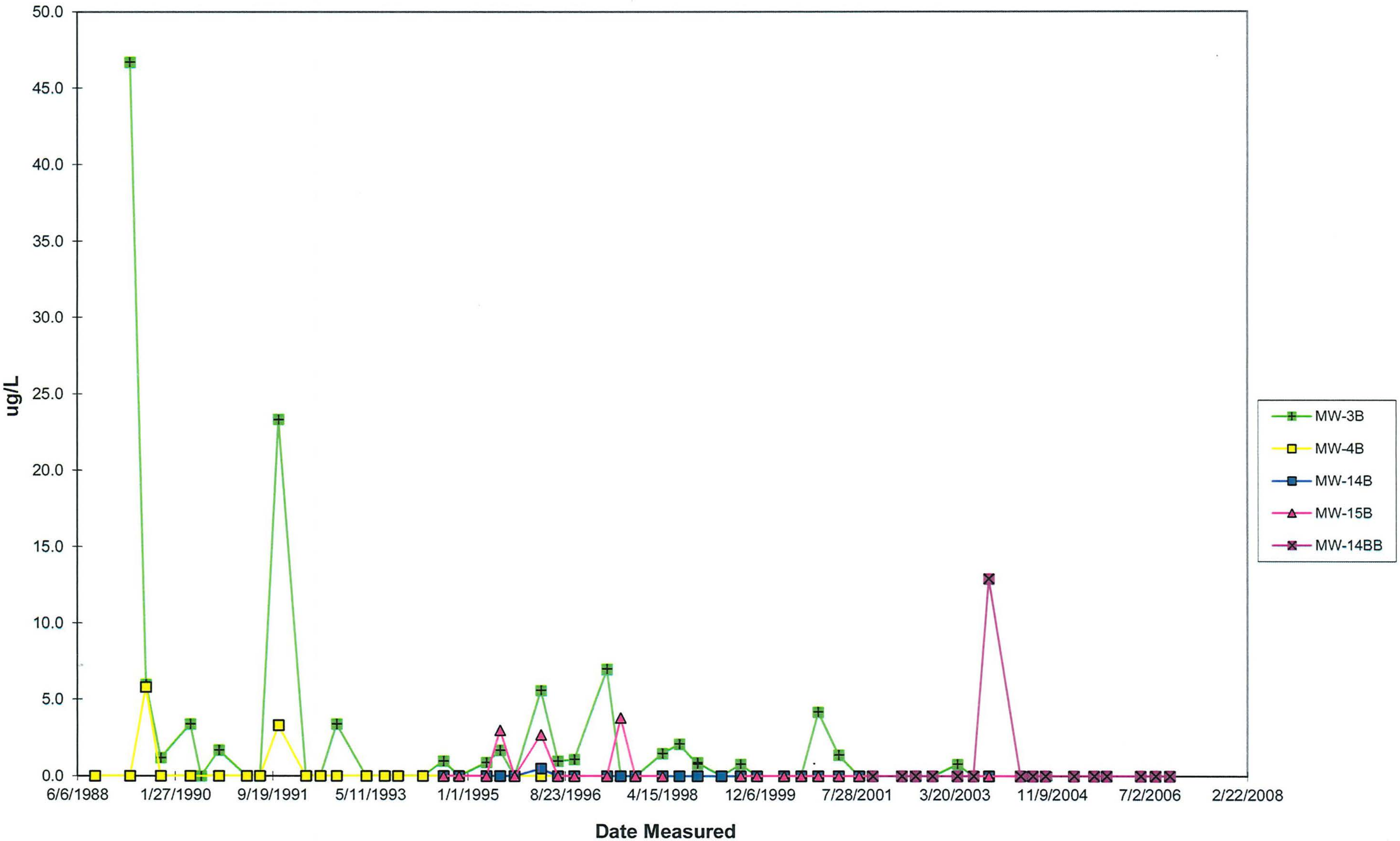
CRA 017224 (14)

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

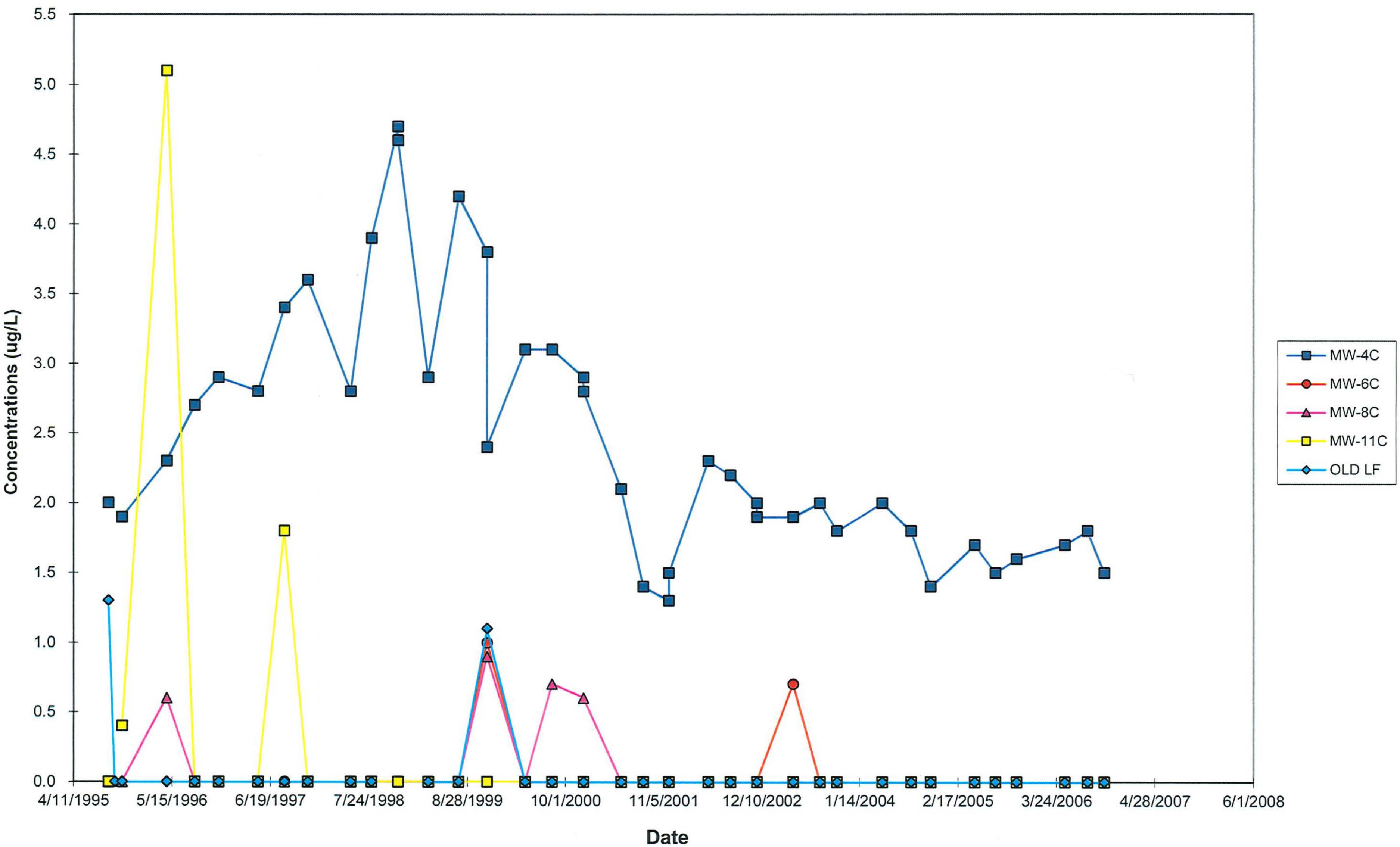


CRA 004710SCHO48-ATTC

Chippewa County SLF Total VOCs B Horizon



Red Rock VOCs



APPENDIX F

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	

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*
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			

