2019 Annual Monitoring Report

Highway 96 Site
White Bear Township, Minnesota

Highway 96 RP Group

GHD | 1801 Old Highway 8 Suite 114 St. Paul Minnesota 55112 USA | 002012 | Report No 71 | March 13, 2020

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1. Introduction

This report presents the results of the 2019 groundwater sampling program conducted at the Highway 96 Site (Site) pursuant to the requirements of the Response Action Plan (RAP), dated January 1994, as amended and referenced in the Consent Order.

This report covers the monitoring period from January 1, 2019 to December 31, 2019.

1.1 Site Description

The Site is located in White Bear Township, Minnesota. The Site location is shown on Figure 1.1. The Site operated as a local disposal area from the 1920s until 1973. Primarily residential wastes were received and burned at the Site. Some drummed wastes were disposed at the Site in the late 1960s and early 1970s. The Site was comprised of two disposal areas, the North and South Disposal Areas, which encompassed 4.5 and 1.5 acres, respectively. A Site Plan is presented on Figure 1.2.

1.2 Project Background

In 1986, a study was conducted at the Site by the United States Environmental Protection Agency (USEPA), which identified groundwater contamination by volatile organic compounds (VOCs). The Minnesota Pollution Control Agency (MPCA) subsequently issued a Request for Response Action (RFRA) to three potentially responsible parties (PRPs): Whirlpool Corporation (Whirlpool), Reynolds Metals Company (Reynolds) and Red Arrow Waste Disposal Services. GHD Services Inc. (GHD) [known as Conestoga-Rovers and Associates (CRA) prior to July 1, 2015] was retained by Reynolds and Whirlpool in 1986 to assist with the implementation of the RFRA.

On behalf of Reynolds and Whirlpool, CRA conducted a Remedial Investigation and Feasibility Study (RI/FS). The RI involved a review of the waste disposal history, installation of monitoring wells, excavation of test pits within the waste, and groundwater monitoring of monitoring wells and nearby residential wells. The results of the RI were submitted to the MPCA in March 1988 (Ref. 1).

In response to the confirmation of groundwater contamination at the Site, Whirlpool and Reynolds proposed an Interim Response Action Plan (IRAP) in the RI Report (Ref. 1) involving the removal of drums found during the investigation and the installation of a groundwater extraction system.

In May 1988, the MPCA approved the RI/IRAP.

The FS involved the evaluation of remedial alternatives, which were presented in the Alternatives Analysis Report (Ref. 2), and was submitted to the MPCA in October 1988. The MPCA approved the Alternative Analysis Report in February 1989. Whirlpool and Reynolds continued with the FS by evaluating potential remedial alternatives. A Detailed Analysis Report (DAR) was submitted to the MPCA in April 1989 (Ref. 3). This evaluation included a proposed remedial plan for the Site. The MPCA did not comment on the DAR until June 1992, and approved the DAR with modifications in June 1994.

In 1993, Reynolds and Whirlpool conducted a groundwater investigation in North Oaks, Minnesota. The groundwater investigation provided a general definition of the groundwater flow system in the vicinity of the Site and the southeast portion of North Oaks. This investigation also delineated the extent of a remnant VOC plume. Vinyl chloride was the only VOC to exceed the Recommended Allowable Limit (RAL). The North Oaks Southeast Groundwater Investigation report was submitted to the MPCA in October 1993 (Ref. 4).

In January 1994, Whirlpool and Reynolds submitted the Phase I Response Action Plan (Ref. 5) to the MPCA. The Phase I Response Action Plan (Phase I RAP) outlined the activities required for the implementation of the final remedy at the Site. The MPCA approved the Phase I RAP with modifications by letter, dated March 1, 1994.

In May 1994, Whirlpool and Reynolds submitted the Phase II Response Action Plan (Ref. 6) to the MPCA. The Phase II Response Action Plan (Phase II RAP) provided additional construction details on the Phase I RAP and provided details on the installation of a dewatering sump and gas probes. The MPCA approved the Phase II RAP, with modifications by letter, dated October 3, 1994.

1.3 Remedial Actions

As a parallel activity to the RI/FS, interim remedial actions were implemented by Whirlpool and Reynolds. These actions included drum removal, groundwater extraction system installation, North Oaks groundwater investigation, and South Disposal Area investigation. The final remedy for the Site is divided into four operable units:

- Operable Unit 1 - Source Control
- Operable Unit 2 - Groundwater Remediation
- Operable Unit 3 - Residential Drinking Water (east of Gilfillan Lake)
- Operable Unit 4 - Residential Drinking Water (west of Gilfillan Lake)

1.3.1 Operable Unit 1 - Source Control

During 1987 and 1988, contractors for the responsible parties removed drums containing hazardous substances from the North Disposal Area (NDA). In 1993, additional drums were removed from the South Disposal Area (SDA). In 1994, waste from the NDA and SDA were screened using a backhoe to look for any remaining drums. Drums and drum-related waste identified during the screening process were removed and transported off-Site for disposal. The contractors also drained the pond located within the NDA. All the pond water was discharged to the sanitary sewer, the sediment and material from the pond bottom were screened, and drums of waste were removed. The drums were disposed at licensed facilities in the fall of 1995.

After screening the NDA and the pond, the contractors transferred all waste material from the SDA to the NDA. Tests of the soils underlying the SDA showed no residual contamination, and the SDA was backfilled with clean soil. The results of the SDA investigation were submitted to MPCA in January 1994 (Ref. 7). All waste material at the NDA, including the waste material transferred from the SDA, was compacted, graded, and capped with two feet (ft.) of clean soil and remains on the property. Since the waste areas were combined, the NDA has been referred to as the Consolidated Waste Area (CWA).

In the spring of 1995, six gas probes (GP-1 through GP-6) were installed in the CWA for methane monitoring, in accordance with the Post Closure Operation and Maintenance Plan (O&M Plan) (Ref. 8). The gas probe locations are shown in Figure 1.3.

The Source Control Operable Unit remedy was completed in the fall of 1995 and is discussed in further detail in the Remedial Action Final Report (Ref. 9). In response to the MPCA's comments to the Remedial Action Final Report, three passive methane vents (GV-1 through GV-3) were installed in the CWA in November of 1996. The gas vent locations are shown on Figure 1.3.

In accordance with the O&M Plan (Ref. 8) and MPCA-approved modifications in 2001 and 2015, gas probe monitoring was conducted on a routine basis through 2018. As approved by the MPCA on June 20, 2018, gas probe monitoring was discontinued following the October 2018 monitoring event. Historical gas probe monitoring results are documented in the 2018 Annual Monitoring Report.

1.3.2 Operable Unit 2 - Groundwater Remediation

The Groundwater Remediation Operable Unit began as an interim remedial action and consists of continued operation of the groundwater extraction system and groundwater monitoring.

1.3.2.1 Groundwater Extraction System

Since June 1989, a groundwater extraction system has operated at the Site. The extraction system collects groundwater from the Lower Sand and St. Peter Sandstone aquifers, effectively limits the spread of contamination, and removes contaminated groundwater. The contaminated groundwater is discharged directly to the sanitary sewer under a Metropolitan Council Environmental Services (MCES) special discharge permit.

1.3.2.2 Dewatering Sump

In late 1994, after the consolidation of the NDA and SDA, a dewatering sump was installed directly into and under the CWA to remove landfill leachate from the perched groundwater unit and reduce downward migration of VOCs into the Lower Sand aquifer. The extracted water was discharged directly into the sanitary sewer under a MCES special discharge permit. From 1995 to 2018, the Dewatering Sump performed as expected and removed approximately 90 pounds of VOCs from the perched groundwater unit before reaching the end of its operational life (i.e., no longer enough VOC mass for efficient removal). As approved by the MPCA on June 20, 2018, operation of the Dewatering Sump was discontinued on June 25, 2018. Historical operation of the dewatering sump is documented in the 2018 Annual Monitoring Report.

1.3.2.3 Groundwater Monitoring Program

On-Site Monitoring

The on-Site groundwater-monitoring network includes 30 monitoring wells and two extraction wells screened in the unconsolidated glacial drift aquifer (Lower Sand aquifer) and the St. Peter Sandstone aquifer. The on-Site groundwater monitoring network is shown on Figure 1.2.

Groundwater samples are collected from on-Site extraction wells and select monitoring wells on an annual basis, as outlined in Table 1.1. Additional groundwater samples are collected from the on-Site extraction wells in accordance with the MCES discharge permit requirements. Seven of the 30 on-Site monitoring wells (MW10B, MW12B, MW12D, MW13B, MW13D, MW16B, and MW16D) are designated as compliance wells.

Off-Site Monitoring

From 1994 to 2008, the off-Site groundwater-monitoring network associated with Operable Unit 2 included residential wells and former residential wells that were converted to monitoring wells. The off-Site groundwater monitoring network is shown on Figure 1.4. As of August 2008, off-Site groundwater monitoring is conducted as part of Operable Unit 4 (see Section 1.3.4).

1.3.3 Operable Unit 3 - Residential Drinking Water (East Of Gilfillan Lake)

In 1993, the Minnesota Department of Health (MDH) issued drinking water well advisories to 12 homes in North Oaks between the Site and Gilfillan Lake, because vinyl chloride had been detected in their wells at levels exceeding the health-based risk level that was in place in 1993. Reynolds and Whirlpool chose to address this off-Site contamination by connecting all 60 homes with private wells located on the east side of the lake to the White Bear Township municipal water system. These connections were completed in 1994. Figure 1.5 shows the area serviced by municipal water.

1.3.4 Operable Unit 4 - Residential Drinking Water (West Of Gilfillan Lake)

From 1993 to 2004, Whirlpool/Reynolds and the MPCA monitored 51 residential wells located outside the municipal water service area on a regular basis, as part of the groundwater monitoring program for Operable Unit 2 (see Section 1.3.2.3). During a routine sampling event conducted in October 2004, low levels of vinyl chloride were detected in water samples collected from two residential well locations (12 West Shore Road and 13 West Shore Road). Residential well sampling was subsequently expanded to include an additional 31 residential well locations west of Gilfillan Lake. Since October 2004, Reynolds and Whirlpool have conducted extensive studies, under the supervision of the MPCA, to investigate the nature and extent of VOC contamination in residential wells located west of Gilfillan Lake. These studies included:

- 37 rounds of residential well sampling
- Installation of 13 new monitoring wells
- Vertical aquifer profiling (VAP) to provide vertical delineation of groundwater quality
- Installation of a test extraction well west of Gilfillan Lake in the Ski Lane Ravine
- A subsurface geophysical survey of Gilfillan Lake
- Continued monitoring at existing wells in North Oaks and at the Highway 96 Site in White Bear Township

CRA submitted various reports to MPCA that present the results of the studies listed above (Ref. 10, Ref.11, Ref. 12, Ref. 13, and Ref. 14).

In June 2007, the MPCA requested that Reynolds and Whirlpool complete a Feasibility Study (FS) to evaluate potential response actions for vinyl chloride contaminated groundwater on the west side of Gilfillan Lake. In July 2007, on behalf of Reynolds and Whirlpool, CRA submitted the FS Report

(Ref. 15) to MPCA. In September 2007, MPCA provided comments on the FS Report. In October 2007, CRA provided responses to MPCA's comments on the FS Report. MPCA approved the FS Report, with modifications, in November 2007.

The MPCA used the FS Report to develop a Proposed Plan for an amendment to the 1993 Minnesota Decision Document (MDD) for the Highway 96 Site. The Proposed Plan outlined the preferred remedial alternative(s) for the area west of Gilfillan Lake (Operable Unit 4). The Proposed Plan was issued by MPCA on February 15, 2008. MPCA held a public meeting on February 26, 2008 and public comments on the Proposed Plan were accepted until March 21, 2008.

The MPCA reviewed the public comments on the Proposed Plan and prepared an amendment to the MDD and a Responsiveness Summary Document. The MDD amendment (MDD Amendment 1), which includes the Responsiveness Summary, was signed by MPCA on August 26, 2008. As outlined in MDD Amendment 1, the final MPCA-selected remedy for homes located within Operable Unit 4 of the Site includes:

- Provision of a new/deeper residential well in the Prairie du Chien aquifer for homes that are issued a well advisory by the MDH due to Listed VOCs.[1]
- Long term groundwater monitoring
- Conditional installation and operation of a pump out system in the Ski Lane Ravine (in the event that vinyl chloride or another Listed VOC exceeds its respective health risk limit (HRL) in any of the Ski Lane Ravine monitoring wells)

As part of the long term groundwater monitoring component associated with the MPCA-selected remedy for Operable Unit 4, MDD Amendment 1 called for installation of two or three angled monitoring wells beneath Gilfillan Lake, while noting that "obtaining access to residential property for the placement of the additional monitoring wells could be a potentially complicating factor." During the period from November 2007 through March 2009, CRA, on behalf of Reynolds and Whirlpool, made several attempts to negotiate access agreements with private property owners for installation of the angled wells. In a letter dated June 1, 2009, CRA provided MPCA with documentation of the access negotiations. Despite reasonable efforts, access for the angled well installations could not be obtained.

In a letter dated September 8, 2009, the MPCA acknowledged the attempts made by Reynolds and Whirlpool to obtain access and stated:

> *"…at this time, the MPCA will not require the Responsible Parties to continue their attempts to obtain access to private parties in order to install the proposed angle monitoring wells, nor will the Agency use its statutory authorities, such as condemnation, to gain access to private properties along the western shore of Gilfillan Lake for the purpose of installing the proposed angle monitoring wells."*

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[1] As identified on Table 1 of MPCA's MDD Amendment dated August 26, 2008 (1,1,2-trichloroethene (TCE), vinyl chloride, trans-1,2-dichloroethene, 1,1-dichloroethane, benzene, toluene, and methyl ethyl ketone).

1.3.4.1 New Residential Well Installations

As stipulated in MDD Amendment 1, the MPCA-selected remedy, for homes within Operable Unit 4 that have been issued a well advisory by the MDH due to Listed VOCs, is provision of a new/deeper residential well in the Prairie du Chien aquifer.

To date (March 2020), MDH has only issued well advisories to three locations in Operable Unit 4 due to Listed VOCs: 13 West Shore Road (August 2007), 12 West Shore Road (December 2008), and 2 Heron Lane (November 2012). Whirlpool and Reynolds provided new/deeper replacement wells to each of these locations in accordance with the selected remedy. Although not required under MDD Amendment 1, Whirlpool and Reynolds voluntarily provided a new/deeper replacement well to 2 Hummingbird Hill even though a MDH well advisory was never issued. Detailed information regarding the replacement well installations is documented in Annual Monitoring Reports during the period from 2009 to 2013.

No MDH well advisories have been issued to homes within Operable Unit 4 since 2012.

1.3.4.2 Long-Term Groundwater Monitoring

The long-term groundwater monitoring network associated with Operable Unit 4 includes off-Site monitoring wells installed by the responsible parties, former residential wells that were converted to monitoring wells, and active residential wells (see Figure 1.4).

Off-Site Monitoring Wells

Eleven monitoring wells and one test extraction well have been installed off-Site to monitor groundwater conditions downgradient from the Highway 96 Site in the Glacial Drift/Lower Sand, St. Peter Sandstone, and Prairie du Chien aquifers. Groundwater samples are collected from these monitoring wells on an annual basis (see Table 1.1).

Converted Residential Monitoring Wells

Five former residential wells located east of Gilfillan Lake were converted to monitoring wells following installation of the municipal water system in 1994 (see Section 1.3.3). One of the converted residential monitoring wells (6 Wren Lane) was abandoned in May 2000 at the request of the property owner (with MPCA approval). The remaining four converted residential monitoring wells (6 Blue Goose Road, 1 Lily Pond Road, 11 Lily Pond Road, 11 Robb Farm Road) are monitored on an annual basis (see Table 1.1).

Active Residential Wells

From 2008 to 2019, residential well sampling was conducted in accordance with the monitoring program stipulated in MDD Amendment 1, which included 82 homes sampled on a semi-annual, annual, or biennial schedule.

Based on improved groundwater conditions reported over time (see Section 4.3.5), the MPCA determined that modifications to the sampling program were appropriate for monitoring potential long-term (chronic) exposure to low-level concentrations of VOCs in groundwater. The MPCA outlined their intended modifications in a second amendment to the MDD (MDD Amendment 2), which was issued draft for public comment on May 1, 2019. The MPCA held a public meeting on May 9, 2019 and accepted public comments through May 30, 2019.

The final version of MDD Amendment 2 was signed into effect on December 30, 2019. The modified (current) residential well monitoring program includes 70 homes that are sampled on an annual schedule or every five years (see Table 1.2).