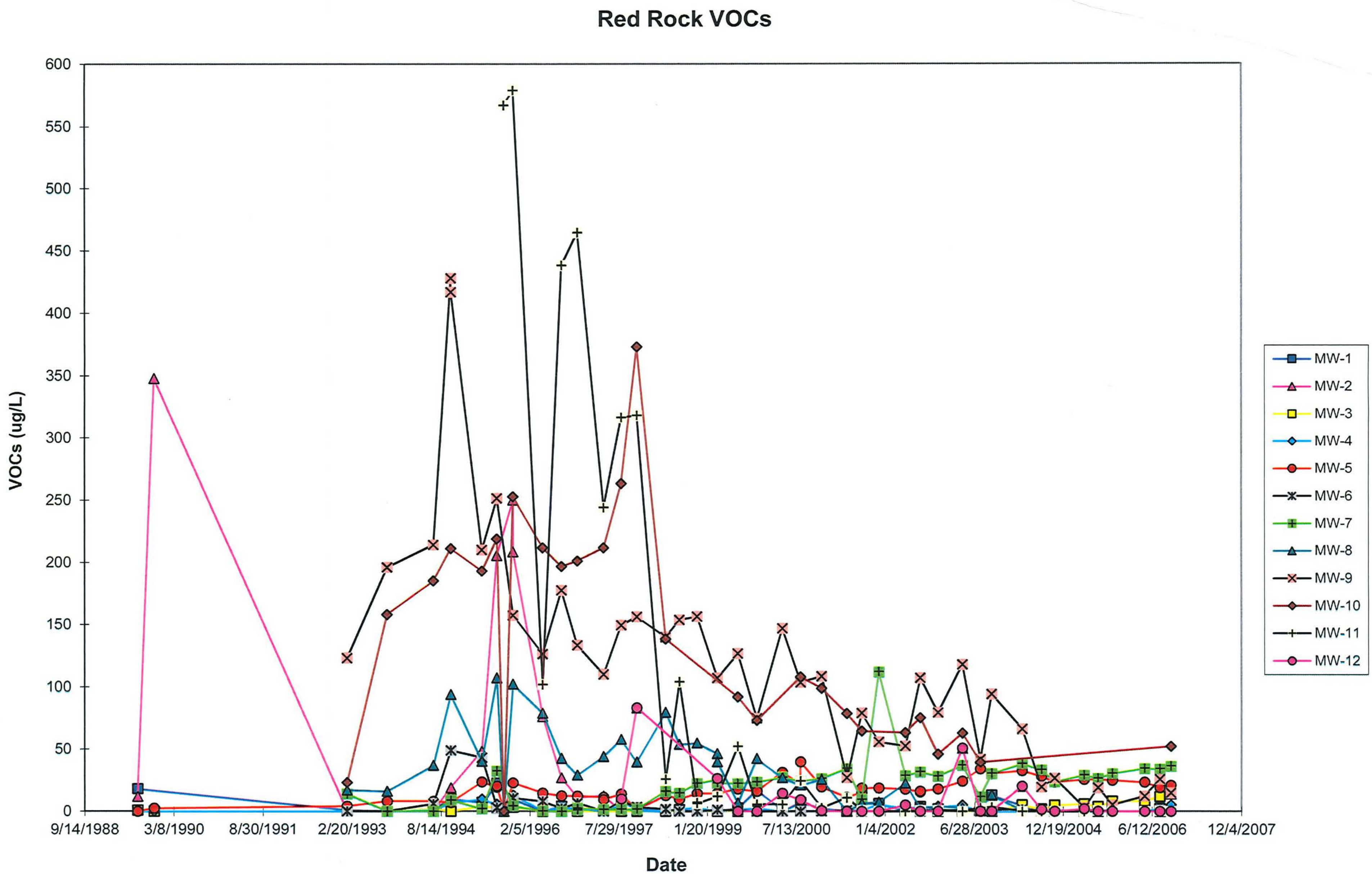
PASSIVE VENTING CASE STUDIES

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

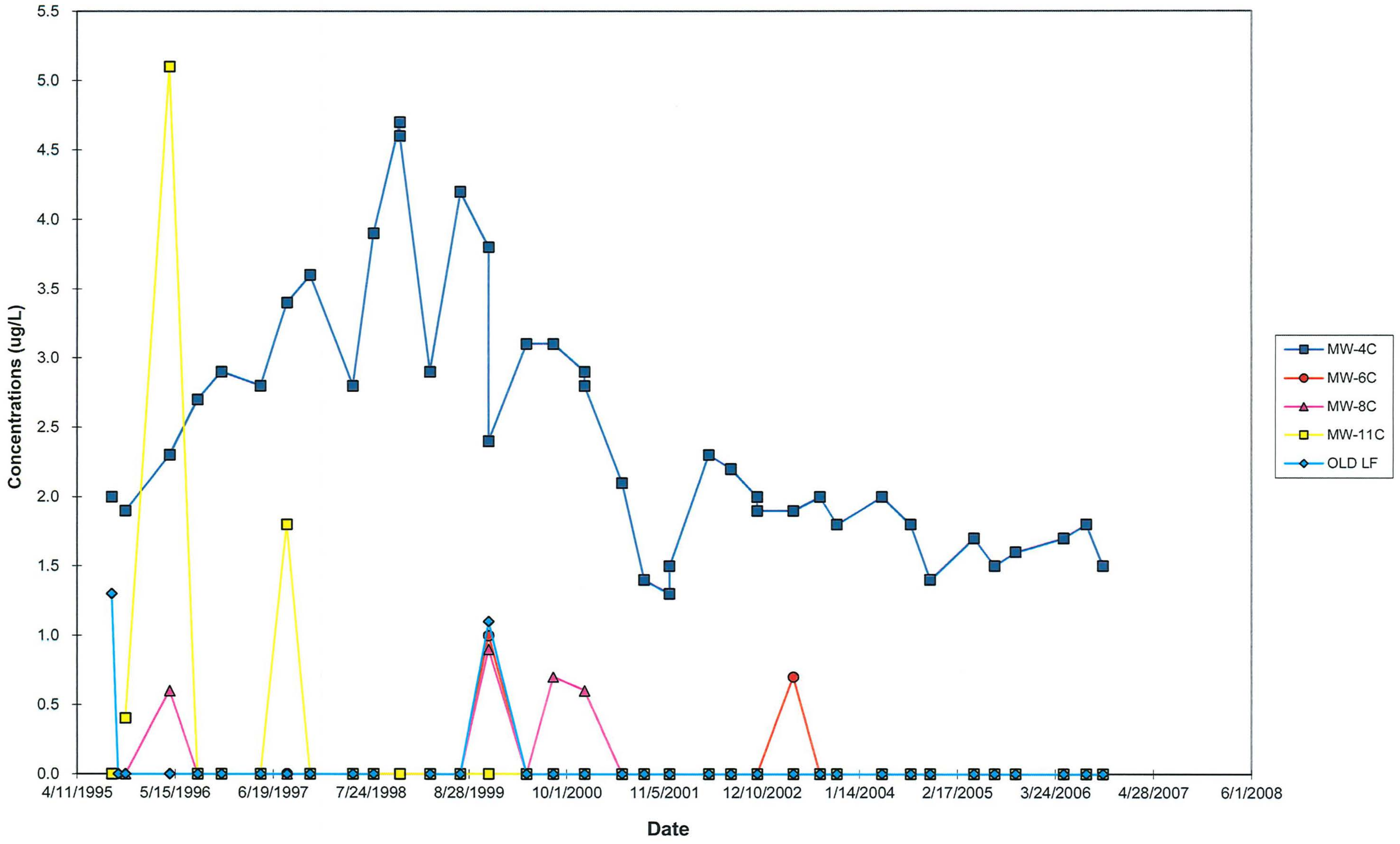
Site Description: The Red Rock Closed Sanitary Landfill (Landfill) is located near Austin, Minnesota in Mower County. The Landfill is 35 acres in size and contains approximately 1,738,500 cubic yards of waste. The Landfill originally operated as an open dump from 1958 until 1971. The Landfill was permitted 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

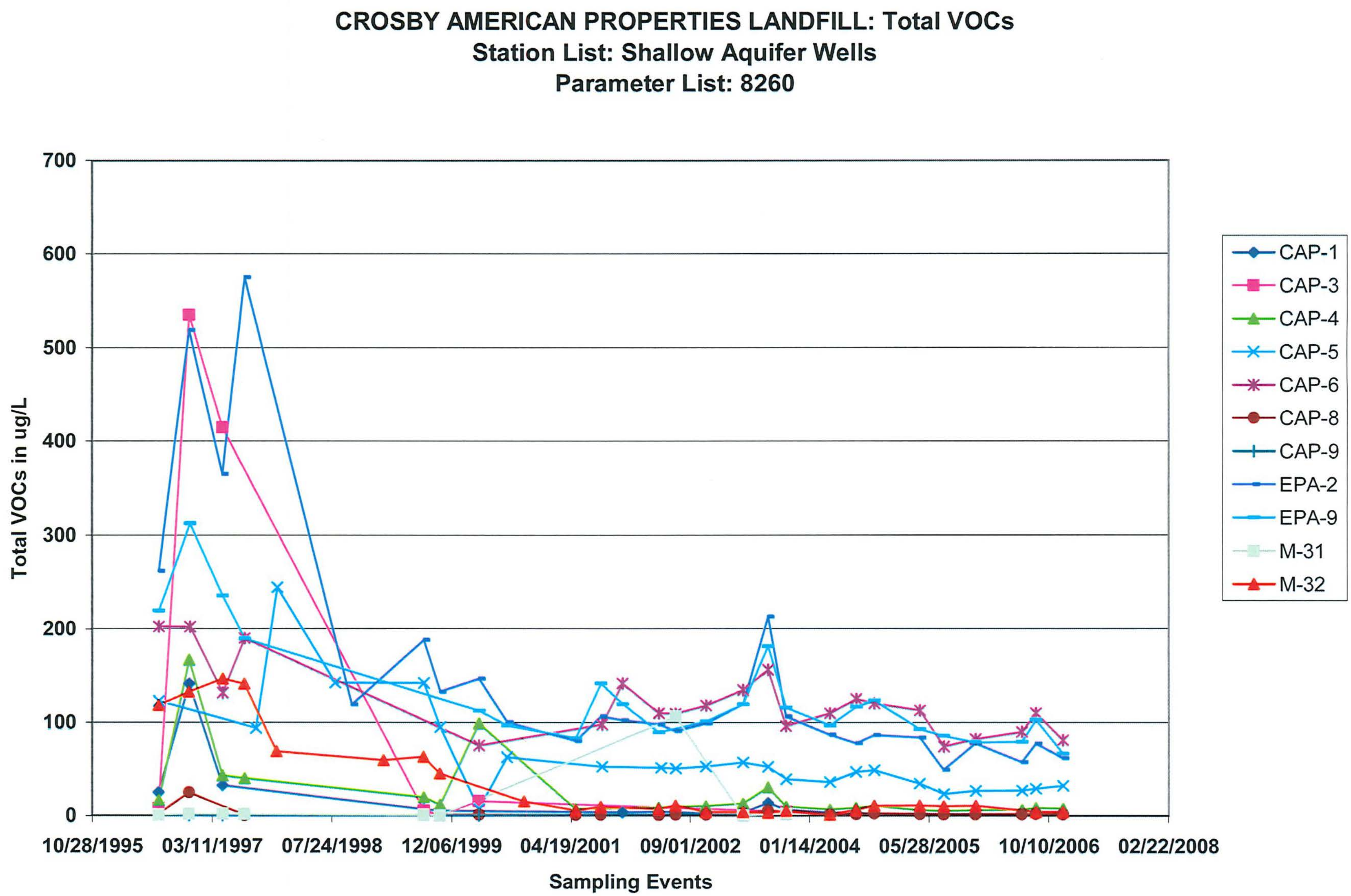
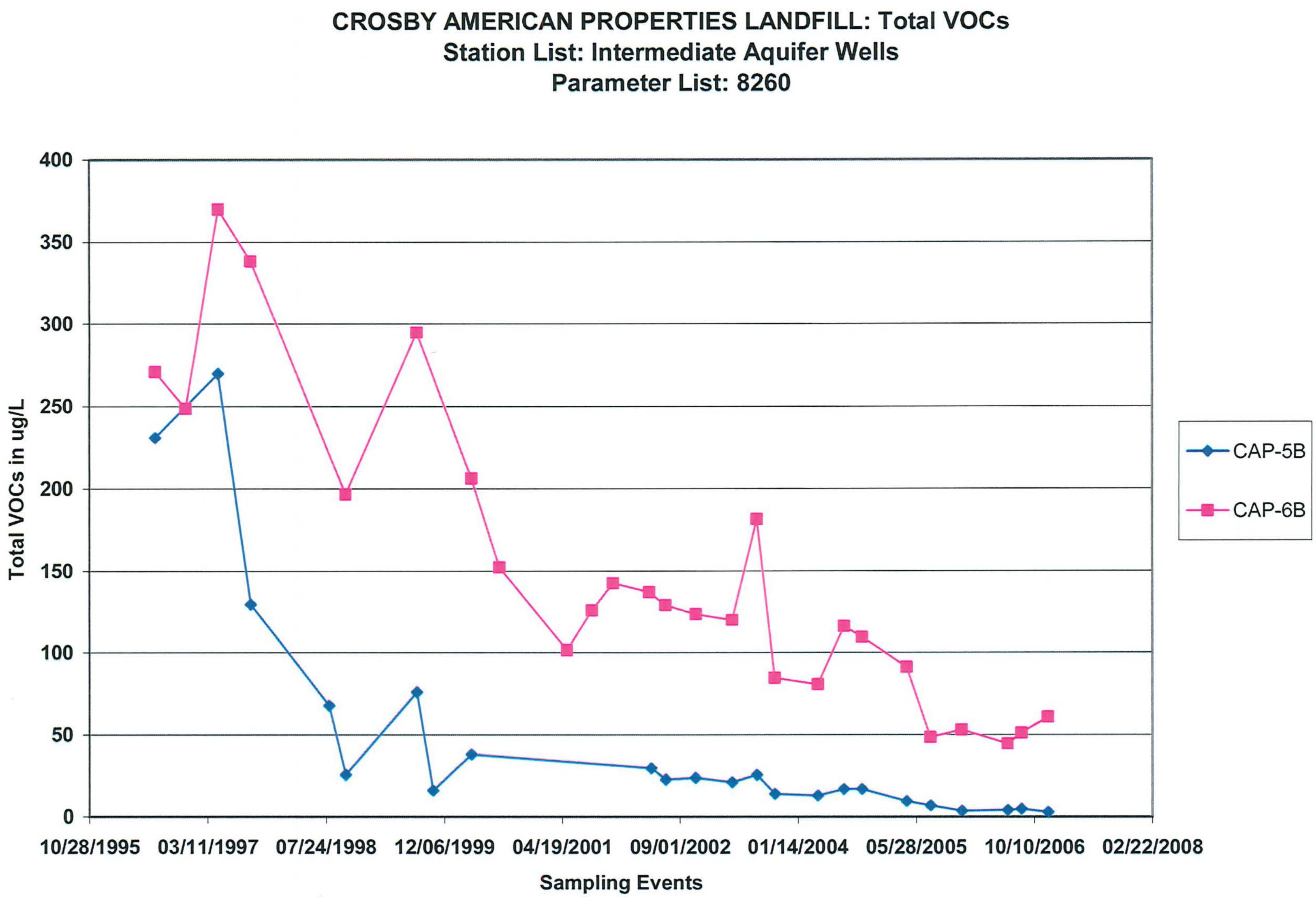