2. Scope of the 2019 Annual Monitoring Report

The Annual Monitoring Report is prepared to report on required activities at the Site as described in the RAP, which include:

- A summary of groundwater elevation data
- A plot of the groundwater elevations for the perched groundwater system
- Groundwater elevation contours for the Lower Sand, St. Peter Sandstone, and Prairie du Chien aquifers
- A plot of total volatile organic compounds (TVOCs) with respect to time for selected wells
- A figure for each monitored groundwater unit showing TVOCs at each monitoring location
- An assessment of the monitoring parameters and sampling frequencies and recommendations for the addition or deletion of monitoring locations

3. Hydrogeologic Update

This section provides a hydrogeologic summary for the Site that includes 2019 groundwater elevation data and performance assessments of the extraction wells and the perched groundwater dewatering sump.

3.1 Geology

The near surface geology of the Site consists of unconsolidated glacial deposits overlying Paleozoic sedimentary bedrock. The topography of the Site is undulating, which is typical of a glacial terrain. The ground surface elevation ranges from 930 to 970 feet above mean sea level (AMSL).

The unconsolidated sediment is highly variable, ranging from clay to gravel size particles. This area has been defined as a complex intermixed deposit of glacial till with sandy loam and sandy clay loam (Ref. 16). The glacial deposit ranges in thickness from 50 to 150 feet.

The glacial deposits are typically underlain by the St. Peter Sandstone. However, erosional remnants of the younger Platteville Limestone and Glenwood Shale exist. The St. Peter Sandstone is classified as a white, fine to medium grained, well-sorted, silica sandstone. The St. Peter Sandstone ranges in thickness from 0 to 150 feet. A 13- to 20-foot thick shale layer separates the upper St. Peter Sandstone aquifer from the basal portion of the St. Peter Sandstone aquifer. The basal St. Peter Sandstone (Pigs Eye Member) is finer grained compared to the upper St. Peter Sandstone and is interbedded with siltstone and shale.

The St. Peter Sandstone is underlain by the Prairie du Chien Group. The Prairie du Chien Group consists of interbedded dolomitic limestone and sandstone. Regionally, the Prairie du Chien ranges in thickness from 0 to 250 feet.

Geologic cross-sections have been constructed west (A-A'), northwest (B-B'), and southwest (C-C') from the Site, through North Oaks (Appendix A). The cross-section lines are located on Figure 3.1. Geologic cross section A-A' extends from the Highway 96 Site westward across Gilfillan Lake through the Ski Lane Ravine area to the North Oaks Golf Course. Geologic cross-section B-B' extends from the Highway 96 Site northwest along Duck Pass Road on the northern shore of Gilfillan Lake. Geologic cross-section C-C' extends from the Dove Lane area (southwest of the Highway 96 Site) to the western shore of Gilfillan Lake.

3.2 Hydrogeology

There are four hydrostratigraphic units associated with the Site: perched groundwater, the unconsolidated glacial drift aquifer (Lower Sand aquifer), the St. Peter Sandstone aquifer, and the Prairie du Chien aquifer.

Groundwater elevations have been monitored at the Site since July 1987. A historical summary of groundwater elevations is presented in Appendix B. A summary of recent groundwater elevation measurements (collected October 23-24, 2019) is presented in Table 3.1.

A perched groundwater system is the uppermost water-bearing unit at the CWA. Perched groundwater units are topographically restricted and are typically associated with enclosed basins that collect surface runoff. The perched groundwater system at the CWA covers an area of approximately five acres and is likely influenced by the surface water and wetland areas located around the CWA.

Perched groundwater elevations historically have ranged from 909 feet to 945 feet AMSL. Groundwater flow within this unit is primarily downward to the Lower Sand aquifer. However, some horizontal migration does occur. October 2019 perched groundwater elevations are presented on Figure 3.2.

The Lower Sand aquifer is the uppermost aquifer across the Site. Groundwater is encountered within this unit at an approximate elevation of 900 feet AMSL. Regional groundwater flow within this unit is towards the west, except in areas affected by groundwater pumping. The hydraulic conductivity within the Lower Sand aquifer varies due to its heterogeneous nature and ranges from $2x10^{-3}$ cm/s to $4x10^{-5}$ cm/s. The average linear groundwater flow velocity is estimated to be 40 ft/yr (Ref. 4).

The St. Peter Sandstone aquifer is hydraulically connected to the overlying Lower Sand aquifer. The potentiometric surface of the St. Peter Sandstone aquifer is approximately 896 feet AMSL. Hence, a downward flow component exists between the Lower Sand and St. Peter Sandstone aquifers, under non-pumping conditions. Similar to the Lower Sand aquifer, groundwater flow within the St. Peter Sandstone aquifer is to the west, except in areas affected by groundwater pumping. In the vicinity of the Site, the average hydraulic conductivity of the upper portion of the St. Peter Sandstone aquifer is calculated at $5x10^{-3}$ cm/s. The average linear groundwater flow velocity for the upper portion of the St. Peter Sandstone aquifer in the vicinity of the Site is estimated at 80 ft/yr (Ref. 4).

October 2019 groundwater contours for the Lower Sand/St. Peter Sandstone aquifers on-Site are presented on Figure 3.3. The groundwater contours depict the hydraulic influence of the on-Site groundwater extraction system (see Section 3.3). Overall, groundwater elevations continue to reflect the heterogeneous nature of the Lower Sand aquifer. As noted on Figure 3.3, some Lower Sand aquifer monitoring locations (e.g., MW10D) are not used for groundwater contouring because they are screened in areas of low permeability soil (i.e., higher silt/clay content).

The St. Peter Sandstone can be divided into two stratigraphic sub-units immediately west of the Highway 96 Site: the upper St. Peter Sandstone and the basal St. Peter Sandstone. Lateral groundwater flow is towards the west for both the upper and basal portions of the St. Peter Sandstone aquifer. The basal St. Peter Sandstone aquifer has a lower permeability compared to the upper St. Peter Sandstone aquifer because it is interbedded with shale and siltstone. A 13 to 20-foot shale layer separates the upper and basal portions of the St. Peter Sandstone aquifer and acts as an aquitard.

October 2019 groundwater contours for the upper St. Peter Sandstone aquifer off-Site are presented on Figure 3.4. For the upper St. Peter aquifer, groundwater flow conditions are characterized by the St. Peter Sandstone monitoring wells at the Highway 96 Site along with off-Site monitoring wells located east of Gilfillan Lake (MW17A) and west of Gilfillan Lake (MW18A, MW19A, and MW21A).

October 2019 groundwater contours for the basal St. Peter Sandstone aquifer off-Site are presented on Figure 3.5. Groundwater flow conditions in the basal St. Peter Sandstone aquifer are characterized by off-Site monitoring wells (MW17B, MW18B, MW19B, and MW20B), converted residential monitoring wells located on the east side of Gilfillan Lake (1 Lily Pond, 11 Lily Pond, 6 Blue Goose and 11 Robb Farm Road), and two active residential wells located on the west side of Gilfillan Lake (6 West Shore Road and 38 East Oaks Road). Lateral groundwater flow in the basal St. Peter Sandstone aquifer is approximately 10 times slower than in the upper St. Peter Sandstone aquifer.

October 2019 groundwater contours for the Prairie du Chien aquifer off-Site are presented on Figure 3.6. Groundwater flow conditions in the Prairie du Chien aquifer are characterized by off-Site monitoring wells MW17L, MW18L, and MW19L. Lateral groundwater flow in the Prairie du Chien aquifer is regionally toward the west (Ref. 17). The Prairie du Chien aquifer underlies the basal St. Peter Sandstone aquifer. The Prairie du Chien has a higher hydraulic conductivity compared to the St. Peter Sandstone, which is attributed to its high fracture density. Based on single well response test data, the hydraulic conductivity of the Prairie du Chien aquifer ranges from 0.03 cm/s to 0.07 cm/s (72 ft/d to 187 ft/d) (Ref. 12), which is comparable to known published values. Applying a regional hydraulic gradient of 0.001 ft/ft and an effective porosity of 0.056 (Ref. 17), the groundwater flow velocity in the Prairie du Chien ranges from 470 to 1,220 ft/yr. This range of flow velocity is attributed to the varying degrees of fractures present in the Prairie du Chien aquifer.

3.3 Groundwater Extraction System Performance Assessment

Since June 1989, operation of an on-Site groundwater extraction system in the Lower Sand/St. Peter Sandstone aquifers has prevented migration of VOCs from the Site. In addition to providing hydraulic containment, the groundwater extraction system removes VOCs from the Lower

Sand/St. Peter Sandstone aquifers. The extracted groundwater is discharged directly into the sanitary sewer under a MCES special discharge permit.

3.3.1 Extraction Well Network

Hydraulic containment and VOC removal associated with the groundwater extraction system has been achieved through operation of the following extraction wells:

EW1

- Installed in 1989 (Lower Sand aquifer)
- Replaced in 2005 by EW2 (see below)
- Currently used only for hydraulic monitoring

EW1A

- Installed in 1995 (Lower Sand aquifer) to supplement EW1
- Replaced in 2010 by EW1B (see below)
- Currently used only for hydraulic monitoring

EW2

- Installed in 2005 (Upper St. Peter Sandstone aquifer) to replace EW1
- Current/active pumping well (see Tables 3.2 and 3.3 for 2019 operation information)

EW1B

- Installed in 2010 (Lower Sand aquifer) to replace EW1A
- Current/active pumping well (see Tables 3.2 and 3.3 for 2019 operation information)

The gradual decline of the pumping capacity at the original extraction well (EW1) had been noted in previous annual monitoring reports. The decline of EW1 was attributed to iron fouling and possible deterioration of the well casing. The decline was expected to continue and the need for a replacement well was inevitable in order to maintain flexibility within the groundwater extraction system and ensure hydraulic containment. A new extraction well (EW2) was installed in September 2005 and began operation in January 2006, replacing EW1. A hydraulic response to pumping at EW2 was observed in both the Lower Sand and St. Peter Sandstone aquifers and the installation and operation of EW2 met MPCA's requirements with respect to pumping rate and effluent water quality. Installation and performance testing results were presented to MPCA in February 2006 (Ref. 11).

After 15 years of operation, EW1A productivity declined due to bio-fouling of the well screen and surrounding formation. As noted in previous annual monitoring reports, numerous well rehabilitation events had been performed to address the fouling issues and reestablish productivity at EW1A. In 2009, EW1A showed minimal improvement to rehabilitation efforts. Continued groundwater extraction from the Lower Sand aquifer is needed to maintain a factor of safety in hydraulic capture and provide operational flexibility in the extraction system (i.e., avoid sole reliance on EW2). Therefore, CRA proposed to replace EW1A with a new extraction well (EW1B). In February 2010, CRA submitted a Work Plan to MPCA for installation of a new/replacement extraction well (Ref. 18). MPCA approved the Work Plan, with comments on March 10, 2010. The new extraction well (EW1B) was installed in April 2010 and began operation in May 2010, replacing EW1A. A hydraulic response to combined pumping at EW1B and EW2 was observed in both the Lower Sand and St. Peter Sandstone aquifers. Installation and performance testing results were presented to MPCA in July 2010 (Ref. 19).

EW1B and EW2 operation and maintenance activities conducted in 2019 are summarized in Table 3.2.

3.3.2 Extraction System Operation

In 2019, EW1B and EW2 operated at a combined average pumping rate of 19.4 gpm. The 2019 average monthly extraction rates for EW1B and EW2 are summarized in Table 3.3.

3.3.3 VOC Removal

From January 1, 2019 through December 31, 2019, approximately 4.5 million gallons of groundwater were extracted by EW1B, removing approximately 4.5 pounds of VOCs from the Lower Sand/St. Peter Sandstone aquifers. Since 1989, approximately 196 pounds of VOCs have been removed by EW1/EW1A/EW1B.

From January 1, 2019 through December 31, 2019, approximately 5.7 million gallons of groundwater were extracted by EW2, removing approximately 3.4 pounds of VOCs from the Lower Sand/St. Peter Sandstone aquifers. Since 2006, approximately 35 pounds of VOCs have been removed by EW2.

Since 1989, a combined total of approximately 342 million gallons of groundwater and 230 pounds of VOCs have been removed from the Lower Sand/St. Peter Sandstone by EW1/EW1A/EW1B and EW2. Figure 3.7 illustrates historical VOC mass removal (per year), Figure 3.8 illustrates historical VOC removal efficiency (in pounds per million gallons), and Figure 3.9 illustrates cumulative VOC mass removal since 1989.

Figure 3.10 shows historic TVOC concentrations over time for EW1/EW1A/EW1B and EW2. As typically seen in groundwater extraction systems, TVOCs declined during the initial pumping years of 1989 through 1996 at EW1/EW1A. From 1996 through 2005, TVOCs remained at levels between 50 and 100 µg/L. In 2006, TVOCs began increasing to levels between 100 µg/L and 300 µg/L. The increase in TVOC concentrations at EW1A/EW1B was almost entirely due to increased 1,1,2-trichloroethene (TCE) concentrations. The increased TCE concentrations are likely attributed to a combination of delayed migration from the CWA and changes in the volume of groundwater extracted from the Lower Sand aquifer.

Delayed migration refers to the later release of VOCs to the Lower Sand aquifer. The CWA is located above a perched groundwater unit that is hydraulically isolated from the regional water table aquifer such that the downward migration of VOCs to the water table aquifer occurs through a zone of partially saturated soil. The rate of downward migration through this partially saturated zone is substantially less than under saturated soil conditions and is dependent on several variable parameters, such as moisture content, soil permeability, and pressure head. Hence, the downward migration rate and time required to reach the water table aquifer can vary both spatially and temporally underneath the CWA.

The total volume of groundwater extracted from the Lower Sand aquifer (EW1A/EW1B) has fluctuated in conjunction with combined groundwater extraction from the upper St. Peter Sandstone aquifer (EW2), which began in 2006. TCE concentrations in the Lower Sand aquifer increased following commission of EW2 and as production decreased at EW1A due to bio-fouling issues (see Section 3.3.1). TCE concentrations in the Lower Sand aquifer have generally decreased since commission of EW1B in May 2010, with the exception of increased concentrations observed in October 2011 when EW1B was temporarily shut down for repair. TCE has not been observed in monitoring locations downgradient of the extraction system.

3.3.4 Hydraulic Containment

A groundwater capture analysis was presented in CRA's July 2010 report (Ref. 19). Based on aquifer testing results referenced in the report, CRA recommended that the groundwater extraction system (EW1B and EW2) should operate at a combined pumping rate between 13 and 20 gpm to obtain a groundwater capture width of 200-300 ft and achieve sufficient hydraulic containment to prevent migration of VOCs from the Site. Based on the 2019 combined average pumping rate of 19.4 gpm (see Table 3.3), the groundwater capture width in the Lower Sand aquifer and the upper portion of the St. Peter Sandstone aquifer is approximately 300 feet (measured at the pumping source). Groundwater elevation measurements collected on October 23-24, 2019 provide verification of hydraulic containment of the VOC plume (see Figure 3.3).

Groundwater analytical results also provide verification of hydraulic containment. Figure 3.11 presents a cross-section of the groundwater extraction system and depicts subsurface conditions along with 2019 groundwater sampling results for vinyl chloride. As shown on Figure 3.11, the groundwater extraction system captures contaminated groundwater from upgradient areas (e.g., as screened by monitoring wells MW4D and MW8B) and the effectiveness of the system is confirmed by low to non-detectable VOC concentrations at downgradient compliance wells and converted residential monitoring wells located east of Gilfillan Lake (see Section 4.3).

3.3.5 Pore Volume Exchanges

The number of pore volume exchanges since operation of the groundwater extraction began in 1989 can be estimated based on an assumed contaminated aquifer volume. The area would encompass the CWA from EW1/EW1A/EW1B/EW2 to P3 in an east-west direction (500 feet) and MW1D to P4 in a north-south direction (450 feet). Assuming an aquifer thickness of 60 feet and a porosity of 30 percent, the aquifer volume would be 4,050,000 ft^3, or approximately 30 million gallons. Since 1989, a combined total of approximately 342 million gallons of groundwater have been removed, which is equivalent to approximately 11.4 pore volume exchanges.

4. Groundwater Assessment

Groundwater sampling associated with the Highway 96 Site has been ongoing since 1986. A total of 82 rounds of groundwater sampling have been conducted at a combination of on-Site monitoring wells, off-Site monitoring wells, converted residential monitoring wells, and active residential wells. A summary of historical groundwater sampling events is provided in Table 4.1.

Groundwater sampling events conducted during 2019 are summarized in the following paragraphs.

July 2019 - Residential Well Sampling Event

During the period from July 29-30, 2019, 26 residential wells were sampled in general accordance with the long-term monitoring program approved by the MPCA on November 7, 2007 and as proposed in GHD's letter to MPCA dated July 22, 2019. A complete description of the July 2019 residential well sampling event and the associated analytical results was previously submitted to the MPCA in GHD’s " July 2019 Residential Well Data Report", dated August 16, 2019.

November 2019 - Residential Well Sampling Event

During the period from November 18-26, 2019 , 63 residential wells were sampled in general accordance with the long-term monitoring program approved by the Minnesota Pollution Control Agency (MPCA) on November 7, 2007 and as proposed in GHD's letter to the MPCA dated October 28, 2019. A complete description of the November 2019 residential well sampling event and the associated analytical results was previously submitted to the MPCA in GHD's November 2019 Residential Well Data Report", dated January 31, 2020.

2019 - Annual Monitoring Well Sampling Event

During the period from October 23, 2019 through December 6, 2019, on-Site and off-Site monitoring wells and the converted residential monitoring wells were sampled as part of the Annual Monitoring Well Sampling Program. A sampling summary associated with the 2019 Annual Monitoring Well Sampling Event is presented in Appendix C.

4.1 Summary of Site Action Levels

Two sets of Site action levels are used to evaluate groundwater data associated with the Highway 96 Site: Site Cleanup Goals (SCGs) and Health Risk Limits (HRLs).

4.1.1 Site Cleanup Goals (SCGs)

SCGs are established in Amended Table 1 of the 1993 MDD and apply to compliance monitoring wells in Operable Unit 2. The 1993 MDD originally stipulated that SCGs applied to all current and future groundwater monitoring points on the Site (defined as all wells east of Robb Farm Road). Since 1993, the list of monitoring points where SCGs apply has been modified by MPCA. The current list of Operable Unit 2 compliance monitoring wells where SCGs apply includes: MW10B, MW12B, MW12D, MW13B, MW13D, MW16B, and MW16D. The list of SCGs (Amended Table 1 of the 1993 MDD) is provided in Appendix D.1.

In May 2010, Wenck Associates (on behalf of the City of North Oaks) requested that this section of the Annual Monitoring Report include clarification provided by MPCA in a letter dated

August 26, 2009 regarding the rationale for the selection of the SCG for vinyl chloride. In their letter dated August 26, 2009, the MPCA stated:

> *"Groundwater cleanup levels in the original Table 1 of the October 7, 1993 MDD included the Minnesota Department of Health (MDH) Recommended Allowable Limit (RAL) for vinyl chloride of 0.1 µg/L. After submitting a Response Action Plan on January 26, 1994, the RPs took the position that the cleanup level for vinyl chloride was unattainable using a groundwater extraction/containment-type technology. On March 25, 1994, MPCA staff met with the RPs, and agreed to re-examine the cleanup level for vinyl chloride. On April 13, 1994, Whirlpool and Reynolds proposed an amended cleanup level for vinyl chloride of 2 µg/L that was based on a technical rationale (i.e., Site specific information). The technical rationale was based, in part, on the observed attenuation of 1,1-dichloroethane (1,1-DCA), another contaminant of concern at the Site, versus migration distance from the Site and on the assumption that the attenuation of vinyl chloride would parallel that of 1,1-DCA. This rationale predicted that a vinyl chloride concentration of 2 µg/L at the Site would attenuate to less than 0.03 µg/L at the west shore of Gilfillan Lake. On October 3, 1994, after several meetings and discussions with the RPs, the MPCA concluded that a cleanup level of 2 µg/L for vinyl chloride "[was] protective of human health, welfare and the environment, and [did] not allow for further degradation of the groundwater resources of the area." The MPCA agreed to change the Site cleanup level for vinyl chloride to 2 µg/L, following the execution of the Consent Order (CO). The CO, which included the MDD with amended Table 1 as Exhibit A, was executed on January 9, 1995."*

4.1.2 Health Risk Limits (HRLs)

HRLs apply to residential wells in Operable Unit 4, as stipulated in Table 1 and Sections 2.2 and 6.0 of MDD Amendment 1. Specifically, Section 2.2 of MDD Amendment 1 states "(the) HRL is the cleanup standard used by the MPCA for vinyl chloride for OU4". Operable Unit 4 is defined as residential areas without municipal water, as shown on Figure 1 of MDD Amendment 1. Excerpts from MDD Amendment 1 (including Table 1 and Figure 1) are provided in Appendix D.2.

Since MDD Amendment 1 was issued, the MDH has repealed or promulgated new HRLs for six of the seven Listed VOCs as summarized below:

- Benzene [2009 HRL - 2 µg/L; previous HRL - 5 µg/L]
- Vinyl Chloride [2018 HRL – 0.2 µg/L; previous HRL 0.2 µg/L (no change)]
- Toluene [2011 HRL - 200 µg/L; previous HRL - 1,000 µg/L]
- trans-1,2-Dichloroethene [2013 HRL - 40 µg/L; previous HRL - 100 µg/L]
- 1,1-Dichloroethane [HRL repealed in 2015]
- TCE [2015 HRL - 0.4 µg/L; previous HRL - 5 µg/L]

Since MDD Amendment 1 was issued, the MDH has issued new Health Based Guidance (HBG) in the form of Health Based Values (HBVs) or Risk Assessment Advice (RAA) for two of the seven Listed VOCs as summarized below:

- 1,1-Dichloroethane [2016 RAA - 80 µg/L; previous HRL (1993) - 70 µg/L repealed in 2015]
- Toluene [2019 HBV – 70 µg/L; current HRL (2011) – 200 µg/L]

HBVs are developed as interim guidance until they are promulgated as new HRLs through formal rulemaking. RAAs may be based on more limited data than HRLs, or may use new methodology. Where multiple HBG criteria are available, the lowest criterion is used for screening purposes.

Laboratory reporting limits are reviewed on a semi-annual basis (and adjusted, if necessary) to ensure they remain inclusive of any new HBVs/RAAs that are issued or new HRLs that have been promulgated for Listed VOCs.

Status of MDH HRL Rule Revision for Vinyl Chloride

In a letter from CRA to MPCA dated July 26, 2007, Whirlpool and Reynolds made the commitment to include as part of the Highway 96 Site Annual Monitoring Report, a status update on the MDH HRL Rule Revision for vinyl chloride.

- The original HRL for vinyl chloride (0.2 µg/L) was established by the MDH in 1993/1994.
- In December 2004, the MDH proposed a draft revised HRL for vinyl chloride (0.08 µg/L), as part of the 2004 Draft HRL Rule Revision.
- In April 2007, the MDH withdrew the proposed draft revised HRL for vinyl chloride.
- In September 2007, the MDH recommended that the HRL for vinyl chloride be included on the list of compounds to be reviewed as part of the Draft HRL Rule Revision.
- In February 2008, MDH completed their review of the HRL for vinyl chloride and proposed that the HRL remain at 0.2 µg/L (no change).
- In July 2008, MDH posted a draft of the Proposed HRL Rule Revision and Statement of Need and Reasonableness (SONAR), a technical document explaining and supporting the revised Rules.
- In September 2008, a copy of the July 2008 Proposed HRL Rule Revision was published in the State Register.
- In October 2008, a public hearing on the July 2008 Proposed HRL Rule Revision was held before an Administrative Law Judge. The hearing was followed by a 20-day comment period (ending October 30, 2008) and a five-day rebuttal period (ending November 6, 2008).
- In April 2009, the July 2008 Proposed HRL Rule Revision was adopted (Minnesota Administrative Rules Parts 4717.7810 through 4717.7900).
- The 2009 HRL for vinyl chloride was established as 0.2 µg/L (no change).
- In March 2017, the MDH issued new HBVs for vinyl chloride. HBVs were established for multiple exposure duration categories (e.g., acute, chronic). The exposure category with the lowest HBV was cancer (0.2 µg/L) which is equal to the 2009 HRL (no change).

- In August 2018, the MDH promulgated new HRLs for vinyl chloride, replacing the previous 2009 HRL. The exposure category with the lowest HRL was cancer (0.2 µg/L) which is equal to the previous HRL (no change).

Specific information regarding the MDH HRL Rule Revision can be obtained by contacting the MDH or by visiting the MDH website:

https://www.health.state.mn.us/communities/environment/risk/guidance/gw/table.html

4.2 Historical Overview of Groundwater Data

Groundwater analytical laboratory data are validated for quality assurance by GHD and compiled into a computer database for the purpose of data management and reporting. Groundwater data are managed according to five groundwater units/groupings:

- Perched groundwater unit
- Lower Sand aquifer
- St. Peter Sandstone aquifer
- Prairie du Chien aquifer
- Residential wells

A historical data summary, which identifies chemical concentrations of VOCs over time at each monitoring location, is presented in Appendix E. Historical VOC data for the current compliance monitoring wells (MW10B, MW12B, MW12D, MW13B, MW13D, MW16B, and MW16D) are provided in Appendix E.1. Historical VOC data for all other monitoring wells are provided in Appendix E.2. Historical VOC data for residential wells are presented in Appendix E.3.

A series of graphs showing historical TVOC concentrations for select wells representing each groundwater unit are presented on Figure 3.10 and Figures 4.1 through 4.10.

TVOC concentrations in the perched groundwater unit are represented by LW3 (Figure 4.1).

- LW3 data represent perched groundwater conditions beneath the limits of the CWA. Figure 4.1 illustrates TVOC concentrations in the perched groundwater unit decreasing from 1987 through 1991, and remaining relatively stable and less than 50 µg/L since 2001. In 2019, the TVOC concentration at LW3 was 11.25 µg/L.

TVOC concentrations in the Lower Sand aquifer are represented by MW4D (Figure 4.2), EW1/EW1A/EW1B (Figure 3.10), and MW12D (Figure 4.3).

- MW4D data represent groundwater conditions in the Lower Sand aquifer immediately downgradient of the CWA. Figure 4.2 illustrates TVOC concentrations at MW4D decreasing from 1987 through 1991, and ranging from 50 µg/L to 500 µg/L since 1991. In 2019, the TVOC concentration at MW4D was 362.60 µg/L.
- EW1/EW1A/EW1B data represent groundwater from the Lower Sand and St. Peter Sandstone aquifers that is captured by the extraction system. Figure 3.10 illustrates TVOC concentrations at EW1/EW1A/EW1B (see Section 3.3).

- MW12D is a compliance well located between the extraction system and Robb Farm Road. MW12D data represent groundwater conditions in the Lower Sand aquifer immediately downgradient of the extraction system. Figure 4.3 illustrates TVOC concentrations at MW12D, which have historically remained below 3 µg/L since 1997. In October 1996, the TVOC concentration was near 400 µg/L. That sample result is considered anomalous because TVOC concentrations were not observed at or near that level prior to or after that sample date. In 2019, no VOCs were detected at MW12D.

TVOC concentrations in the St. Peter Sandstone aquifer, are represented by MW8B (Figure 4.4), EW2 (Figure 3.10), MW12B (Figure 4.5), and the four converted (former) residential monitoring wells (Figures 4.6 through 4.9).

- MW8B is located between the CWA and the groundwater extraction system. MW8B data represent groundwater conditions in the St. Peter Sandstone aquifer immediately downgradient of the CWA. Figure 4.4 illustrates TVOC concentrations at MW8B, which have ranged from 1 µg/L to 300 µg/L since sampling began in 1987. TVOC concentrations at MW8B have remained below 100 µg/L since the commission of extraction well EW2 in January 2006. In 2019, the TVOC concentration at MW8B was 68.15 µg/L.
- EW2 data represent groundwater from the Lower Sand and St. Peter Sandstone aquifers that is captured by the extraction system. EW2 was installed in September 2005 and commissioned in January 2006. Figure 3.10 illustrates TVOC concentrations at EW2 (see Section 3.3).
- MW12B is a compliance well located between the extraction system and Robb Farm Road. MW12B data represent groundwater conditions in the St. Peter Sandstone aquifer immediately downgradient of the extraction system. Figure 4.5 illustrates TVOC concentrations at MW12B, which have historically remained below 6 µg/L since 1997. In 2019, the TVOC concentration at MW12B was 0.19 µg/L.
- Data from the four converted residential monitoring wells represent groundwater conditions in the St. Peter Sandstone aquifer further downgradient of the Highway 96 Site. Figure 4.6 illustrates that TVOC concentrations at 11 Robb Farm Road decreased from 1989 through 1992 and have remained relatively stable (below 10 µg/L) since 1990. In 2019, the TVOC concentration at 11 Robb Farm Road was 0.26 µg/L. Figure 4.7 illustrates that TVOC concentrations at 1 Lily Pond Road have fluctuated between not detected and 30 µg/L since sampling began in 1990. In 2019, the TVOC concentration at 1 Lily Pond Road was 9.80 µg/L. Figure 4.8 illustrates that TVOC concentrations at 11 Lily Pond Road have typically remained below 5 µg/L since 1996. In 2019, no VOCs were detected at 11 Lily Pond Road. Figure 4.9 illustrates that TVOC concentrations at 6 Blue Goose Road have remained below 5 µg/L since 1997. In 2019, no VOCs were detected at 6 Blue Goose Road. The overall decline of TVOC concentrations at the four converted residential well locations can be attributed to Site remediation activities and natural attenuation.

TVOC concentrations in the Prairie du Chien aquifer are represented by MW17L (Figure 4.10).

- MW17L data represent groundwater conditions in the Prairie du Chien aquifer downgradient of the Highway 96 Site. Figure 4.10 illustrates that TVOC concentrations at MW17L have remained below 10 µg/L since sampling began at this location in 2005. In 2019, no VOCs were detected at MW17L.

TVOC concentrations in each groundwater unit will continue to be evaluated through future groundwater monitoring.

4.3 2019 Data Presentation

Laboratory analytical reports for samples collected in 2019 are presented in Appendix F. Analytical data was reviewed by the GHD quality control/quality assurance (QA/QC) officer. Data quality assessment and validation memos are also presented in Appendix F.

Analytical results for 2019 groundwater samples collected from the perched groundwater unit, Lower Sand aquifer, St. Peter Sandstone aquifer, and Prairie du Chien aquifer monitoring wells are presented in Tables 4.2 through 4.5, respectively. Analytical results for 2019 groundwater samples collected from residential wells are presented in Table 4.6.

To illustrate the analytical results, Figures 4.11 through 4.16 show the distribution of TVOCs detected in 2019 groundwater samples collected from the perched groundwater unit, Lower Sand aquifer, St. Peter Sandstone aquifer (on-Site monitoring wells), St. Peter Sandstone aquifer (off-Site monitoring wells), Prairie du Chien aquifer, and in residential wells, respectively.

4.3.1 Perched Groundwater Unit

Six perched groundwater wells (LW1, LW2, LW3, MW1S, MW4U, and the Sump) were sampled in 2019. Perched groundwater analytical results from 2019 are presented in Table 4.2 and on Figure 4.11. Historical perched groundwater VOC results are presented in Appendix E.2.

Compliance Monitoring Wells

None of the perched groundwater monitoring well locations are included in the current list of compliance monitoring wells.

Other Monitoring Wells

VOCs detected in 2019 groundwater samples collected from the perched groundwater unit include: 1,1-dichloroethane, 1,2-dichloroethane, acetone, benzene, chloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, dichlorofluoromethane, ethyl ether, ethylbenzene, isopropylbenzene, toluene, trans-1,2-dichloroethene, TCE, vinyl chloride, and total xylenes. Detections of these VOCs are generally consistent with historical sampling results.

For comparison purposes, vinyl chloride was the only VOC detected above its SCG in perched groundwater monitoring well samples collected in 2019. *[Note: SCGs are established for compliance wells only.]* In 2019, vinyl chloride was detected above its SCG (0.2 µg/L) at MW4U (6.3 µg/L). Monitoring well MW4U is located between the CWA and the groundwater extraction system and represents perched groundwater conditions immediately downgradient of the CWA.

The 2019 chloride concentrations in the perched groundwater unit ranged from 1.4 mg/L (LW1) to 140 mg/L (MW4U). Chloride has historically been detected in groundwater samples from perched groundwater monitoring wells at concentrations within this range.

4.3.2 Lower Sand Aquifer

Eight Lower Sand aquifer monitoring wells (EW1B, MW1D, MW4S, MW4D, MW11D, MW12D, MW13D, and MW16D) were sampled in 2019. Monitoring well MW10D was inaccessible and could not be sampled (see Appendix C). Lower Sand aquifer analytical results from 2019 are presented in Table 4.3 and on Figure 4.12. Historical Lower Sand aquifer VOC results at the current compliance monitoring wells and other monitoring wells are presented in Appendix E.1 and Appendix E.2, respectively.

4.3.2.1 Compliance Monitoring Wells

The Lower Sand aquifer compliance monitoring wells (MW12D, MW13D, and MW16D) are located on Site, near the east side of Robb Farm Road and represent Lower Sand aquifer groundwater conditions immediately downgradient of the on-Site extraction system. VOCs detected in 2019 in Lower Sand aquifer compliance well samples include: 1,1-dichloroethane, benzene, and cis-1,2-dichloroethene. All 2019 VOC detections from the Lower Sand aquifer compliance monitoring wells were below their respective SCGs.