CROSBY AMERICAN PROPERTIES LANDFILL: Total VOCs
Station List: Shallow Aquifer Wells
Parameter List: 8260
Total VOCs in ug/L
700
600
500
400
300
200
100
0
10/28/1995
03/11/1997
07/24/1998
12/06/1999
04/19/2001
09/01/2002
01/14/2004
05/28/2005
10/10/2006
02/22/2008
Sampling Events
CAP-1
CAP-3
CAP-4
CAP-5
CAP-6
CAP-8
CAP-9
EPA-2
EPA-9
M-31
M-32

Figure 8


CROSBY AMERICAN PROPERTIES LANDFILL: Total VOCs
Station List: Intermediate Aquifer Wells
Parameter List: 8260
Total VOCs in ug/L
400
350
300
250
200
150
100
50
0
10/28/1995
03/11/1997
07/24/1998
12/06/1999
04/19/2001
09/01/2002
01/14/2004
05/28/2005
10/10/2006
02/22/2008
Sampling Events
CAP-5B
CAP-6B

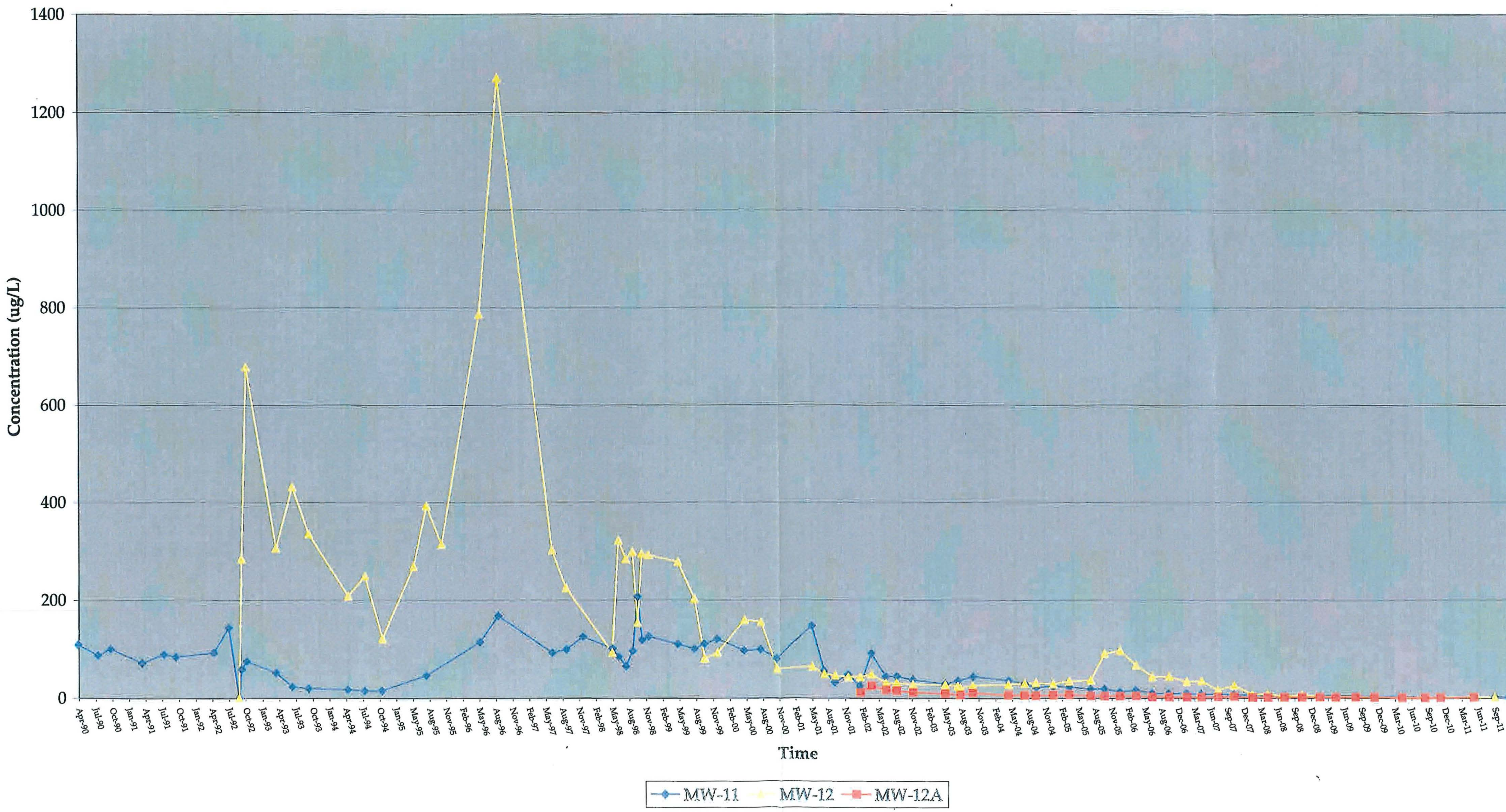
Project Name: Becker County Landfill
Project Location: Detroit Lakes, Minnesota
Project Owner: Minnesota Pollution Control Agency
Project Contact: Tom Newman–MPCA Project Manager Peter Tiffany– MPCA Project Engineer

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.

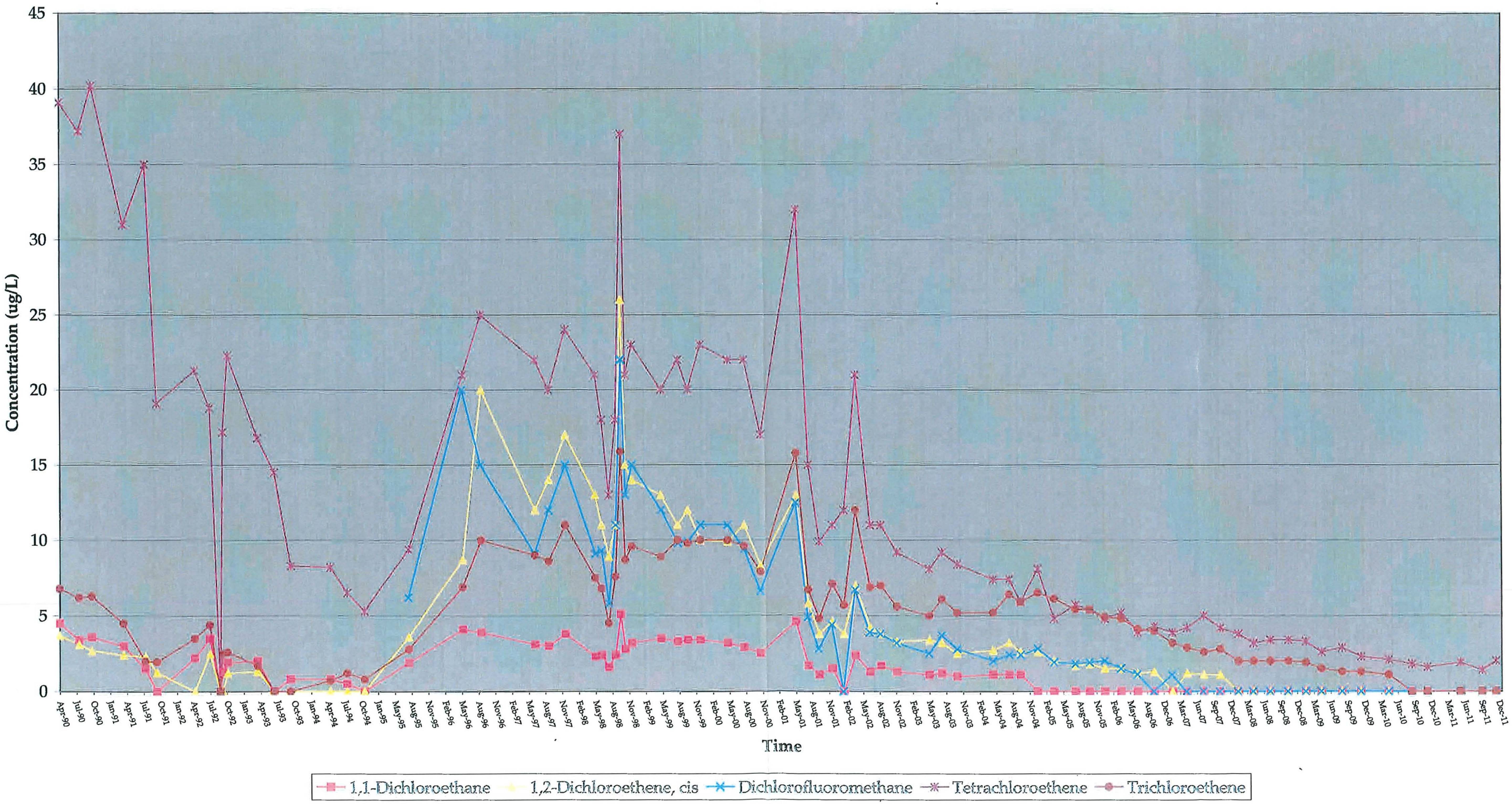
In late 1996, the MPCA constructed an active gas extraction system at the landfill. During the installation of the extraction wells it was discovered that half of the landfill was covered with only six inches to one foot of cover material rather than the three to four foot cover system required by Minnesota 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.