4.3.2.2 Other Monitoring Wells

The remaining Lower Sand aquifer monitoring wells (EW1B, MW1D, MW4D, MW4S, MW10D, and MW11D) are also located between the CWA and Robb Farm Road. VOCs detected in 2019 in the other Lower Sand aquifer monitoring well samples include: 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, benzene, chloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, dichlorofluoromethane, ethyl ether, tetrachloroethene, toluene, trans-1,2-dichloroethene, TCE, vinyl chloride, and total xylenes. Detections of these VOCs are generally consistent with historical sampling results.

For comparison purposes, 1,1-dichloroethane, 1,2-dichloroethane, benzene, TCE, and vinyl chloride were the only VOCs detected above their respective SCGs in non-compliance Lower Sand aquifer groundwater monitoring well samples collected in 2019 *[Note: SCGs are established for compliance wells only.]* In 2019, 1,1-dichloroethane was detected above its SCG (70 µg/L) at MW4D (120µg/L), 1,2-dichloroethane was detected above its SCG (4 µg/L) at MW4D (10 µg/L), benzene was detected above its SCG (5 µg/L) at MW4D (6.3 µg/L), TCE was detected above its SCG (5 µg/L) at EW1B (maximum concentration reported was 110 µg/L), and vinyl chloride was detected above its SCG (2 µg/L) at EW1B (maximum concentration reported was 10.0 µg/L), MW4D (30 µg/L), and MW4S (10 µg/L). Monitoring wells MW4D and MW4S are located between the CWA and the groundwater extraction system and represents Lower Sand aquifer groundwater conditions immediately downgradient of the CWA, prior to capture by the extraction system. EW1B represents groundwater from the Lower Sand and St. Peter Sandstone aquifers that is captured by the extraction system.

The 2019 chloride concentrations in the Lower Sand aquifer ranged from 30 mg/L (MW11D) to 270 mg/L (MW4D). Chloride has historically been detected in groundwater samples from Lower Sand aquifer wells at concentrations below 1,000 mg/L.

4.3.3 St. Peter Sandstone Aquifer

Nineteen St. Peter Sandstone aquifer monitoring wells (MW8B, MW10B, MW12B, MW13B, MW16B, MW17A, MW17B, MW18A, MW18B, MW19A, MW19B, MW20B, MW21A, EW2, EW3, and the four converted residential monitoring wells) were sampled in 2019. St. Peter Sandstone aquifer analytical results from 2019 are presented in Table 4.4 and on Figure 4.13 (on-Site monitoring locations) and Figure 4.14 (off-Site monitoring locations). Historical St. Peter Sandstone aquifer VOC results at the current compliance monitoring wells, and other monitoring wells are presented in Appendix E.1 and Appendix E.2, respectively.

4.3.3.1 Compliance Monitoring Wells

The St. Peter Sandstone aquifer compliance monitoring wells (MW10B, MW12B, MW13B, and MW16B) are located on Site, near the east side of Robb Farm Road and represent St. Peter Sandstone aquifer groundwater conditions immediately downgradient of the on-Site extraction system. VOCs detected in 2019 in the St. Peter Sandstone aquifer compliance well samples include: 1,1-dichloroethane. All 2019 VOC detections from the St. Peter Sandstone aquifer compliance monitoring wells were below their respective SCGs.

4.3.3.2 Other Monitoring Wells

The remaining St. Peter Sandstone aquifer monitoring wells are located both on Site and off Site.

On-Site St. Peter Sandstone Aquifer Monitoring Wells

St. Peter Sandstone aquifer monitoring wells MW8B and EW2 are located on Site. MW8B is located between the CWA and the groundwater extraction system, and represents St. Peter Sandstone aquifer groundwater conditions immediately downgradient of the CWA and prior to capture by the groundwater extraction system. EW2 represents groundwater from the St. Peter Sandstone aquifer that is captured by the extraction system.

VOCs detected in 2019 samples collected from MW8B and EW2 include: 1,1-dichloroethane, 1,2-dichloroethane, benzene, chloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, dichlorofluoromethane, ethylbenzene, toluene, trans-1,2-dichloroethene, TCE, vinyl chloride, and total xylenes. Detections of these VOCs are generally consistent with historical sampling results.

For comparison purposes, TCE and vinyl chloride were the only VOCs detected above their SCG in on-Site, non-compliance St. Peter Sandstone aquifer monitoring well samples collected in 2019. *[Note: SCGs are established for compliance wells only.]* In 2019, vinyl chloride was detected above its SCG (2 µg/L) at EW2 (maximum concentration reported was 15 µg/L) and MW8B (5.7 µg/L). TCE was detected above its SCG (5 µg/L) at EW2 (maximum concentration reported was 5.6 µg/L)

The 2019 chloride concentrations in on-Site St. Peter Sandstone aquifer monitoring wells ranged from 1.3 mg/L (MW10B) to 52 mg/L (EW2). Chloride has historically been detected in groundwater samples from on-Site St. Peter Sandstone aquifer wells at similar concentrations.

Off-Site St. Peter Sandstone Aquifer Monitoring Wells

St. Peter Sandstone aquifer monitoring wells MW17A, MW17B, MW18A, MW18B, MW19A, MW19B, MW20B, MW21A, EW3, and the four converted residential monitoring wells (6 Blue Goose Road, 1 Lily Pond Road, 11 Lily Pond Road, and 11 Robb Farm Road) are located off-Site and represent groundwater conditions in the St. Peter Sandstone aquifer, further downgradient of the Highway 96 Site.

VOCs detected in 2019 in the St. Peter Sandstone aquifer samples collected from off-Site monitoring locations include: 1,1-dichloroethane, dichlorodifluoromethane, and vinyl chloride. Detections of these VOCs are generally consistent with historical sampling results.

For comparison purposes, vinyl chloride was the only VOC detected above its MDH HBG in off-Site, non-compliance St. Peter Sandstone monitoring wells. *[Note: HBGs are established for private drinking water supplies only.]* In 2019, vinyl chloride was detected above its MDH HBG (0.2 µg/L) at MW17B (0.27 µg/L). Since 2005, the concentration of vinyl chloride in the St. Peter Sandstone aquifer on the east side of Gilfillan Lake, as represented by MW17A/MW17B, has ranged from non-detect to 1.2 µg/L (see Appendix G), which is generally lower compared to historical sampling results from 1993/1994 in the 15 Gilfillan Road/17 Gilfillan Road/8 Edgewater Lane area. The lower vinyl chloride concentrations are attributed to Site remediation activities and natural attenuation.

The 2019 chloride concentrations in off-Site St. Peter Sandstone aquifer monitoring wells ranged from 6.2 J mg/L (11 Lily Pond Road) to 133 J mg/L (MW17A). Chloride has historically been detected in groundwater samples from off-Site St. Peter Sandstone aquifer wells at similar concentrations.

4.3.4 Prairie du Chien Aquifer

Three Prairie du Chien aquifer monitoring wells (MW17L, MW18L, and MW19L) were sampled in 2019. Prairie du Chien aquifer analytical results from 2019 are presented on Table 4.5 and Figure 4.15. Historical Prairie du Chien aquifer VOC results are presented in Appendix E.2.

Compliance Monitoring Wells

No Prairie du Chien aquifer monitoring wells are included in the current list of compliance monitoring wells.

Other Monitoring Wells

MW17L, MW18L, and MW19L are located off-Site and represent groundwater conditions in the Prairie du Chien aquifer, downgradient of the Highway 96 Site. In 2019, no VOCs were detected in the Prairie du Chien aquifer monitoring wells, which is generally consistent with historical sampling results.

Analytical results from MW17L, MW18L, and MW19L show that the Prairie du Chien aquifer is not impacted and continues to represent a suitable alternative water supply for the MPCA-selected remedy outlined in MDD Amendment 1 (i.e., installation of new/deeper wells for homes located in Operable Unit 4 that are issued a well advisory due to Listed VOCs).

The 2019 chloride concentrations in the Prairie du Chien aquifer ranged from 21.6 J mg/L (MW18L) to 28.6 mg/L (MW19L). Chloride has historically been detected in groundwater samples from Prairie du Chien aquifer wells at similar concentrations.

4.3.5 Residential Wells

A total of 98 groundwater samples were collected from 66 residential well locations in 2019. Residential well analytical results from 2019 are presented in Table 4.6 and on Figure 4.16. Historical residential well VOC results are presented in Appendix E.3.

In 2019, vinyl chloride was not detected at any residential well location. The last reported detection of vinyl chloride in a residential well was in April 2014.

Figure 4.17 presents the maximum vinyl chloride concentrations detected in off-Site monitoring well locations and residential wells in 2019. As shown on Figure 4.17, vinyl chloride was not detected at any residential well and was detected at one off-Site monitoring well location (east of Gilfillan Lake) in 2019 (see Section 4.3.3).

Residential well sampling conducted during the period from October 2004 through November 2019 of over 80 residential wells located in the southeast portion of North Oaks has shown that the number of residential wells west of Gilfillan Lake that have ever had detectable concentrations of vinyl chloride is limited to ten locations:

- 50 East Oaks Road (last detected in April 2014)
- 2 Heron Lane (last detected in February 2013; well advisory issued by MDH; well abandoned/replaced with a new/deeper well by the RPs.)
- 3 Heron Lane (last detected in May 2012; not part of the long-term groundwater monitoring program for Operable Unit 4; at the direction of the MPCA, supplemental sampling was initiated in 2012 following the detection of vinyl chloride at 2 Heron Lane and discontinued in 2018 following six subsequent sampling events with no detections)
- 1 Hummingbird Hill (last detected in May 2013)
- 2 Hummingbird Hill (last detected in September 2009; well abandoned and replaced with a new/deeper well by the RPs.)
- 10 West Shore Road (last detected in April 2014)
- 11 West Shore Road (last detected in April 2014)
- 12 West Shore Road (last detected in August 2010; well advisory issued by MDH; well abandoned and replaced with a new/deeper well by the RPs.)
- 13 West Shore Road (last detected in March 2009; well advisory issued by the MDH; well abandoned and replaced with a new/deeper well by the RPs.)
- 15 West Shore Road (last detected in April 2014)

Graphs of historical vinyl chloride concentrations for off-Site monitoring well locations and the above-referenced residential wells where vinyl chloride has been detected are presented in Appendix G.

VOCs detected in the residential well samples collected in 2019 include: 1,1-dichloroethane and dichlorodifluoromethane. All detected concentrations were below their respective HBGs for private water supplies.

The 2019 chloride concentrations in the residential wells ranged from 1.8 mg/L (1 Robb Farm Road) to 162 mg/L (4 Thompson Lane). Chloride has historically been detected at similar concentrations in residential well samples.

5. Soil Cap Inspections

In accordance with the O&M Plan (Ref. 8) and MPCA-approved modifications on July 19, 2001, soil cap inspections were conducted on a semi-annual basis through 2014. Beginning in 2015, the frequency of soil cap inspections was reduced from semi-annually to annually, as recommended in the 2014 Annual Monitoring Report and approved by the MPCA on April 23, 2015.

The annual soil cap inspection was performed during the fourth quarter of 2019. The following items were evaluated during the inspections:

- The soil cover was inspected for detrimental erosion, settlement and stressed or overgrown vegetation
- Access roads were inspected for physical damage and obstructions
- Monitoring locations were inspected for physical damage

A record of each inspection is maintained on a checklist. .

Landfill cap maintenance activities conducted in 2019 are summarized in Table 3.2. To date, the soil cover shows no indications of detrimental erosion or stressed vegetation. Minor settlement has been detected periodically and repaired by placing fill. The cap vegetation is well established and monitoring locations are in good condition.

6. Conclusions

Based on the information presented in this 2019 Annual Monitoring Report, the following conclusions are made:

1. The groundwater extraction system (EW1B and EW2) is effectively providing hydraulic containment in the Lower Sand/St. Peter Sandstone aquifers and preventing contaminant migration downgradient from the Site based on the evaluation of hydraulic conditions (i.e., groundwater elevation contours) and groundwater chemistry (i.e., analytical results at downgradient compliance wells are below SCGs).
2. Groundwater samples from monitoring wells show that vinyl chloride is not present in wells screened in the unconsolidated Glacial Drift aquifer (Lower Sand aquifer) in North Oaks.
3. Groundwater samples from monitoring wells did not identify any detectable levels of vinyl chloride in the St. Peter Sandstone aquifer in wells west of Gilfillan Lake.
4. Groundwater samples from monitoring wells show that vinyl chloride is not present in wells screened in the Prairie du Chien aquifer in North Oaks.

5. In 2019, ongoing residential well sampling of homes in North Oaks did not identify any detectable levels of vinyl chloride. To date, the number of residential wells that have ever had detectable concentrations of vinyl chloride is limited to ten locations near the west shore of Gilfillan Lake: 50 East Oaks Road, 2 Heron Lane, 3 Heron Lane, 1 Hummingbird Hill 2 Hummingbird Hill, 10 West Shore Road, 11 West Shore Road, 12 West Shore Road, 13 West Shore Road, and 15 West Shore Road. Four of the ten wells (2 Heron Lane, 2 Hummingbird Hill, 12 West Shore Road, and 13 West Shore Road) have been replaced with new/deeper residential wells (see Section 1.3.4.1). Vinyl chloride concentrations at the remaining six wells (50 East Oaks Road, 3 Heron Lane, 1 Hummingbird Hill, 10 West Shore Road, 11 West Shore Road, and 15 West Shore Road) have never exceeded the vinyl chloride HRL (0.2 µg/L) and there have been no detections since April 2014

7. Recommendations

Based on the information presented in this 2019 Annual Monitoring Report, GHD recommends the following:

1. Operation of the on-Site groundwater extraction system should continue in the Lower Sand/St. Peter Sandstone aquifers (via extraction wells EW1B and EW2).
2. Annual groundwater sampling of on-Site and off-Site monitoring well locations should continue.
3. Residential well sampling in Operable Unit 4 should continue, as stipulated in MDD Amendment 2.
4. If the MDH issues a well advisory in Operable Unit 4 due to Listed VOCs then a new residential well in the Prairie du Chien aquifer should be provided, as stipulated in MDD Amendment 1.
5. Soil cap inspections should be conducted on an annual basis as approved by the MPCA on April 13, 2015. Cap maintenance should continue as needed, for the duration of operation of the groundwater extraction system.

8. References

1. Conestoga-Rovers & Associates. March 1988. Remedial Investigation/Interim Response Action Plan.
2. Conestoga-Rovers & Associates. October 1988. Alternatives Analysis Report.
3. Conestoga-Rovers & Associates. April 1989. Detailed Analysis Report.
4. Conestoga-Rovers & Associates. October 1993. North Oaks - Southeast Area Groundwater Investigation.
5. Conestoga-Rovers & Associates. January 1994. Response Action Plan.
6. Conestoga-Rovers & Associates. May 1994. Phase II Response Action Plan.

7. Conestoga-Rovers & Associates. January 1994. South Disposal Area Groundwater Investigation.

8. Conestoga-Rovers & Associates. May 1994. Post Closure Operation and Maintenance Plan.

9. Conestoga-Rovers & Associates. January 1995. Remedial Action Final Report.

10. Conestoga-Rovers & Associates. June 2005. Groundwater and Residential Well Evaluation Report - North Oaks, Minnesota.

11. Conestoga-Rovers & Associates. February 2006. Groundwater and Residential Well Evaluation Report - North Oaks, Minnesota (June 2005 - January 2006).

12. Conestoga-Rovers & Associates. February 2007. Groundwater and Residential Well Evaluation Report - North Oaks, Minnesota (February 2006 - January 2007).

13. Conestoga-Rovers & Associates. May 2007. Subsurface Geophysical Survey Report.

14. Conestoga-Rovers & Associates. December 2008. Completion Report - Monitoring Well Installation (MW-19A/MW-21A)

15. Conestoga-Rovers & Associates. July 2007. Feasibility Study - VOCs in Groundwater - West of Gilfillan Lake - North Oaks, Minnesota.

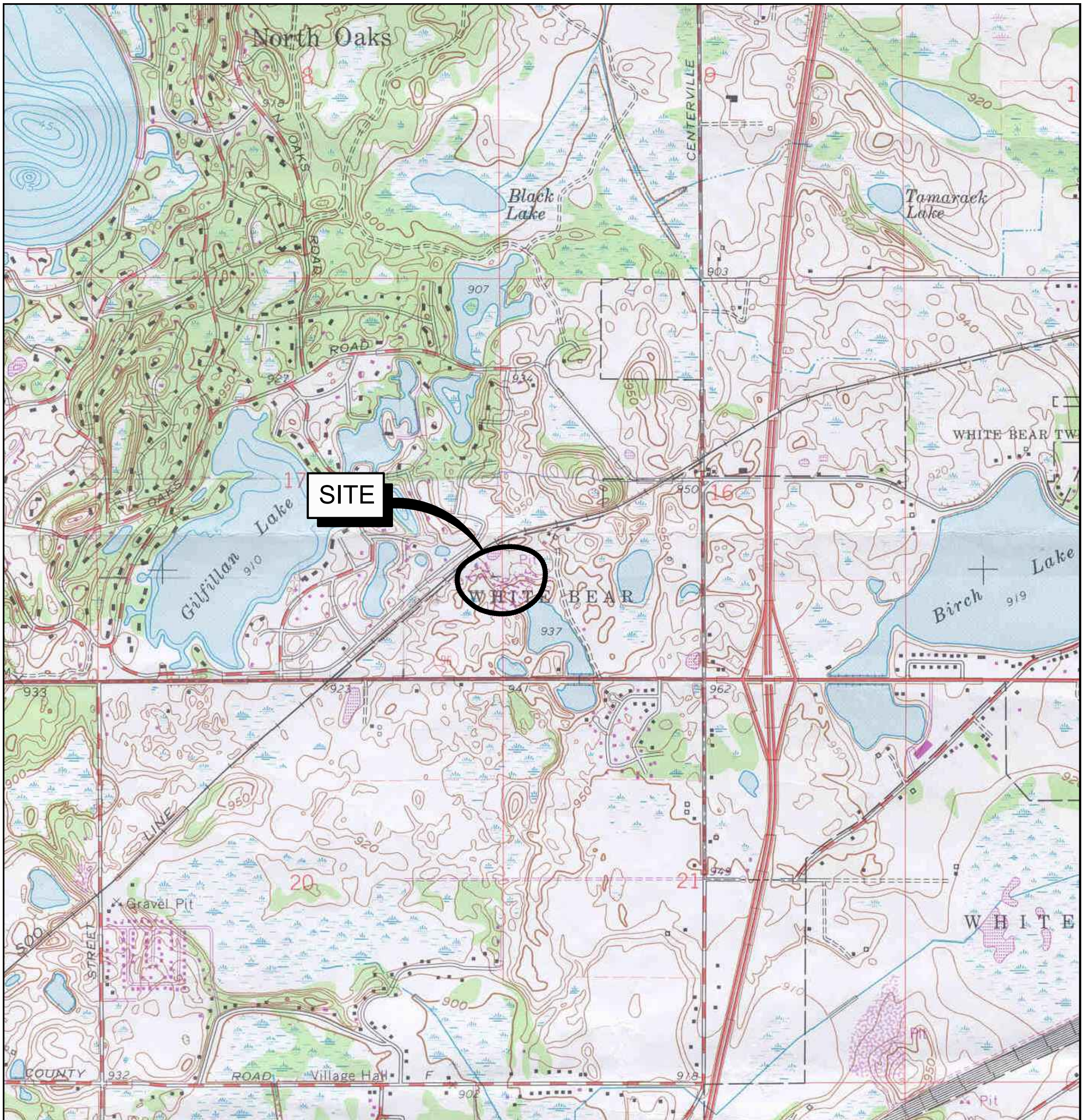
16. Meyer, G.N. 1985. Quaternary Geologic Map of the Minneapolis-St. Paul Urban Area, Minnesota. Minnesota Geological Survey, Miscellaneous Map Series M-54, and Scale 1:48,000.

17. Norvitch, R.F., Ross, T.G., and Brietkrietz, A. 1973. Water Resources Outlook for the Minneapolis-St. Paul Metropolitan Area, Minnesota.

18. Conestoga-Rovers & Associates. February 2010. Work Plan - Extraction Well Replacement.

19. Conestoga-Rovers & Associates. July 2010. Installation and Operation Report - Extraction Well EW1B.

Figures



SOURCE: USGS 7.5 MINUTE QUAD
WHITE BEAR LAKE WEST, MINN.

0 1000 2000ft

figure 1.1

SITE LOCATION
HIGHWAY 96 SITE
White Bear Township, Minnesota

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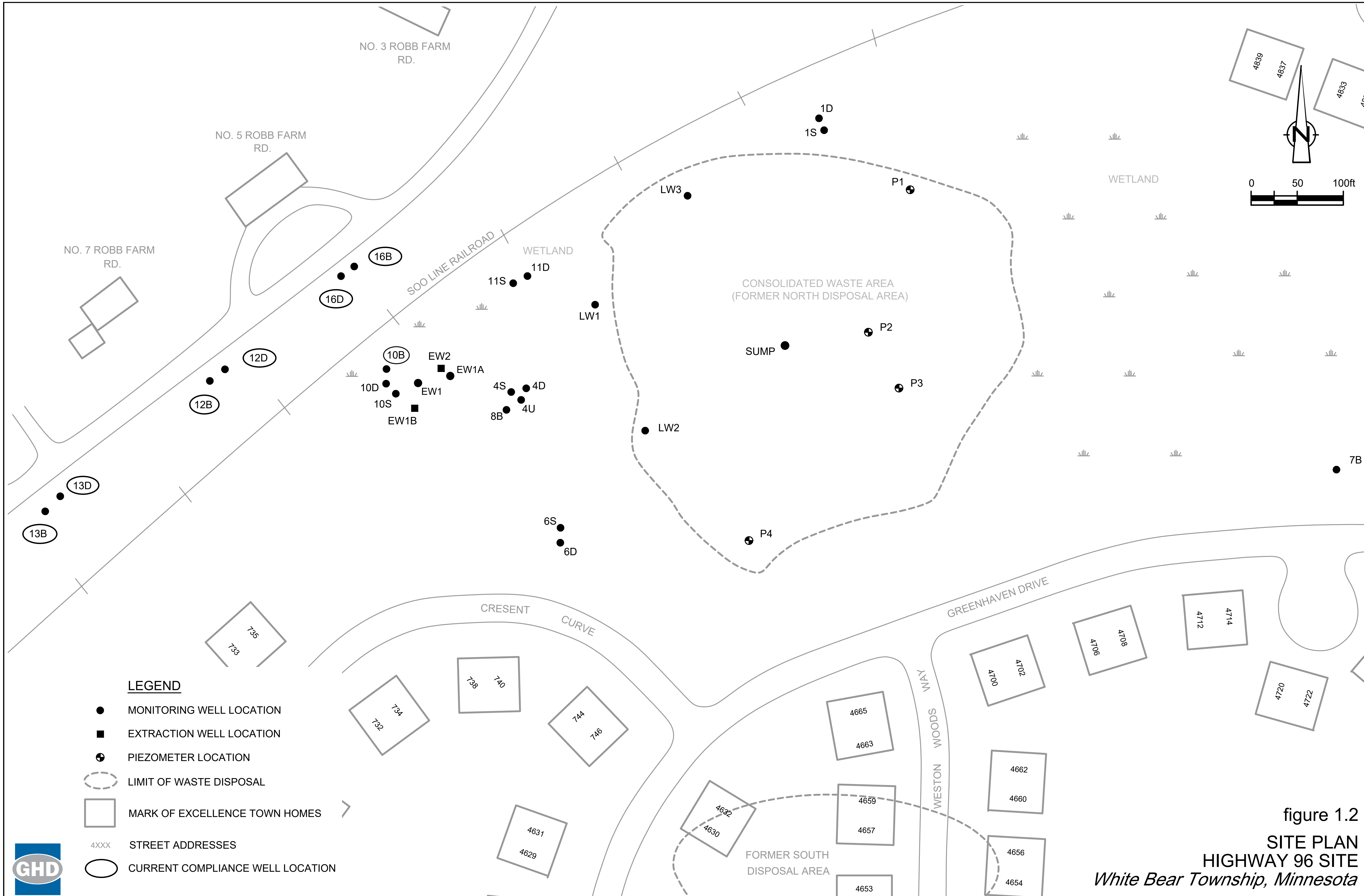

figure 1.2

SITE PLAN
HIGHWAY 96 SITE
White Bear Township, Minnesota

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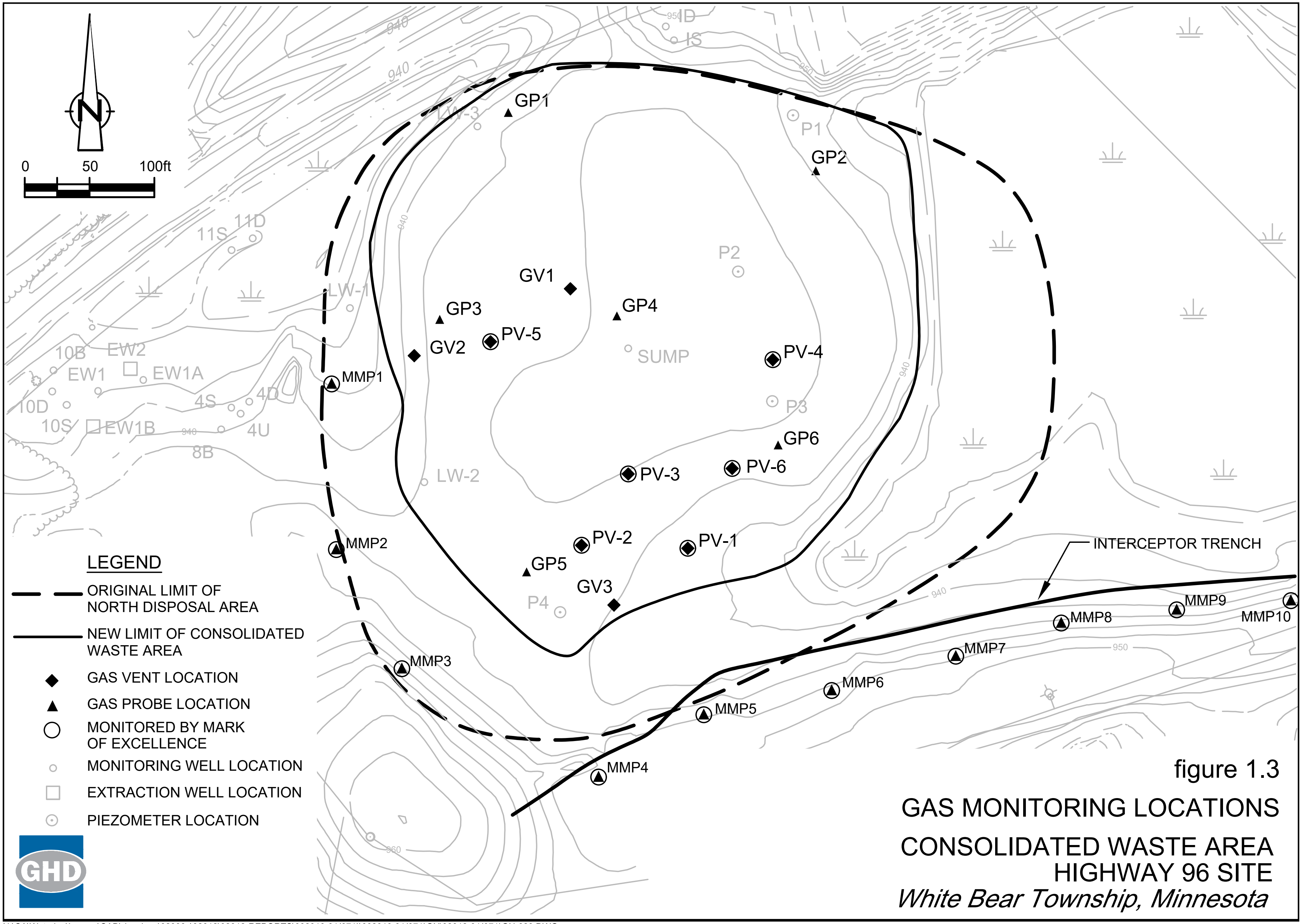

figure 1.3

GAS MONITORING LOCATIONS

CONSOLIDATED WASTE AREA
HIGHWAY 96 SITE
White Bear Township, Minnesota

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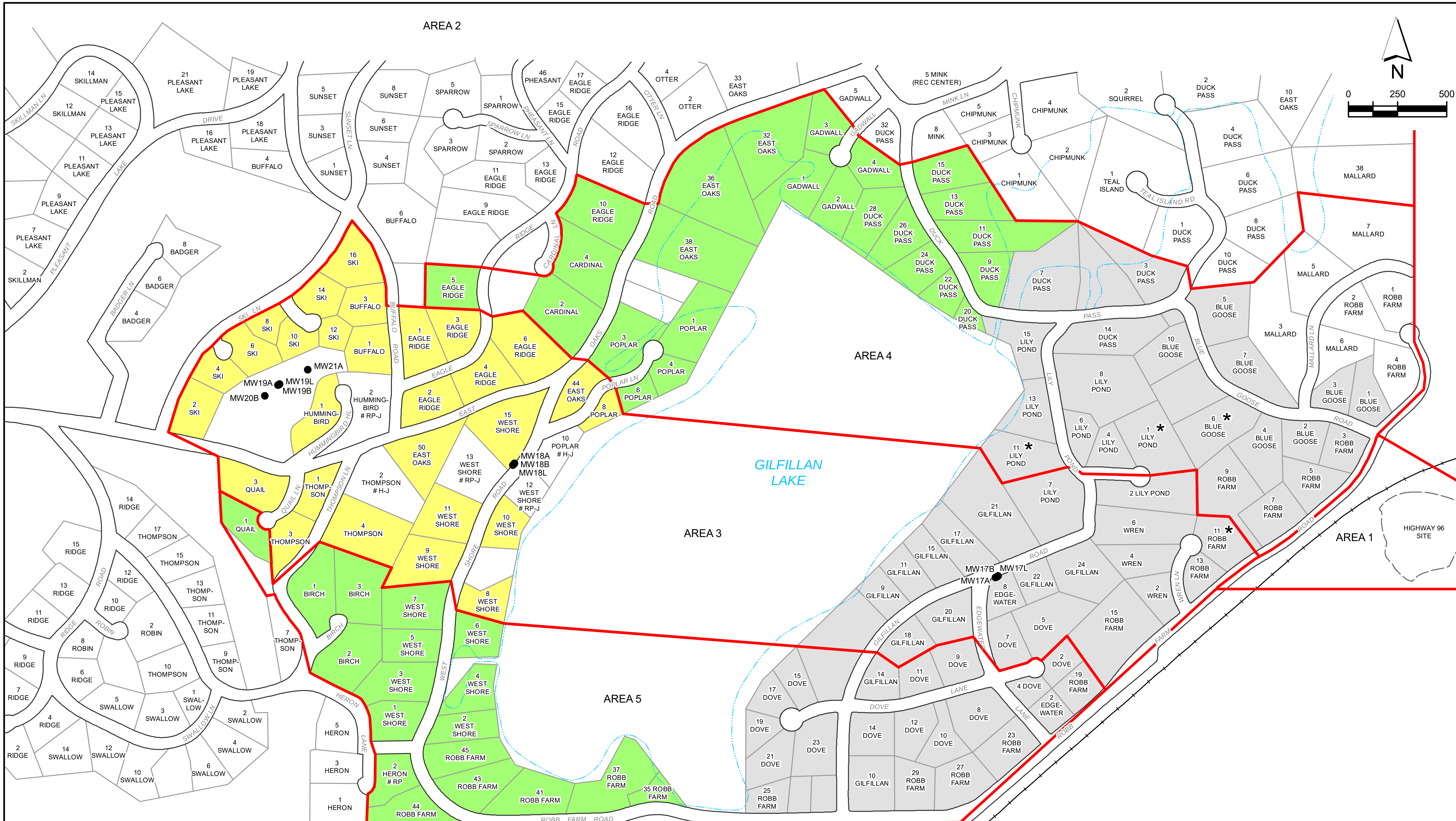


LEGEND

- GEOGRAPHIC AREAS
- ● MONITORING WELL LOCATION (ANNUAL SAMPLING - OCTOBER)
- * CONVERTED RESIDENTIAL MONITORING WELL LOCATION (ANNUAL SAMPLING - OCTOBER)
- CONNECTED TO MUNICIPAL WATER SUPPLY
- # RP — REPLACEMENT WELL INSTALLED BY RPs (PRAIRIE DU CHIEN AQUIFER) [OLD WELL ABANDONED]
- # RP-J — REPLACEMENT WELL INSTALLED BY RPs (EXTENDED INTO JORDAN AQUIFER AT HOMEOWNERS REQUEST/EXPENSE) [OLD WELL ABANDONED]
- # H-J — NEW WELL INSTALLED BY HOMEOWNER (JORDAN AQUIFER) [OLD WELL ABANDONED]
- RESIDENTIAL WELL LOCATION (ANNUAL SAMPLING - OCTOBER)
- RESIDENTIAL WELL LOCATION (SAMPLED EVERY FIVE YEARS) [NEXT EVENT OCTOBER 2024]

figure 1.4

OFF-SITE GROUNDWATER MONITORING NETWORK
HIGHWAY 96 SITE
White Bear Township, Minnesota

002012-01(071)GIS-SP001 FEB 19/2020

NOTE: FIGURE TAKEN FROM "REMEDIAL ACTION FINAL REPORT" CRA (1996)

figure 1.5

MUNICIPAL WATER SYSTEM
HIGHWAY 96 SITE
White Bear Township, Minnesota

N:\CA\Waterloo\Legacy\CAD\drawings\02000s\02012\02012-REPORTS\002010-01(071)\002010-01(071)GN\02012-01(071)GN-005.DWG 2019