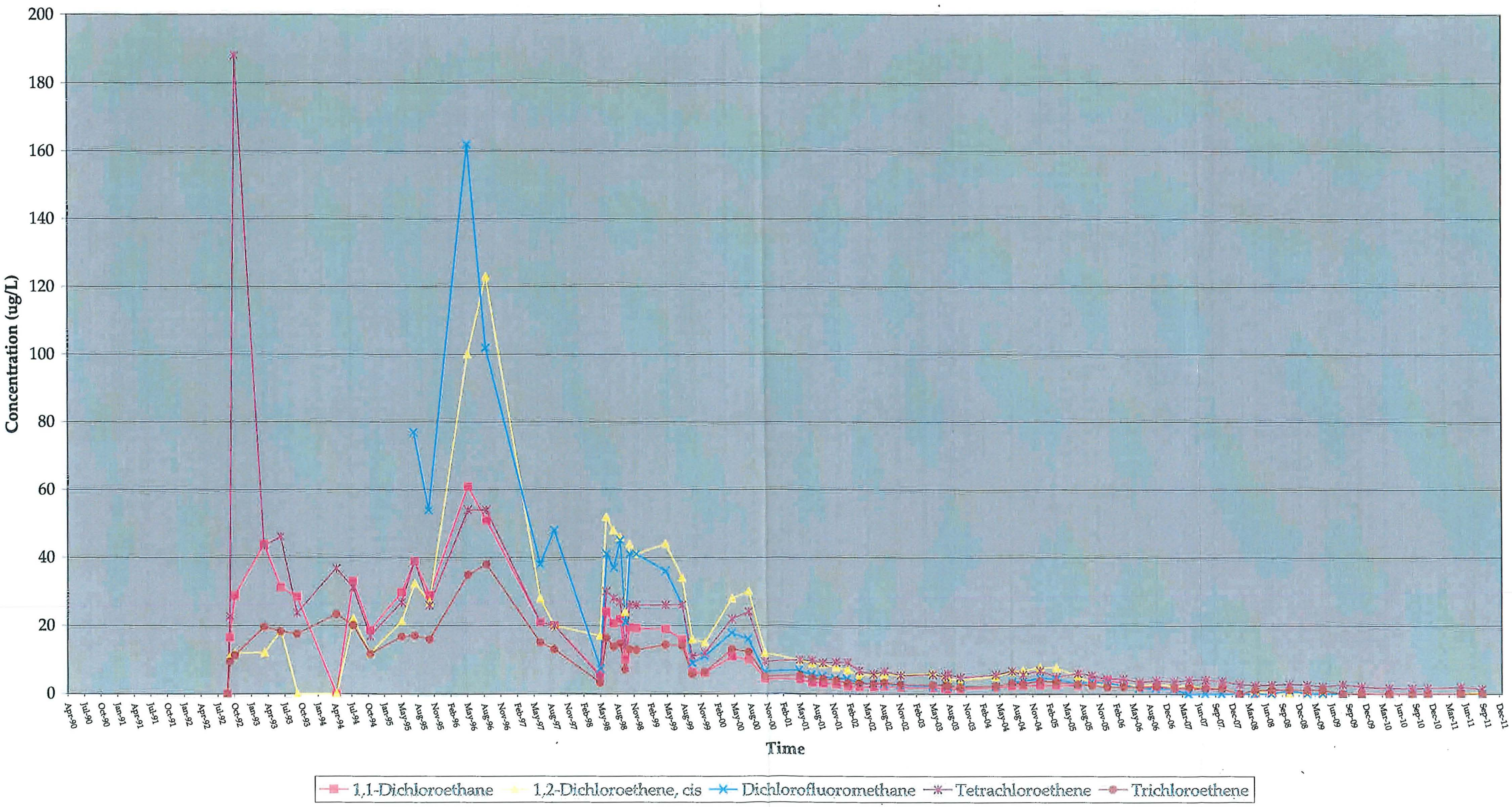
Total VOC Concentrations



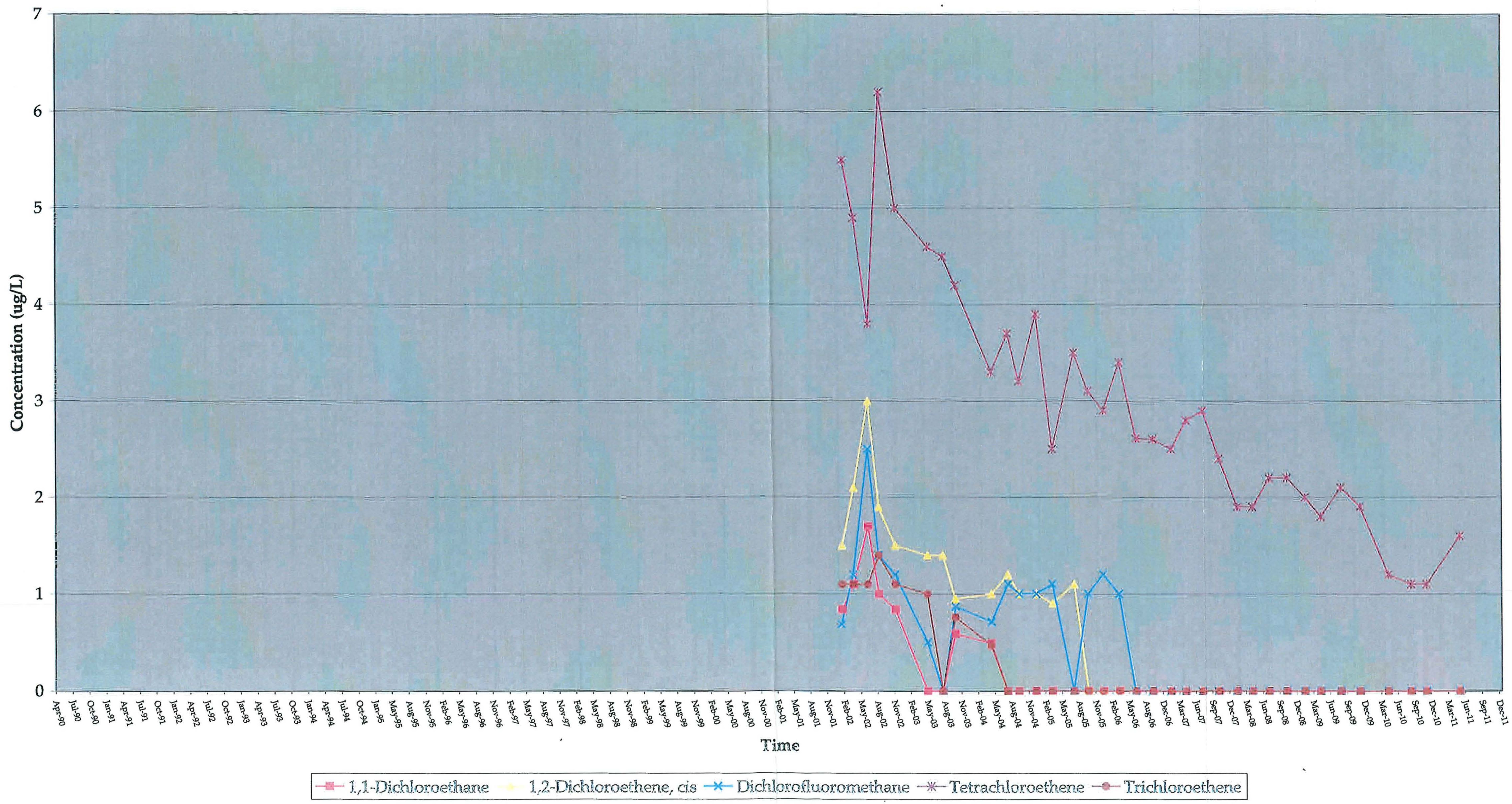
Select VOC Concentrations (MW-11)



Select VOC Concentrations (MW-12)



Select VOC Concentrations (MW-12A)

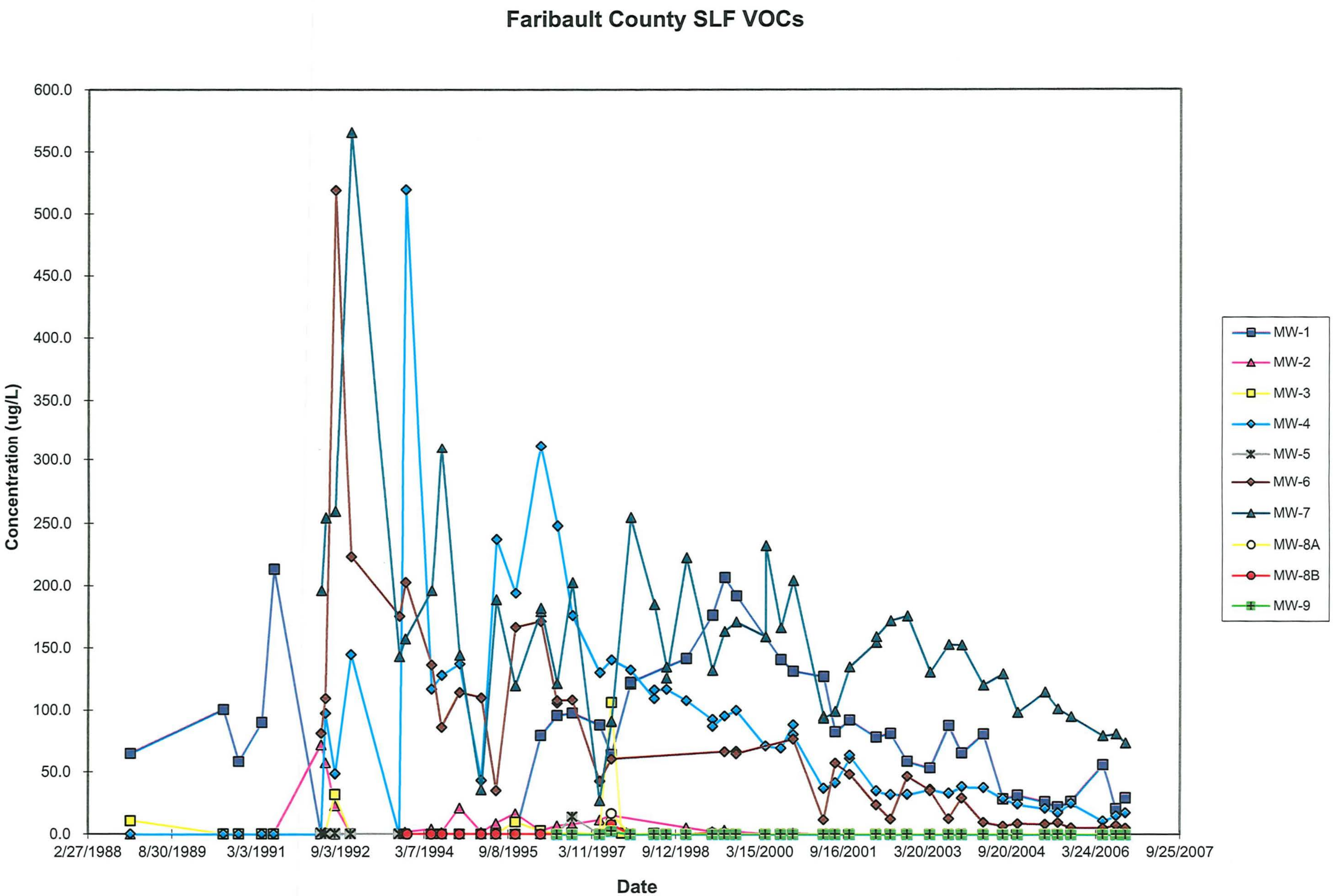


Project Name: Faribault Closed Landfill
Project Location: Faribault County, Minnesota
Project Owner: Minnesota Pollution Control Agency
Project Contact: Shawn Ruotsinoja-MPCA Project Manager Ben Klismith- MPCA Project Engineer

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.

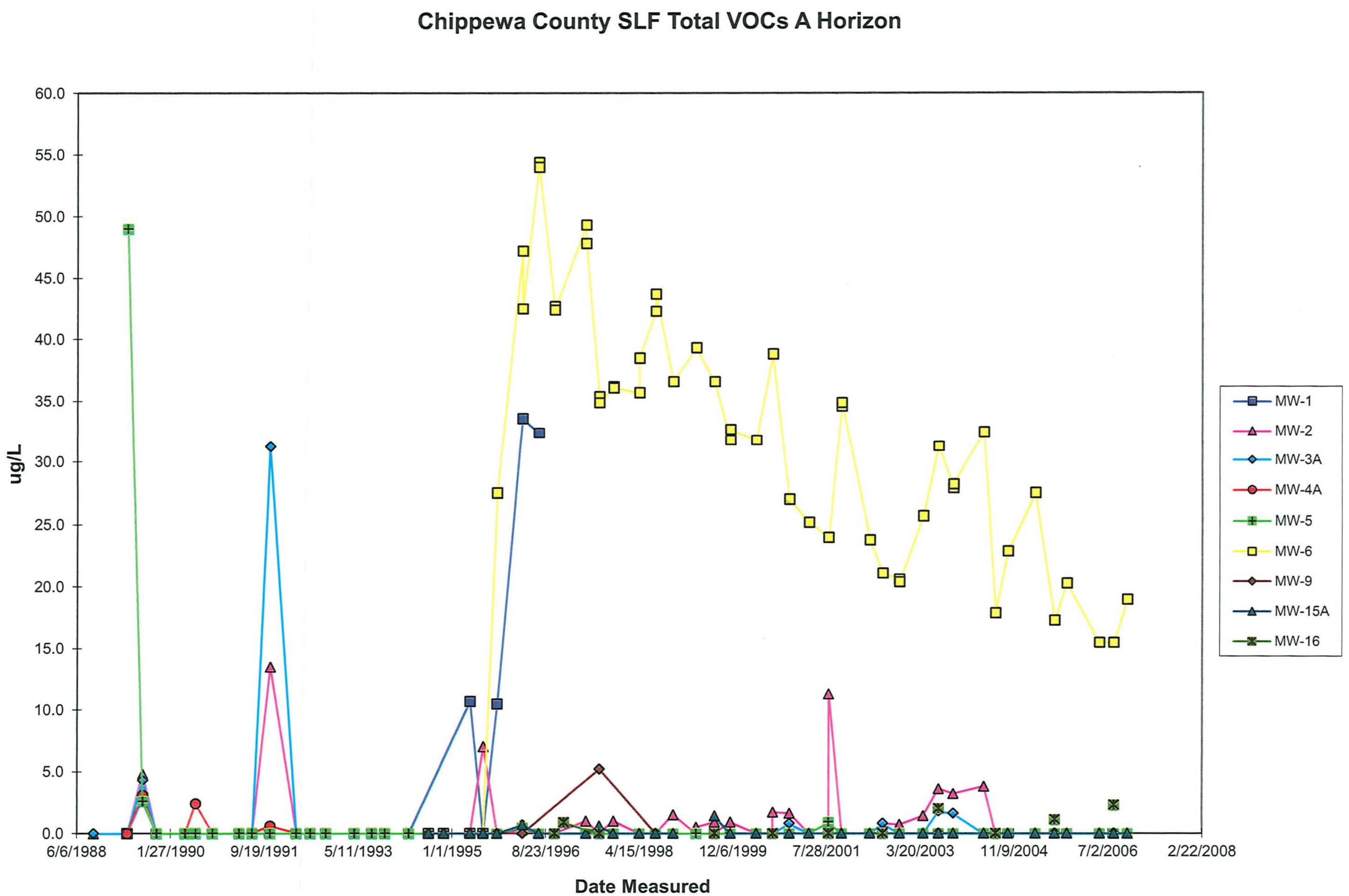
Shallow groundwater at the Site has been impacted by VOCs in landfill waste. Types of VOCs that have impacted groundwater include BETXs, chlorinated solvents, freons, and tetrahydrafuran. As stated above, a 3-foot soil cover was in place at the time of closure in the early 1990's. The landfill does not 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
Concentration (ug/L)
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
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

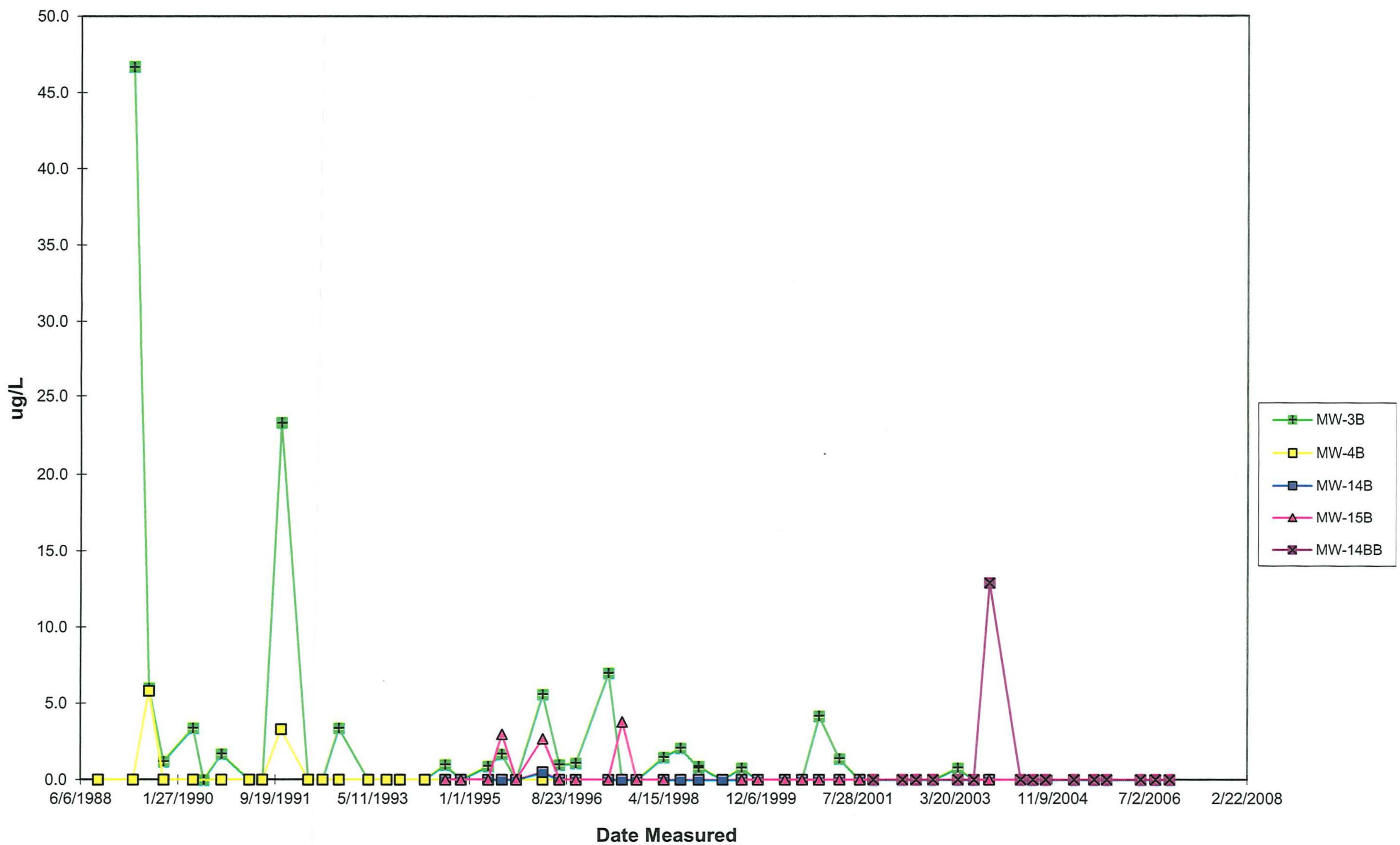
Project Name: Chippewa County Closed Sanitary Landfill
Project Location: Chippewa County, Minnesota
Project Owner: Minnesota Pollution Control Agency
Project Contact: Tom Newman–MPCA Project Manager Ben Klismith– MPCA Project Engineer