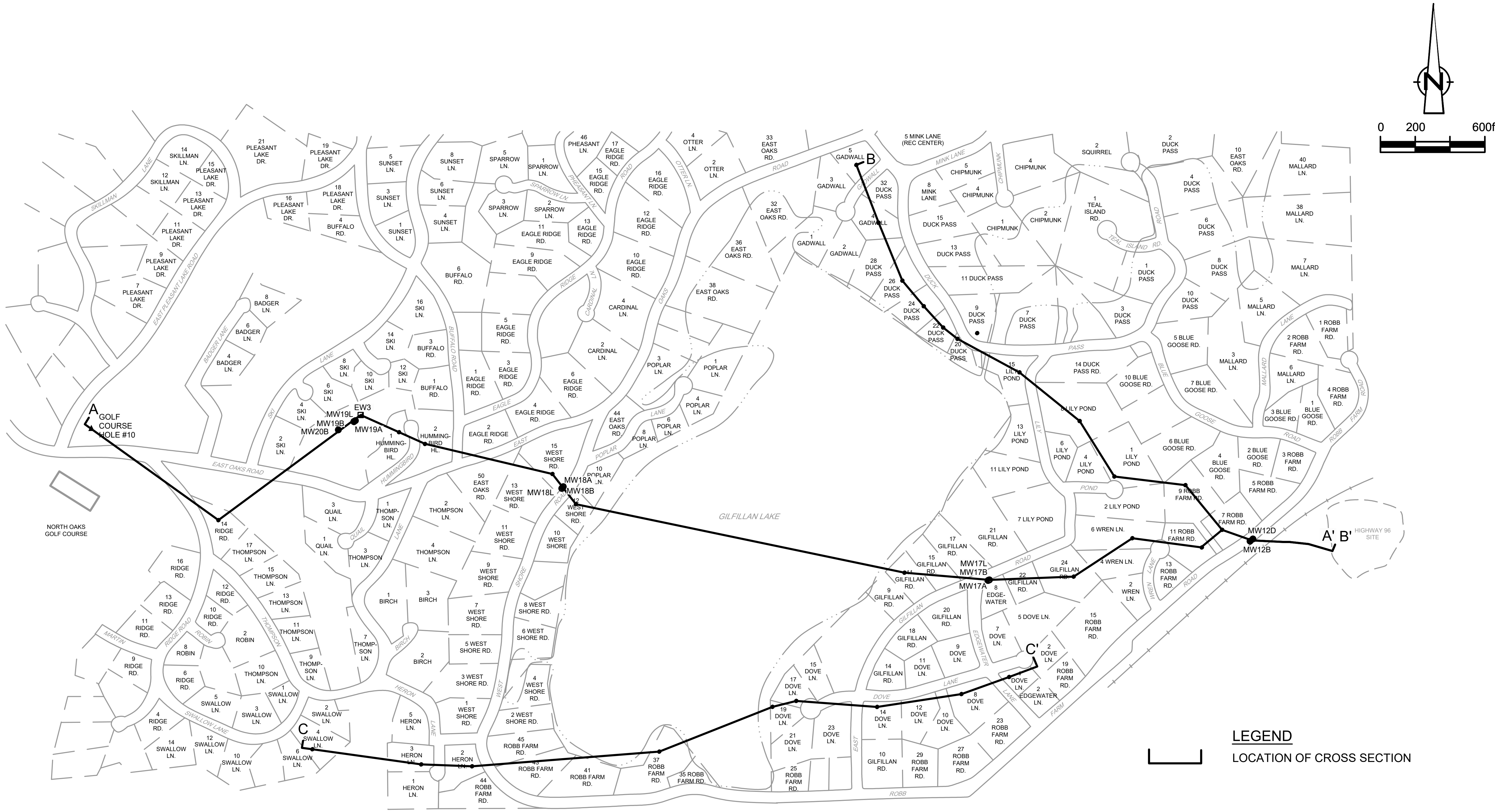


figure 3.1

LOCATION OF CROSS SECTIONS
HIGHWAY 96 SITE
White Bear Township, Minnesota

N:\CA\Waterloo\Legacy\CAD\drawings\02000s\02012\02012-REPORTS\002010-01(071)\002010-01(071)GN\02012-01(071)GN-006.DWG 2019

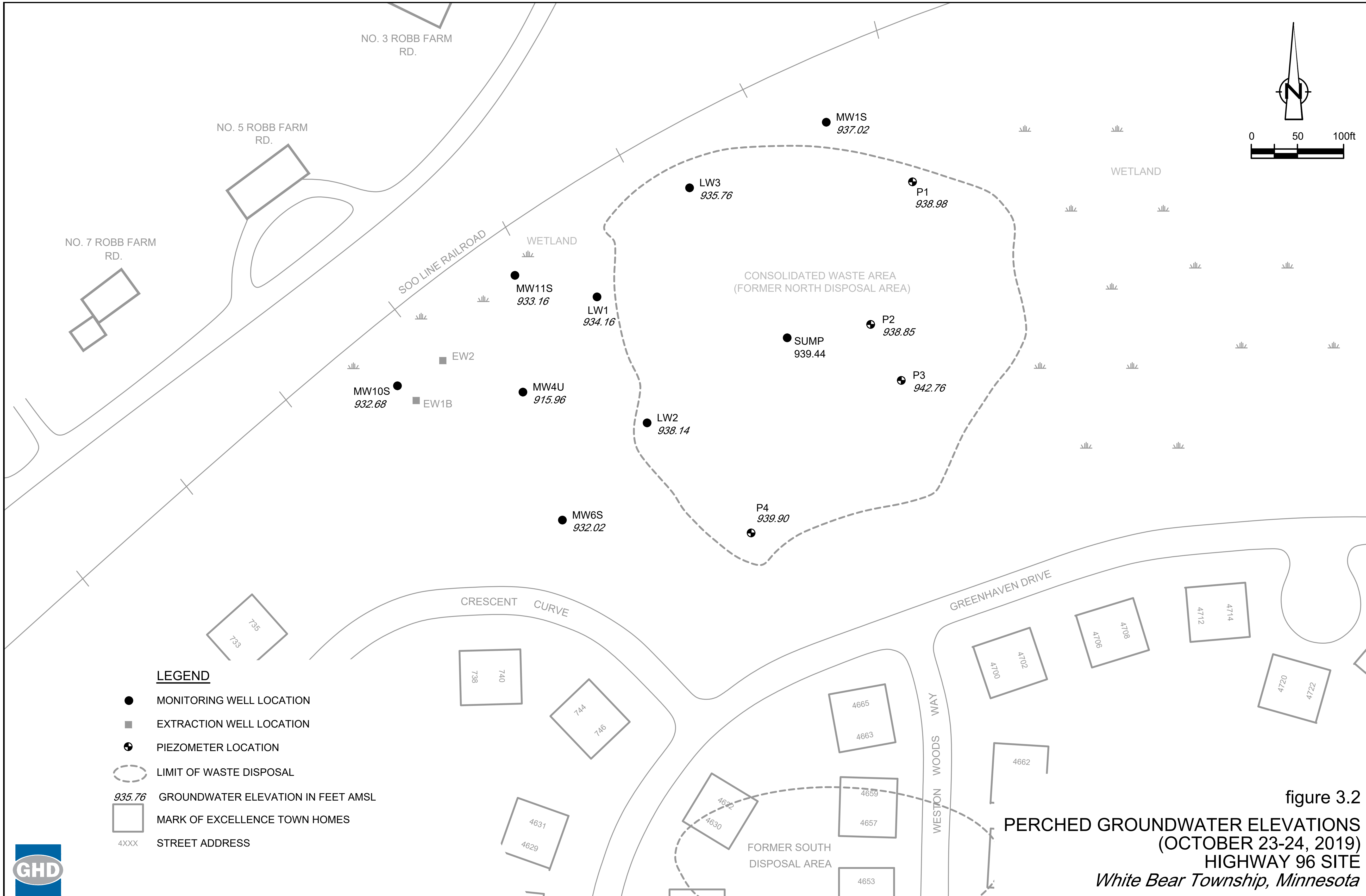
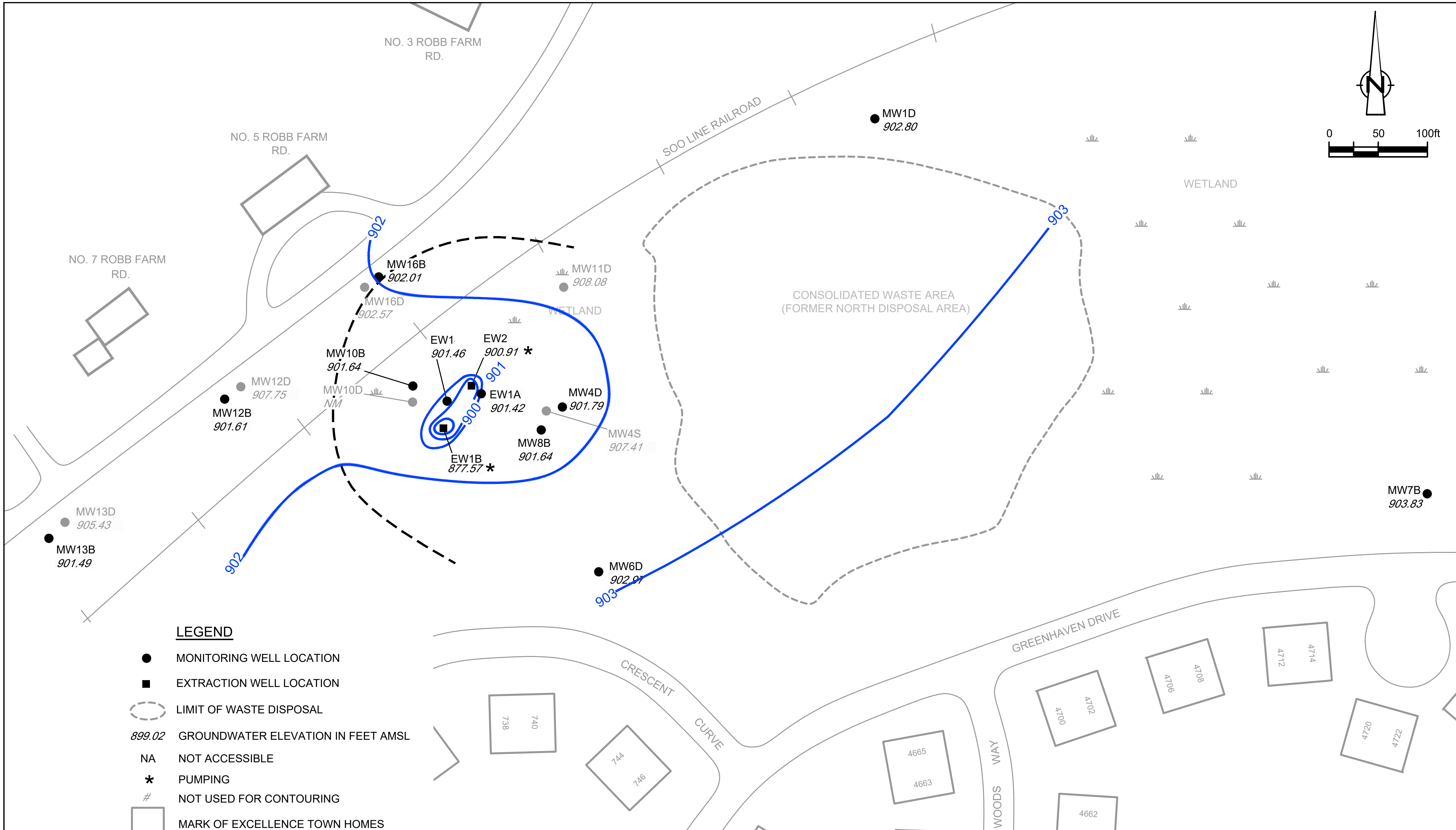


figure 3.2

PERCHED GROUNDWATER ELEVATIONS
(OCTOBER 23-24, 2019)
HIGHWAY 96 SITE
White Bear Township, Minnesota

GHD

N:\CA\Waterloo\Legacy\CAD\drawings\02000s\02012\02012-REPORTS\002010-01(071)\002010-01(071)GN\02012-01(071)GN-007.DWG



LEGEND

- ● MONITORING WELL LOCATION
- ■ EXTRACTION WELL LOCATION
- LIMIT OF WASTE DISPOSAL
- *899.02* GROUNDWATER ELEVATION IN FEET AMSL
- NA NOT ACCESSIBLE
- * PUMPING
- # NOT USED FOR CONTOURING
- MARK OF EXCELLENCE TOWN HOMES
- 4XXX STREET ADDRESS
- 900 GROUNDWATER CONTOUR
- APPROXIMATE LIMIT OF CAPTURE (BASED ON ANNUAL AVERAGE COMBINED PUMPING RATE)

NOTES:
-EW1B PUMPING AT A RATE OF APPROXIMATELY 3.5 GPM
-EW2 PUMPING AT A RATE OF APPROXIMATELY 10.2 GPM
-AVERAGE ANNUAL COMBINED PUMPING RATE (EW1B + EW2) FOR 2019 WAS 19.4 GPM [SEE TABLE 3.3]

figure 3.3
LOWER SAND/ST. PETER SANDSTONE AQUIFER
GROUNDWATER ELEVATIONS (OCTOBER 23-24, 2019)
HIGHWAY 96 SITE
White Bear Township, Minnesota

N:\CA\Waterloo\Legacy\CAD\drawings\02000s\02012\02012-REPORTS\002010-01(071)\002010-01(071)GN\02012-01(071)GN-008.DWG

LEGEND

UPPER ST. PETER SANDSTONE MONITORING WELL LOCATION

901.99 GROUNDWATER ELEVATION IN FEET AMSL

895 GROUNDWATER CONTOUR

figure 3.4

UPPER ST. PETER SANDSTONE AQUIER
GROUNDWATER ELEATIONS (OCTOBER 2-2, 2019)
HIGHWAY 96 SITE
White Bear Township, Minnesota

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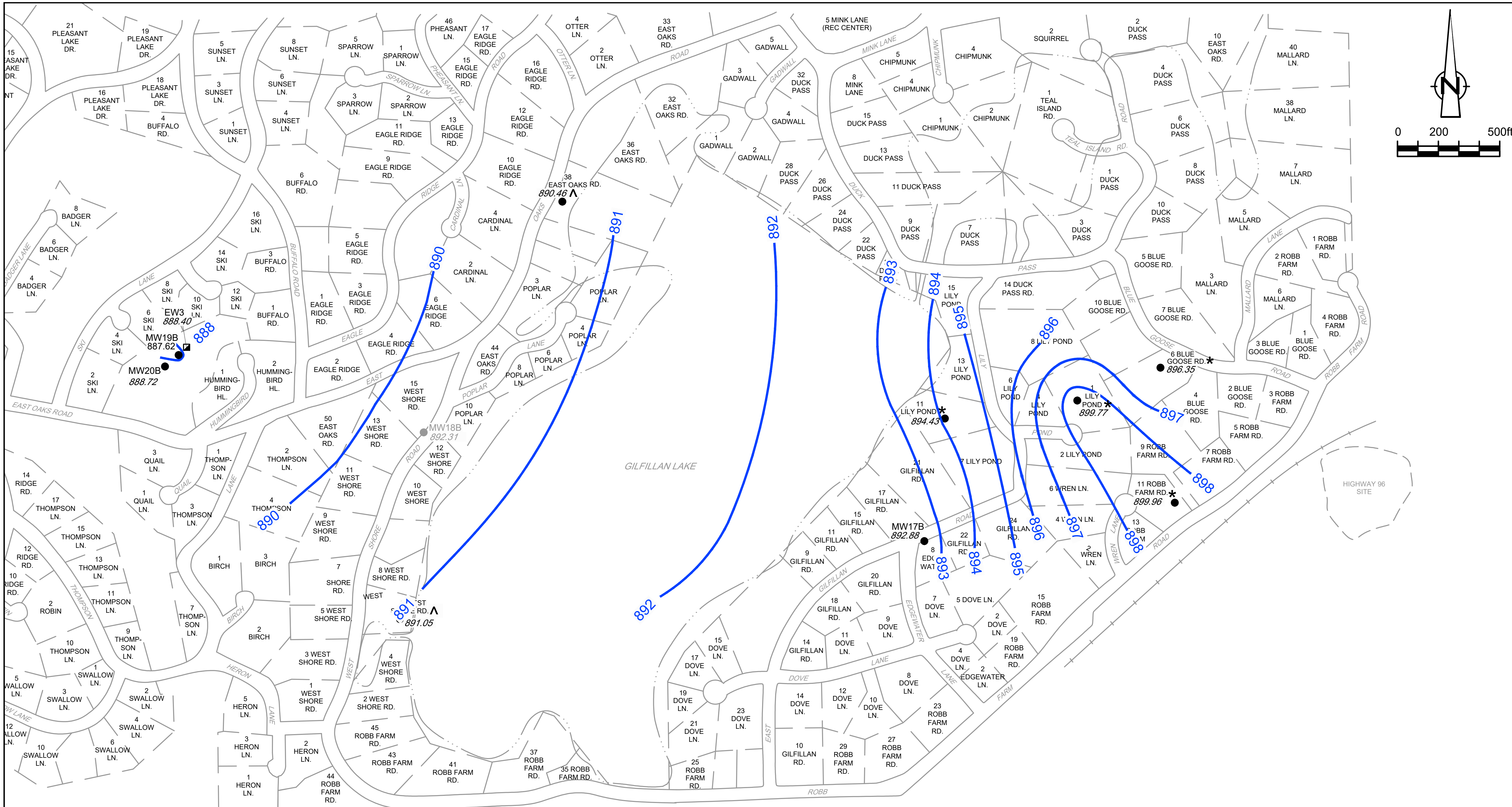