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.

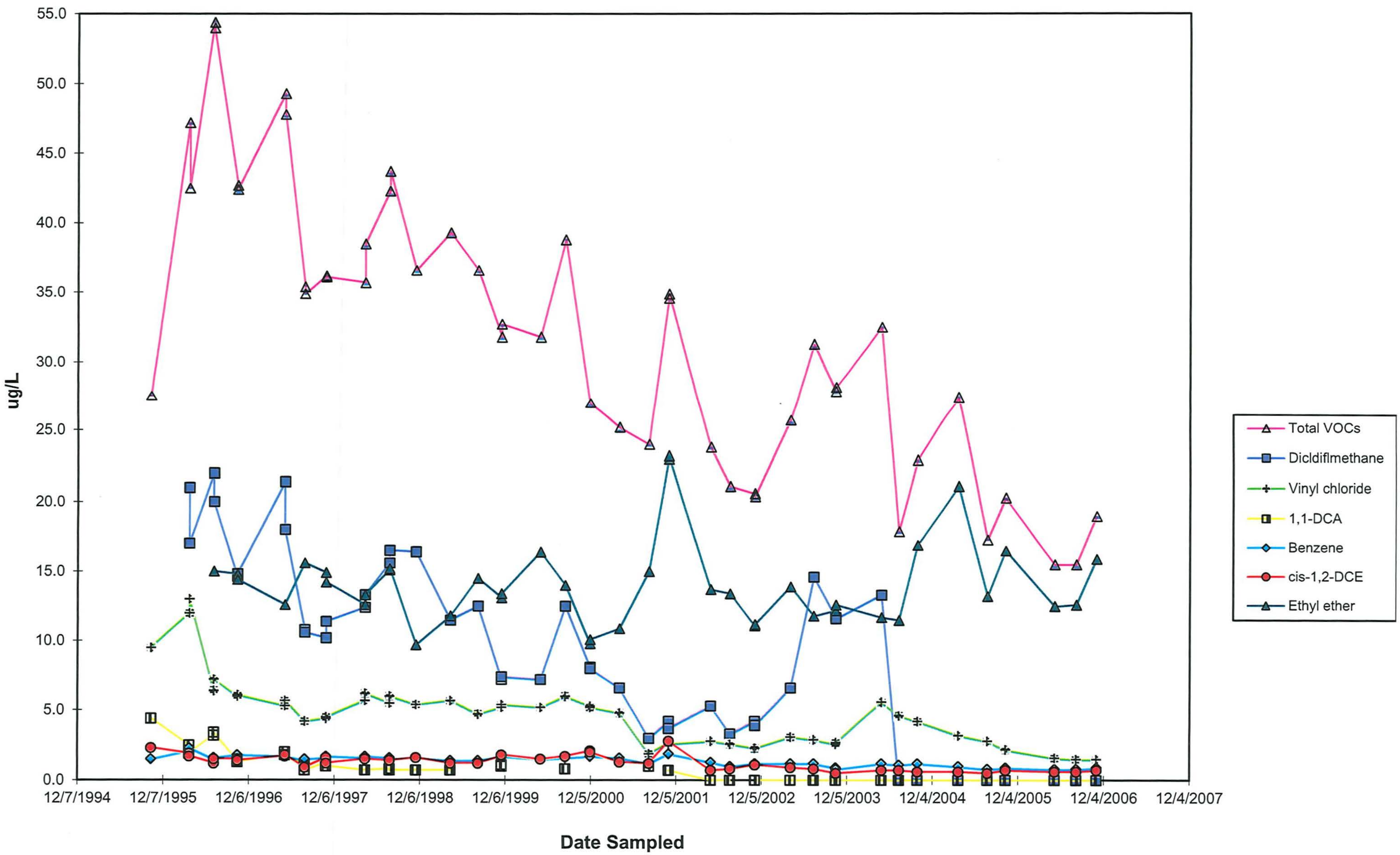
The groundwater monitoring system consists of 11 monitoring wells. Of these, four wells are located in an upgradient direction and seven are downgradient. VOCs in the landfill waste have impacted groundwater. Types of VOCs include benzene, various chlorinated VOCs including freons, ethyl ether, xylene, 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
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
ug/L
6/6/1988
1/27/1990
9/19/1991
5/11/1993
1/1/1995
8/23/1996
4/15/1998
12/6/1999
7/28/2001
3/20/2003
11/9/2004
7/2/2006
2/22/2008
Date Measured
MW-1
MW-2
MW-3A
MW-4A
MW-5
MW-6
MW-9
MW-15A
MW-16

Chippewa County SLF Total VOCs B Horizon



Chippewa County SLF MW-6 VOCs



APPENDIX G

DEVELOPMENT AT HISTORIC FILL SITE OR LICENSED LANDFILL EXEMPTION APPLICATION

Development at Historic Fill Site or Licensed Landfill Exemption Application

Form 4400-226 (R 12/05)

Notice: Use of this form is required by the DNR for any application to develop at a historic fill site or licensed landfill pursuant to secs. NR 506.085 and NR 500.08(4), Wis. Adm. Code. The Department will not consider your application unless you provide complete information requested. Personally identifiable information collected will be used to process your application and will also be accessible by request under Wisconsin's Open Records law [ss.19.31 - 19.39, Wis. Stats.]

Instructions: See *Development at Historic Fill Sites and Licensed Landfills: What you need to know* (PUB-RR-683, April 2002) for detailed instructions.

- All Exemption Application materials should be sent to the region where the site is located, as listed on page 6.
- Include $500 fee payment with this application unless a fee was already paid for the review of the remedial design report under the NR 700 process.
- Determine the appropriate exemption type for the site and check appropriate box below.
- Provide complete information requested for each type of exemption. Include the following attachments:
  Required: Summary of Existing and Potential Impacts described in Section V as an attachment, under the seal of a professional engineer or geologist registered to practice in Wisconsin.
  Optional: Site Visit Summary Comments (Section IX) including any photos, sketches or site visit notes.

Exemption Type

[x] **Remediation and Redevelopment Program NR 700 Rule Series Process Exemption:** Site with remedial actions conducted in accordance with NR 700 series
Required: Sections I - VI ***Optional:*** Sections VII - X

[ ] **Case-by-Case Evaluation:** Sites with anticipated environmental impacts or wastes of special concerns
Required: Sections I - VI ***Optional:*** Sections VII - X

[ ] **Expedited Exemption:** Site with no expected environmental impact
Required: Sections I - VI <u>and</u> Form 4400-256A Expedited Exemption Application ***Optional:*** Sections VII - X

I. Applicant Information

Owner - Last Name	First	MI	Telephone Number
Holtz Krause PRP Group			414-271-2400

Contact Name (if different): Mark Thimke, Foley & Lardner

Street Address	City	State	ZIP Code
777 East Wisconsin Avenue	Milwaukee	WI	53202-5306

Developer - Last Name	First	MI	Telephone Number
Holtz Krause PRP Group, c/o Foley and Lardner			414-271-2400

Street Address	City	State	ZIP Code
777 East Wisconsin Avenue	Milwaukee	WI	53202-5306

II. Site Name and Location

Site Name: Holtz Krause Landfill

Location / Address: 602 East Kent Street

Is the site known by another name(s)? [ ] Yes [x] No [ ] Unknown

[x] City [ ] Town [ ] Village of Wausau

If yes, provide name.

ZIP Code: 54403 State: WI

Does the site have a license number? [x] Yes [ ] No [ ] Unknown

If yes, License Number: #0674

County: Marathon

A. Attach a map with site location and limits of fill/waste disposal area.

B. Global Positioning System Coordinates

Latitude: 44 DEG 56 MIN 15 SEC N

Longitude: 89 DEG 36 MIN 30 SEC W

Describe method for collecting GPS Coordinates: Google Earth

Program Lead, Fee Status and Regulatory ID Numbers *(This area for DNR use only)*

[ ] **Waste Management Bureau**

[ ] **Remediation and Redevelopment Bureau - Exemption is part of remedy under NR 700 program**

[ ] Fee already paid for review of remedial design report.

[ ] Review of remedial design report not requested and payment is attached.

[ ] Payment Attached

Amount $

Hazardous Waste Facility License ID No. (5 digits)	DNR FID No. (9 digits)	USEPA ID No. (used for both RCRA and CERCLIS #s) (WI+Alpha+9 digits)

Region	Project Manager	Telephone Number

III. Site Ownership History

Previous Owner - Last Name	First	MI	Telephone Number
Holtz Krause Inc.			

Street Address	City	State	ZIP Code
602 East Kent St	Wausau	WI	54403

Responsible Municipal / Private Operator - Last Name (if applicable)	First	MI	Telephone Number
N/A			

Street Address	City	State	ZIP Code

IV. Evaluation of Existing and Potential Impacts. **See Development at Historic Fill Sites and Licensed Landfill: Guidance for Investigation and Development at Historic Fill Sites and Licensed Landfill: Potential Problems and Considerations.**

A. Analytical data for the following media have been collected and/or examined before completing this application:

1. Groundwater: ☒ Yes ☐ No
2. Soil: ☒ Yes ☐ No
3. Surface water / sediment: ☒ Yes ☐ No
4. Air: ☒ Yes ☐ No
5. Methane or other explosive gases: ☒ Yes ☐ No

B. Based on known or suspected sources and wastes, their physical characteristics, containment and geologic environment, do you suspect a release of pollutants to the environment?

☐ Yes: ☐ Groundwater ☐ Soil ☐ Surface Water / Sediment ☐ Methane or Other Explosive Gases
☒ No

If yes, an expedited exemption is not appropriate unless further investigation shows that a release of pollutants is not likely.

C. If there is NOT a likelihood of a release of pollutants or evidence of a release, would the impact of the proposed development be likely to cause a release to the environment?

☐ Yes **If yes, be sure to summarize actions to be taken to prevent adverse environmental impacts in V. Part C below.**
☒ No

V. Summary of Existing and Potential Impacts. **See Development at Historic Fill Sites and Licensed Landfill: Guidance for Investigation and Development at Historic Fill Sites and Licensed Landfill: Potential Problems and Considerations.**

Describe the following in an attached narrative under the signature of a qualified professional. Organize, label and package as listed below.

A. Existing Site Conditions
1. existing site conditions including waste types,
2. potential for impacts, and
3. evaluation of existing impacts.

B. Proposed Development Summary. Include explanation for overall site decision.

C. Summary of actions to be taken and engineering controls that will prevent or minimize adverse environmental impacts and potential threats to human health and welfare, including worker safety.

VI. Certification of Application Information

I certify that information in this application and all its attachments is true and correct and in conformity with applicable Wis. statutes.

Print / Type Name of Applicant
Ron Frehner, CRA on behalf of the Holtz Krause PRP Group

Applicant Signature	Date Signed
Ron Frehner	April 11/12

Sections VII - IX are optional for all Applicants.

VII. Current and Historic Type of Waste Disposal Site (Check all that apply)

- [x] Licensed Landfill
- [ ] Non-approved {See s.289.01(3)}, Wis Stats.
- [ ] Approved
- [ ] One-time Disposal
- [ ] Construction / Demolition
- [ ] Historic Fill Site

Liner

- [x] Unlined
- [ ] Lined
- [ ] Composite Liner
- [ ] Other Liner (Describe): ____________
- [ ] Clay Liner
- [ ] Unengineered

Total Landfill Volume

- [ ] < 50,000 yd^3
- [ ] 50,000-500,000 yd
- [x] > 500,000 yd^3

	Yes	No	Unknown
Does the landfill have a closure plan?	[x]	[ ]	[ ]
Does the landfill have a groundwater monitoring plan?	[x]	[ ]	[ ]
Have groundwater monitoring wells been installed?	[x]	[ ]	[ ]

Was a cover installed? [x] Yes [ ] No **If no, go to Past Land Uses.**

- [x] Composite cap
- [ ] Layered soil cap with clay barrier
- [ ] Clay cap
- [ ] Soil cap - not recompacted clay
- [ ] Other cover
- [ ] Unknown

What is the thickness of the cover? [ ] <6 in [ ] 6-12 in [ ] 12-24 in [x] >24 in [ ] Unknown

Past Land Uses. (Check all that apply)

- [ ] Agricultural co-op
- [ ] Brush pile
- [ ] Bulk plant
- [ ] Coal gas manufacturer
- [ ] Deer pit
- [ ] Dry cleaner
- [ ] Electroplater
- [ ] Lagoon
- [ ] Manufacturing Type: ____________
- [ ] Old burn pit
- [ ] Pipeline
- [ ] RCRA generator
- [ ] Salvage yard
- [ ] Service Station
- [ ] Tannery
- [ ] Unknown
- [ ] Other: ____________

Date(s) of Site Operation		No. of Years	
From: 1957	To: 1980	23	[ ] Unknown

VIII. Waste Information & Geologic Environment. See Development at Historic Fill Sites and Licensed Landfills: Guidance for Investigation

A. Known or Suspected Sources/Wastes. (Check all that apply)

- [ ] Abandoned containers
- [ ] Above ground pipeline or tank
- [ ] Animal carcasses
- [ ] Buried drums
- [ ] Burning of materials
- [ ] Foundry sand
- [ ] Industrial accident
- [ ] Known or suspected hazardous materials
- [x] Municipal waste
- [ ] Paper mill sludge
- [ ] Transformer
- [ ] Trees/brush
- [ ] Surface spills
- [ ] Fly ash
- [x] Demolition/construction waste
- [ ] Surface impoundment/lagoons
- [ ] Underground pipeline or tank
- [ ] Exempted fill {NR 500.08(1) and (2)}
- [ ] Unknown
- [ ] Other: ____________

B. Physical Characteristics of Sources/Wastes

[ ] Liquid [x] Solid [ ] Liquid & Solid [ ] Unknown

VIII. Waste Information & Geologic Environment *(continued)*

C. Waste Containment ☐ Liner ☐ Unknown ☒ Not applicable

☒ Engineered cover
☒ Maintained ☐ Not maintained

☐ Functioning leachate collection & removal system
☐ Functioning & maintained run-off management system
☐ Functioning groundwater monitoring system

D. Soil Type: Estimate distances or determinations based on regional or site specific information.

☐ Regional ☐ Site specific

Clay, silt or other fine grained soils present? (lacustrine, tills, etc.) ☐ Yes ☒ No

At surface? ☐ Yes ☒ No At depth? ☐ Yes ☒ No ______ feet

Sand & gravel, coarse grained soils present? ☐ Yes ☐ No

At surface? ☒ Yes ☐ No At depth? ☒ Yes ☐ No 0 to 50 feet

E. Depth to Groundwater

☐ Regional ☒ Site specific 0 to 10 feet

F. Direction of Groundwater Flow

☐ Regional ☒ Site specific SW direction

G. Depth to Bedrock

☐ Regional ☒ Site specific >50 ft direction

H. Bedrock Type

☒ Regional ☐ Site specific ☐ Sandstone ☐ Limestone/Dolomite ☒ Metamorphic/Igneous

IX. Site Visit

Conduct a site visit to complete site screening and determine general site conditions, on-site activities and adjacent land use encroachment issues. As appropriate to document the site, take photos, sketch the site and prepare a Site Visit Report.

On-site visit conducted? ☒ Yes ☐ No

General site conditions: Document any observed releases and note whether or not you were able to walk the site. Examples of things to be aware of include the following:

- leachate seeps or evidence of seeps such as stained soil/vegetation
- stressed vegetation as a sign of gas migration to the surface or of leachate seeps;
- quality and coverage of vegetation on the cap;
- odors which may indicate gas migration to the atmosphere;
- erosion of the cap;
- maintenance of positive drainage over the capped area;
- visual desiccation cracks in the cap.

Attach the following to your application:

☐ Photographs, regular or digital ☐ Site sketch ☒ Sit Visit Report

Name(s) of Person(s) Conducting Site Visit	Date of Site Visit
WDNR and Holtz Krause Site Visit	3/7/2012

IX. Site Visit *(continued)*

A. Adjacent Land Uses. Indicate all directions. (Check all that apply)

Use	N	S	E	W	NE	NW	SE	SW
☐ Agricultural	☐	☐	☐	☐	☐	☐	☐	☐
☐ Industrial	☐	☐	☐	☐	☐	☐	☐	☐
☐ Recreational	☐	☐	☐	☐	☐	☐	☐	☐
☐ Residential	☐	☐	☐	☐	☐	☐	☐	☐
☒ Undeveloped	☐	☒	☐	☒	☐	☐	☐	☐
☒ Commercial	☒	☐	☐	☐	☐	☐	☐	☐
☒ Other: Railroad	☐	☐	☒	☐	☐	☐	☐	☐

B. Potential Groundwater Receptors. Estimate distances. (1 mile = 5,280 ft)

Distance to and direction of nearest municipal well: ______ feet ☒ > ½ mile from the waste SW direction

Distance to and direction of nearest other-than-municipal well: ______ feet ☒ > ½ mile from the waste SW direction

Distance to and direction of nearest non-community well: ______ feet ☒ > ½ mile from the waste SW direction

Distance to and direction of nearest private well: ______ feet ☒ > ½ mile from the waste SW direction

Distance to and direction of nearest residence: ______ feet ☒ > ½ mile from the waste SW direction

C. Potential For Gas Migration

1 No. of homes within 300 feet of waste (gas migration potential)

20* No. of homes between 300 & 1,000 ft to waste (gas migration potential)

Distance to and direction of nearest building: 200 feet ☐ > ½ mile from the waste W direction

Type of building: ☐ On-site building ☐ Municipal ☒ Residential ☐ Commercial ☐ Industrial ☐ Unknown

D. Potential Surface Water Receptors. Estimate distances.

☒ Creek: 0(E) and 600 (W) feet ☐ Drainage ditch: ______ feet ☐ Intermittent stream ______ feet

☐ River: ______ feet ☐ Lake: ______ feet ☒ Wetland: 0 (S) feet

E. Based on the site visit, did you visually observe…

1. a release to a surface water body? ☐ Yes ☒ No ☐ Unknown
2. a leachate seep? ☐ Yes ☒ No ☐ Unknown
3. a release to soils? ☐ Yes ☒ No ☐ Unknown

X. Comments: Use this section to provide comments on any aspect of the site visit. Attach any information or explanations labeled with the appropriate section number to which the material applies.

*Note: Residential houses located east of the east side creek and west of Cemetery Slough are not included because the creeks provide a barrier to gas migration. The estimated 20 residential home are located NE of the landfill.