LEGEND

BASAL ST. PETER SANDSTONE TEST EXTRACTION WELL LOCATION

BASAL ST. PETER SANDSTONE MONITORING WELL LOCATION

CONVERTED RESIDENTIAL MONITORING WELL LOCATION

ACTIVE RESIDENTIAL WELL LOCATION

885.91 GROUNDWATER ELEVATION IN FEET AMSL

NOT USED FOR CONTOURING

890 GROUNDWATER CONTOUR

GHD

figure 3.5

BASAL ST. PETER SANDSTONE AQUIER
GROUNDWATER ELEATIONS (OCTOBER 2-2, 2019)
HIGHWAY 96 SITE
White Bear Township, Minnesota

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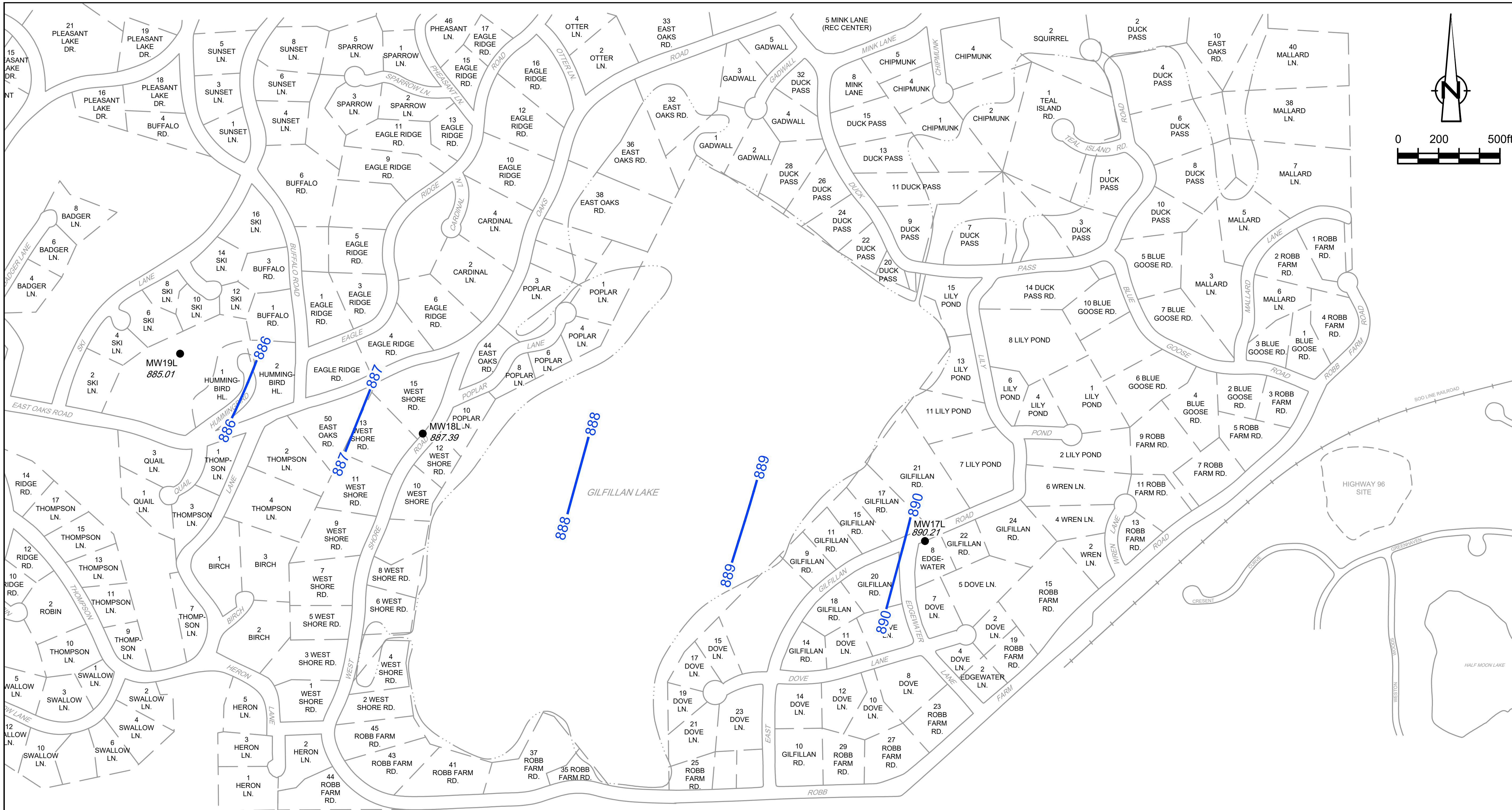

LEGEND

● PRAIRIE DU CHIEN MONITORING WELL LOCATION

888.17 GROUNDWATER ELEVATION IN FEET AMSL

—886— GROUNDWATER CONTOUR

figure 3.6

PRAIRIE DU CHIEN AQUIFER

GROUNDWATER ELEVATIONS (OCTOBER 23-24, 2019)

HIGHWAY 96 SITE

White Bear Township, Minnesota

GHD

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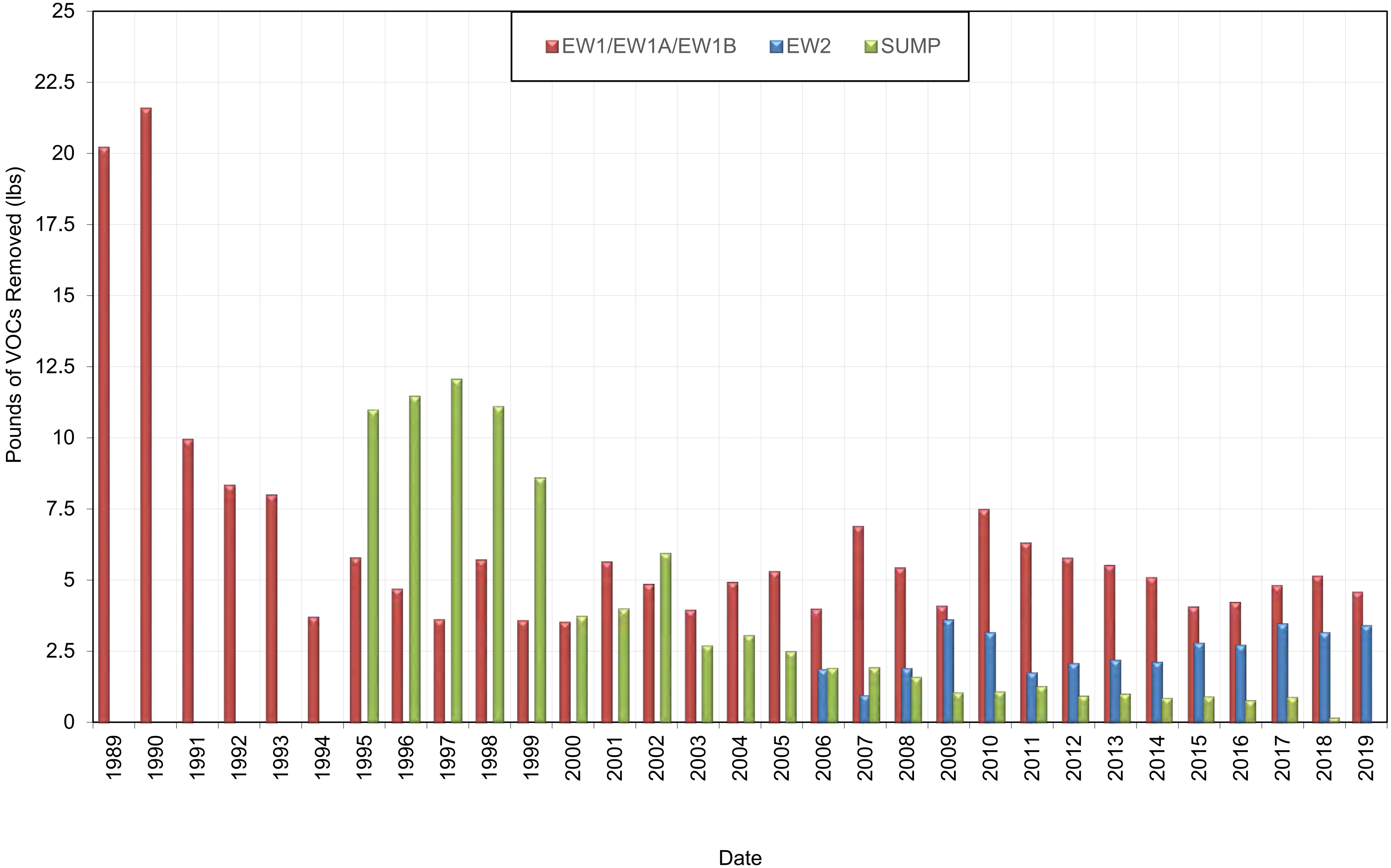
Figure 3.7

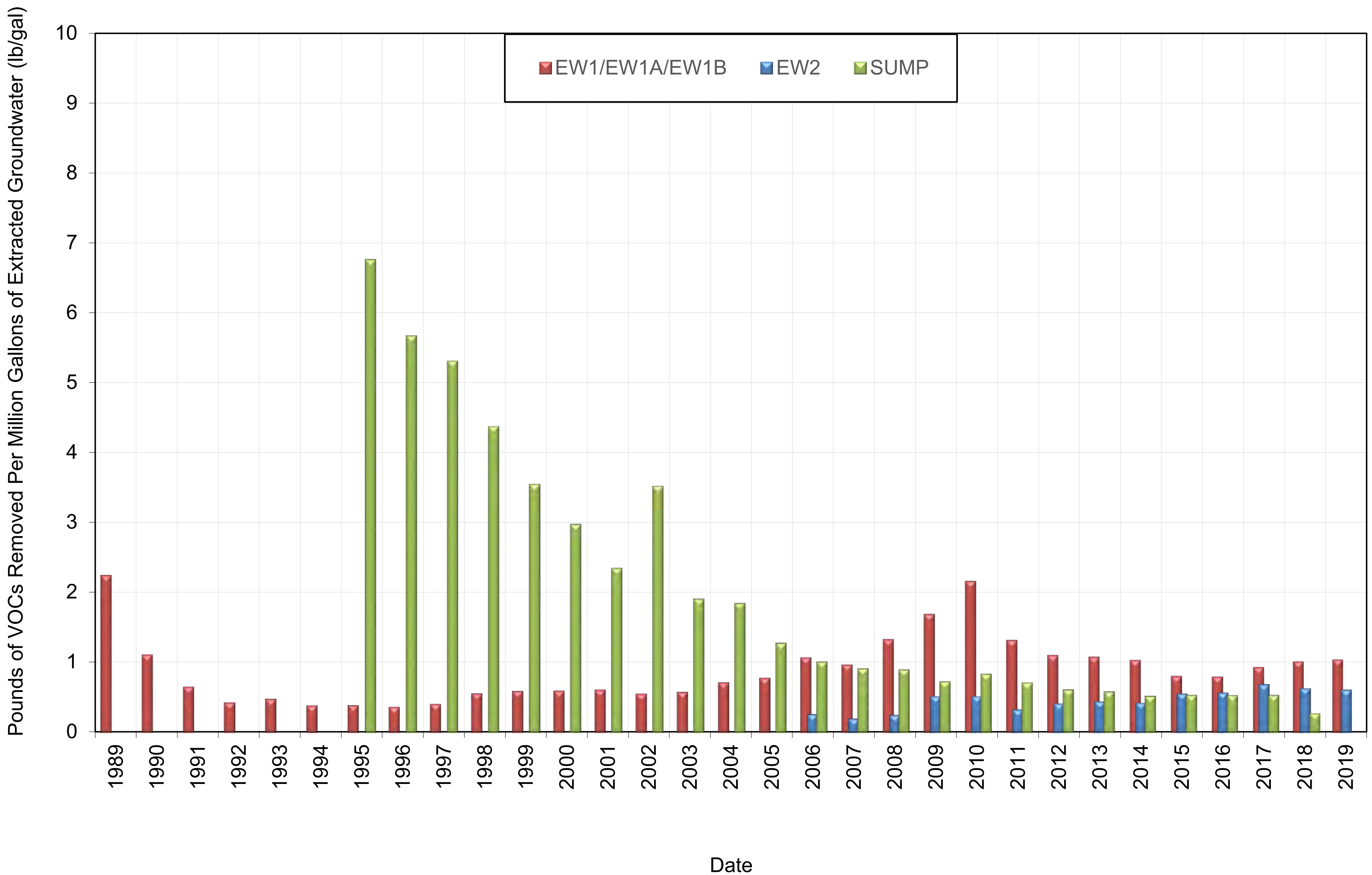
Historical VOC Mass Removal
Highway 96 Site
White Bear Township, Minnesota



GHD 002012 (71)

Figure 3.8

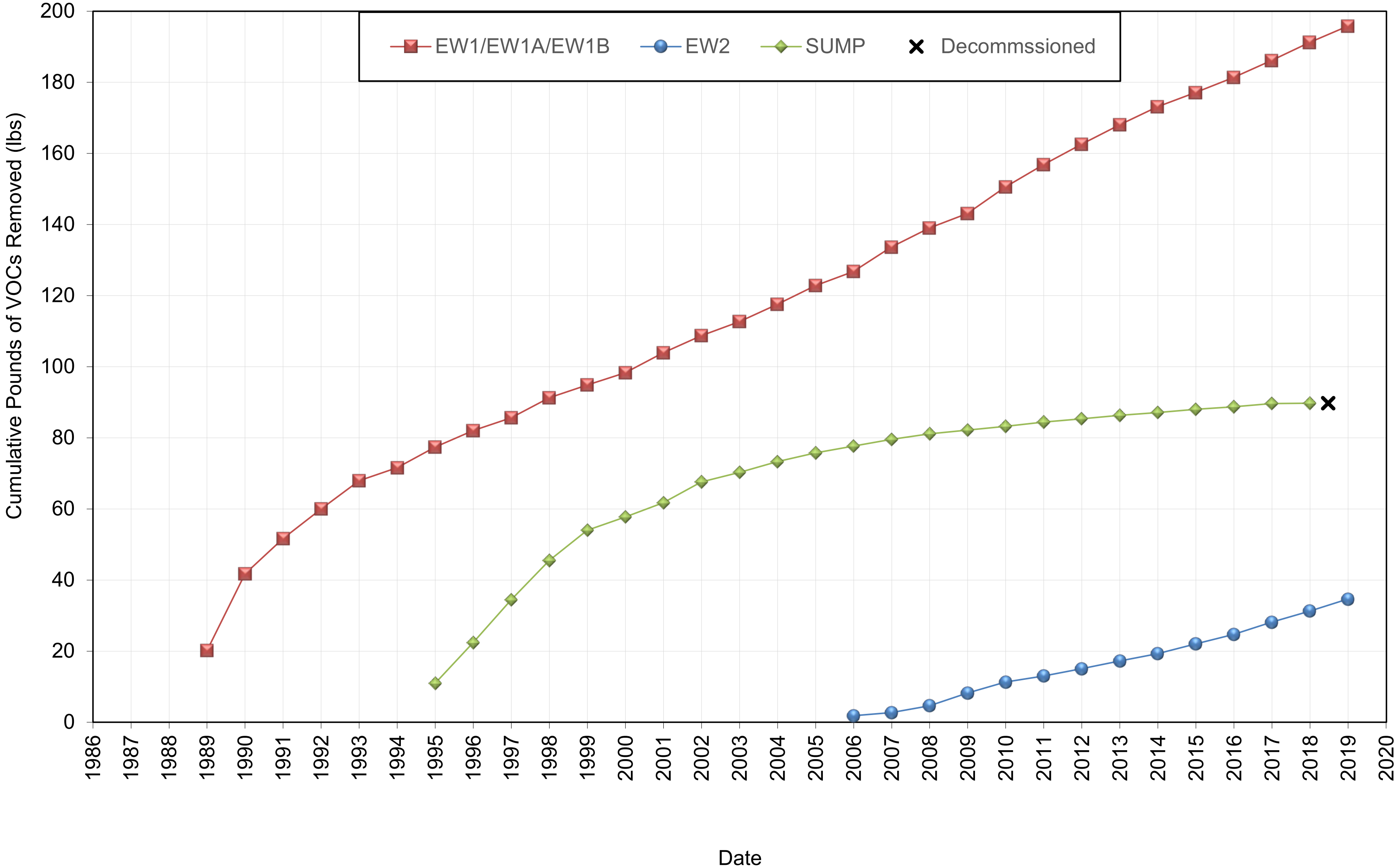
Historical VOC Mass Removal Efficiency
Highway 96 Site
White Bear Township, Minnesota