Region Map

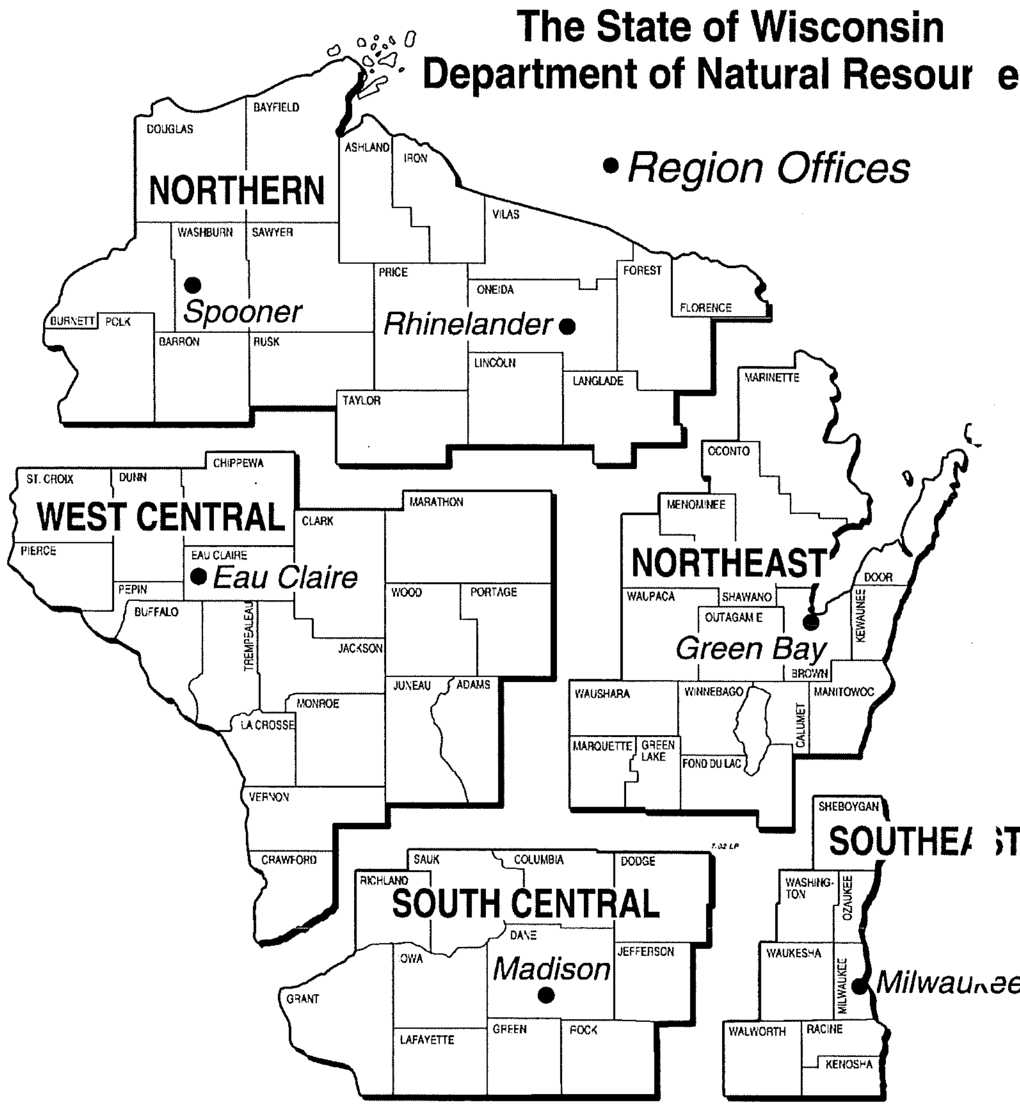
NORTHERN REGION
Remediation & Redevelopment
Team Supervisor
Department of Natural Resources
107 Sutliff Avenue
Rhinelander, WI 54501
(715) 365-8976
OR
Regional Waste Program Manager
Department of Natural Resources
107 Sutliff Avenue
Rhinelander WI 54501
(715) 365-8946

NORTHEAST REGION
Remediation & Redevelopment
Team Supervisor
Department of Natural Resources
2984 Shawano Avenue
Green Bay, WI 54307-0448
(920) 662-5160
OR
Regional Waste Program Manager
Department of Natural Resources
2984 Shawano Avenue
Green Bay, WI 54307-0448
(920) 662-5120

SOUTHEAST REGION
Remediation & Redevelopment
Team Supervisor
Department of Natural Resources
P.O. Box 12436
Milwaukee, WI 53212-0436
(414) 263-8561 or (414) 263-8714
OR
Regional Waste Program Manager
Department of Natural Resources
P.O. Box 12436
Milwaukee WI 53212-0436
(414) 263-8694 or (414) 263-8697

WEST CENTRAL REGION
Remediation & Redevelopment
Team Supervisor
Department of Natural Resources
1300 Clairemont Avenue
Eau Claire, WI 54701
(715) 839-3710
OR
Regional Waste Program Manager
Department of Natural Resources
1300 Clairemont Avenue
Eau Claire WI 54701
(715) 839-3708

SOUTH CENTRAL REGION
Remediation & Redevelopment
Team Supervisor
Department of Natural Resources
3911 Fish Hatchery Rd.
Fitchburg, WI 53711
(608) 275-3241
OR
Regional Waste Program Manager
Department of Natural Resources
3911 Fish Hatchery Road
Fitchburg WI 53711
(608) 275-3466



1.0 INFORMATION SUPPORTING THE APPLICATION FOR AN EXEMPTION FOR HISTORI FILL SITE OR LICENSED LANDFILL

This Exemption Application is intended to allow the construction of a concession/restroom facility on the Holtz Krause landfill. At this time a building is not planned but the Holtz Krause group would like the exemption in case a building is added.

Figure C.1 shows the location of the potential concession/restroom building.

1.1 EXISTING SITE CONDITIONS AND WASTE TYPES

The Holtz Krause Landfill is a 57-acre site that operated between 1957 and 1980 and received approximately 2.0 million cubic yards of waste, including municipal solid waste, noncombustible waste, demolition material, and wood waste. In February 1979, a landfill abandonment plan was completed and initial landfill cover construction, consisting of a 2-foot thick soil cover, was completed in 1982.

In 1994, an additional cover system was installed over the existing soil cover and now consists of (from the ground surface):

- A vegetative layer of 6 inches of topsoil and 2.5 feet of rooting zone soil
- A primary barrier layer of 40 mil flexible membrane liner (FML)
- A secondary barrier layer of 2 feet of clay
- The 1982 existing soil cover (0 to 2 feet thick)

The site currently has a landfill gas extraction and treatment system consisting of a blower and flare to combust the collected methane gas. Additionally, the site has a groundwater monitoring system that is sampled and analyzed on a semi-annual basis.

1.2 POTENTIAL FOR IMPACTS

The historical impacts from the landfill included the potential migration of landfill gas and groundwater contamination. However, these impacts have been remediated through the WDNR-approved remedy completed in 1994/1995.

1.3 EVALUATION OF EXISTING IMPACTS

In 2011 the WDNR approved Monitored Natural Attenuation (MNA) as the final groundwater remedy. The decision to approve MNA was based on monitoring data from approximately 38 monitoring wells which have developed a data base covering the 16 year post-remediation period. The approval was issued because studies have shown that the groundwater contamination plume is stable or decreasing and aquifer chemistry is favorable for anaerobic biodegradation of the contaminants of concern.

Gas migration has been addressed by implementation of the active gas collection and treatment system. This landfill remedy was constructed in 1994 and included an active venting system that has operated for 16 years. Currently, the amount of landfill gas production is approximately 170 to 200 cubic feet per minute (CFM), averaging 191 CFM, which is much less than the 375 CFM measured in 1994 when the landfill gas system was installed. The existing active gas collection system has served its intended purpose to prevent off site gas migration and reduce VOCs in the waste. The future plan for the soccer complex is to modify the active gas collection system for odor control. All of the access points to gas wells will be outside the soccer fields and at grade. The surface feature will look like a manhole cover. The horizontal gas collection and piping network will continue to be located below the liner system. A new blower and flare will be installed and will be smaller than the existing system in order to balance the blower size with the lower rate of landfill gas production.

2.0 PROPOSED DEVELOPMENT SUMMARY

The proposed development for which this Exemption Application is being prepared is the construction of a concession building with restrooms to enhance the development of a proposed soccer complex on the Holtz Krause Landfill. At this time, a concession/restroom building is not planned. However, the Holtz Krause group is seeking approval now so that a building could be added in the future, if desired.

3.0 SUMMARY OF ACTIONS

With respect to any future building construction on the landfill, the following is a summary of actions taken and engineering controls to prevent or minimize adverse environmental impacts and potential threats to human health and welfare, including worker safety:

- Methane Gas - For any building that may be constructed, controls will include installation of a vapor barrier and methane detectors.
- Settlement - Settlement of the landfill has been measured by survey for the past 16 years. Building footings will be above the impermeable liner on re-compacted soils.
- Surface Water Infiltration - Any building constructed will not interfere with the existing flexible membrane liner and two-foot clay layer. All of the building components, including the foundation will be constructed above the liner system. As such, the two barrier layers will not be disturbed. Surface water will not infiltrate through the barrier layers.
- Worker Safety - All of the construction related to the building will take place in clean soils above the waste. There will be no contact with waste materials or landfill gas. As such, there will be no need for special provision for worker safety.
- Underground Utilities - Utilities (i.e. water service, sanitary service, electrical and telephone) that may be constructed in conjunction with the structures will be installed entirely above the FML/clay barrier layers. In the area of the concession building, the thickness of the cover soil will be increased from 3 feet above the liner to approximately 5 feet above the liner. Frost protection would be provided for the water main and sanitary service. As a precautionary measure, vapor seals will be installed at the point of entry of each utility to the building.
- Waste Handling - The waste will be not handled as part of the construction.

4.0 AUTHORITY

All of Which is Respectfully Submitted,

CONESTOGA-ROVERS & ASSOCIATES

Ron Frehner, P.E.
Wisconsin P.E. No. 31708
(Expiration July 31, 2012)

LEGEND

PROPOSED CONCESSION / RESTROOM FACILITY

PROPOSED FIELD

FUTURE CURLING RINK

GAS PROBE LOCATION

figure G.1

FUTURE POTENTIAL CONCESSION/ RESTROOM FACILITY LOCATION HOLTZ KRAUSE LANDFILL

Wausau, Wisconsin

74702-10(008)GIS-SP013 APR 10/2012