GHD 002012 (71)

Figure 3.9

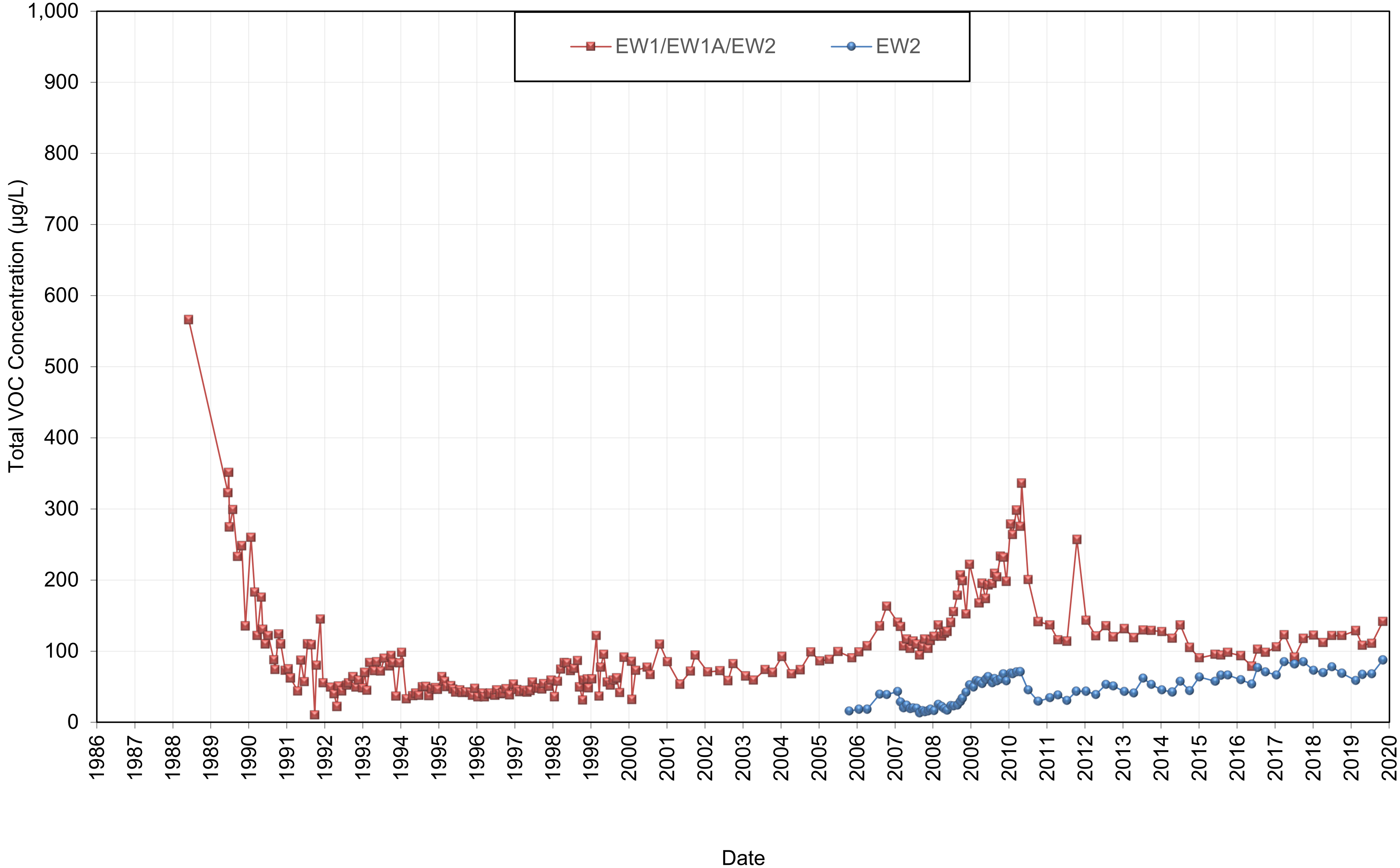
Cumulative VOC Mass Removal
Highway 96 Site
White Bear Township, Minnesota



GHD 002012 (71)

Figure 3.10

Historical Total VOC Concentrations
EW1/EW1A/EW1B and EW2
Highway 96 Site
White Bear Township, Minnesota



GHD 002012 (71)

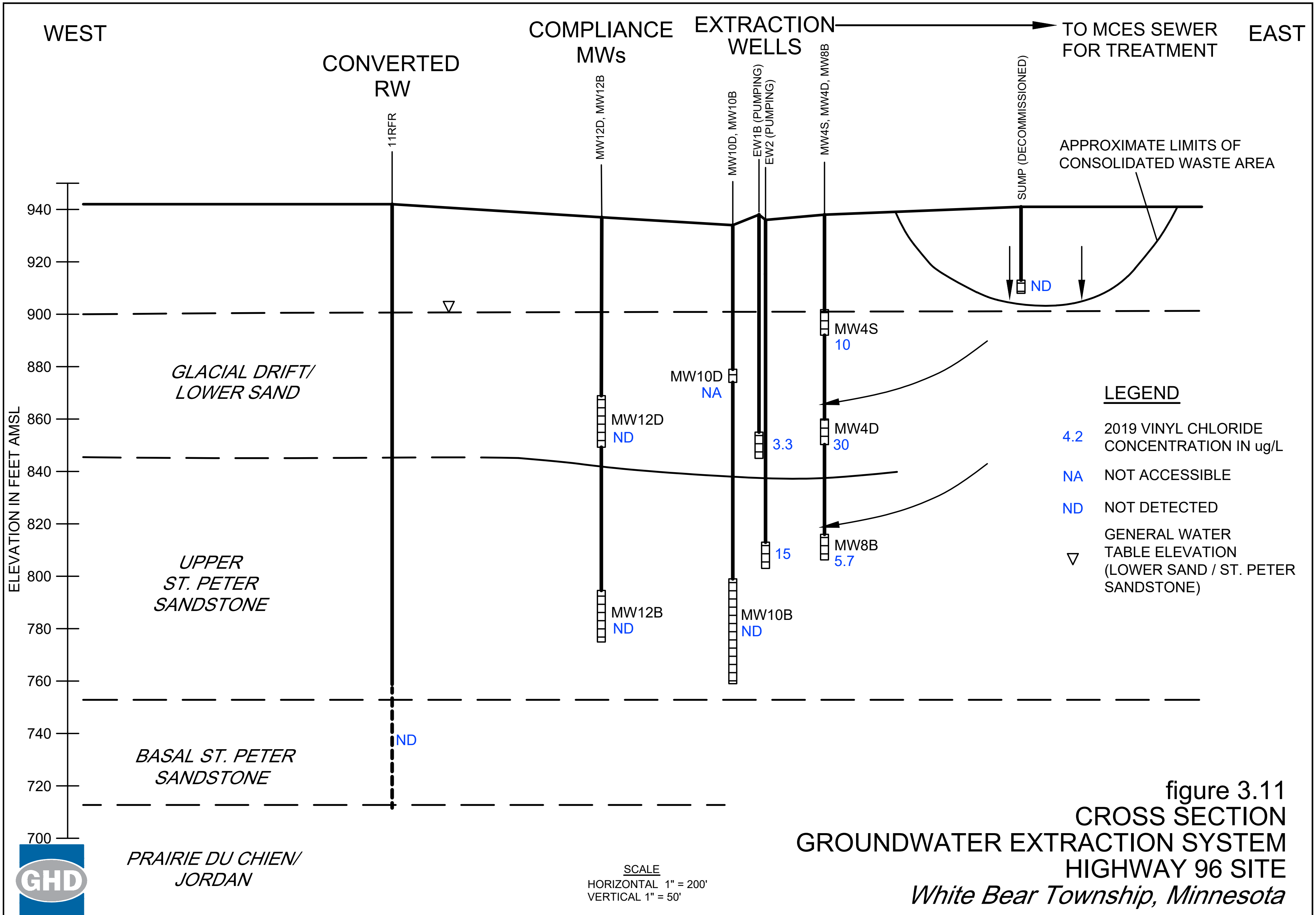
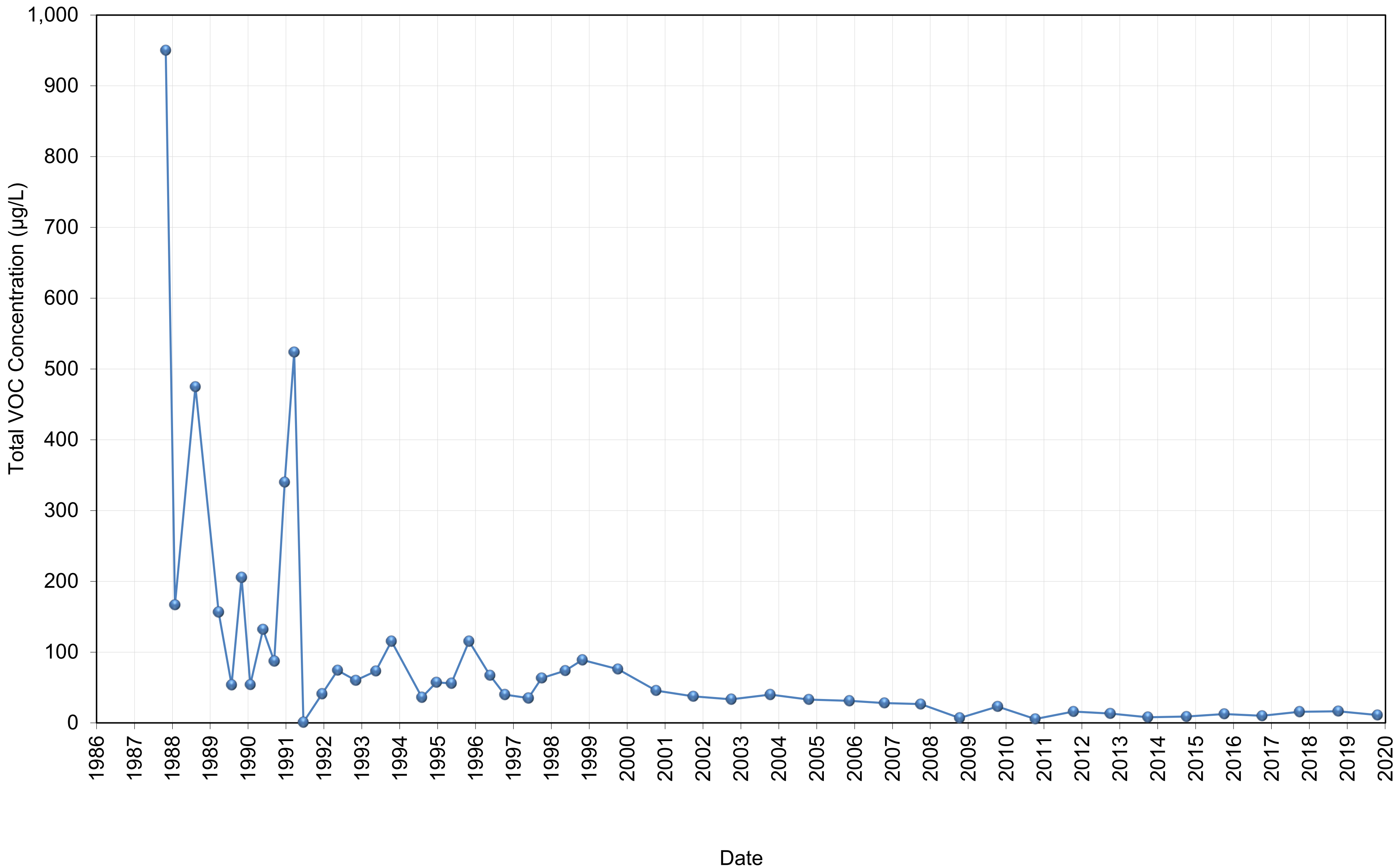


figure 3.11
CROSS SECTION
GROUNDWATER EXTRACTION SYSTEM
HIGHWAY 96 SITE
White Bear Township, Minnesota

N:\CA\Waterloo\Legacy\CAD\drawings\02000s\02012\02012-REPORTS\002010-01(071)\002010-01(071)GN\02012-01(071)GN-012.DWG

Figure 4.1

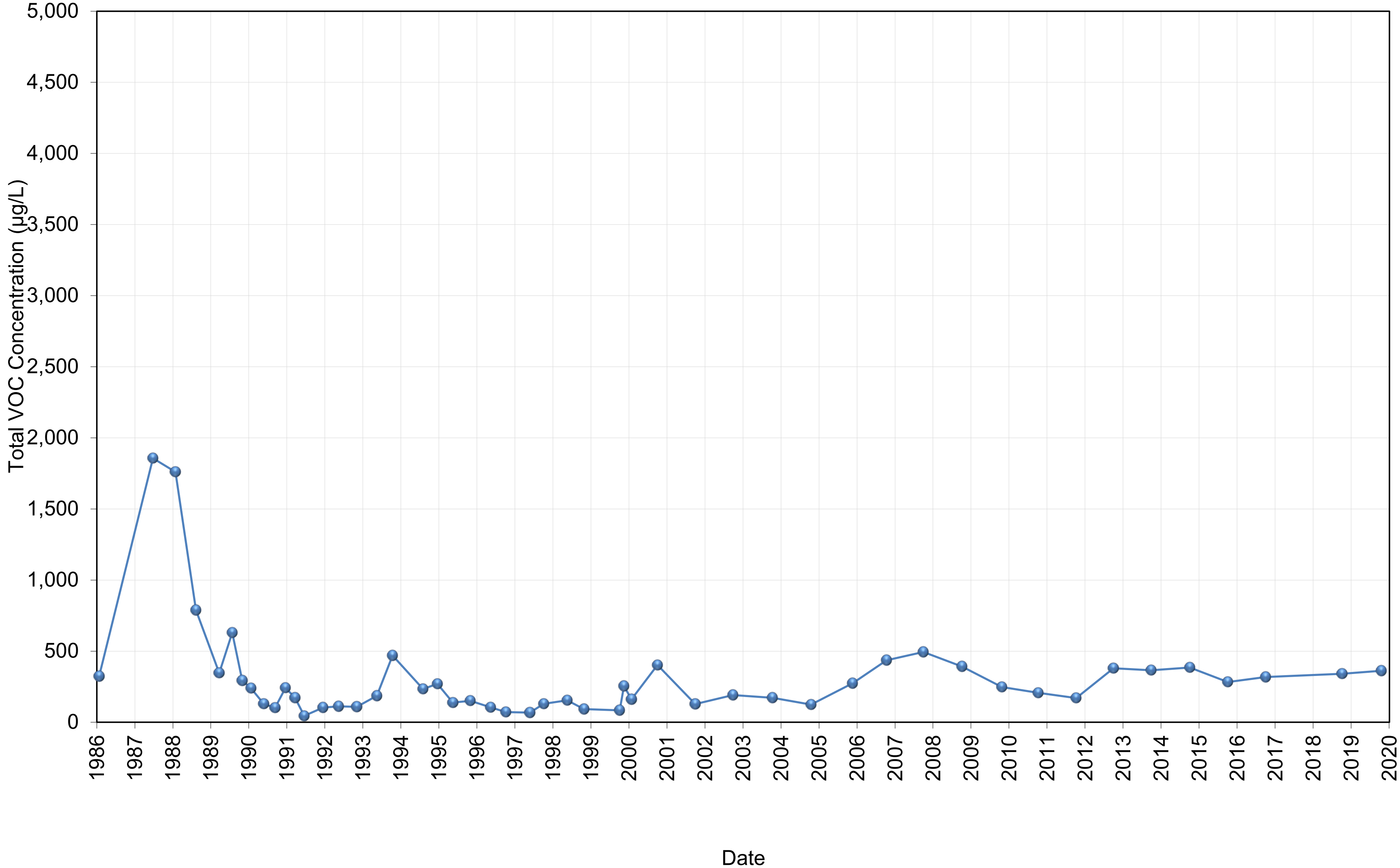
Historical Total VOC Concentrations
LW3
Highway 96 Site
White Bear Township, Minnesota



GHD 002012 (71)

Figure 4.2

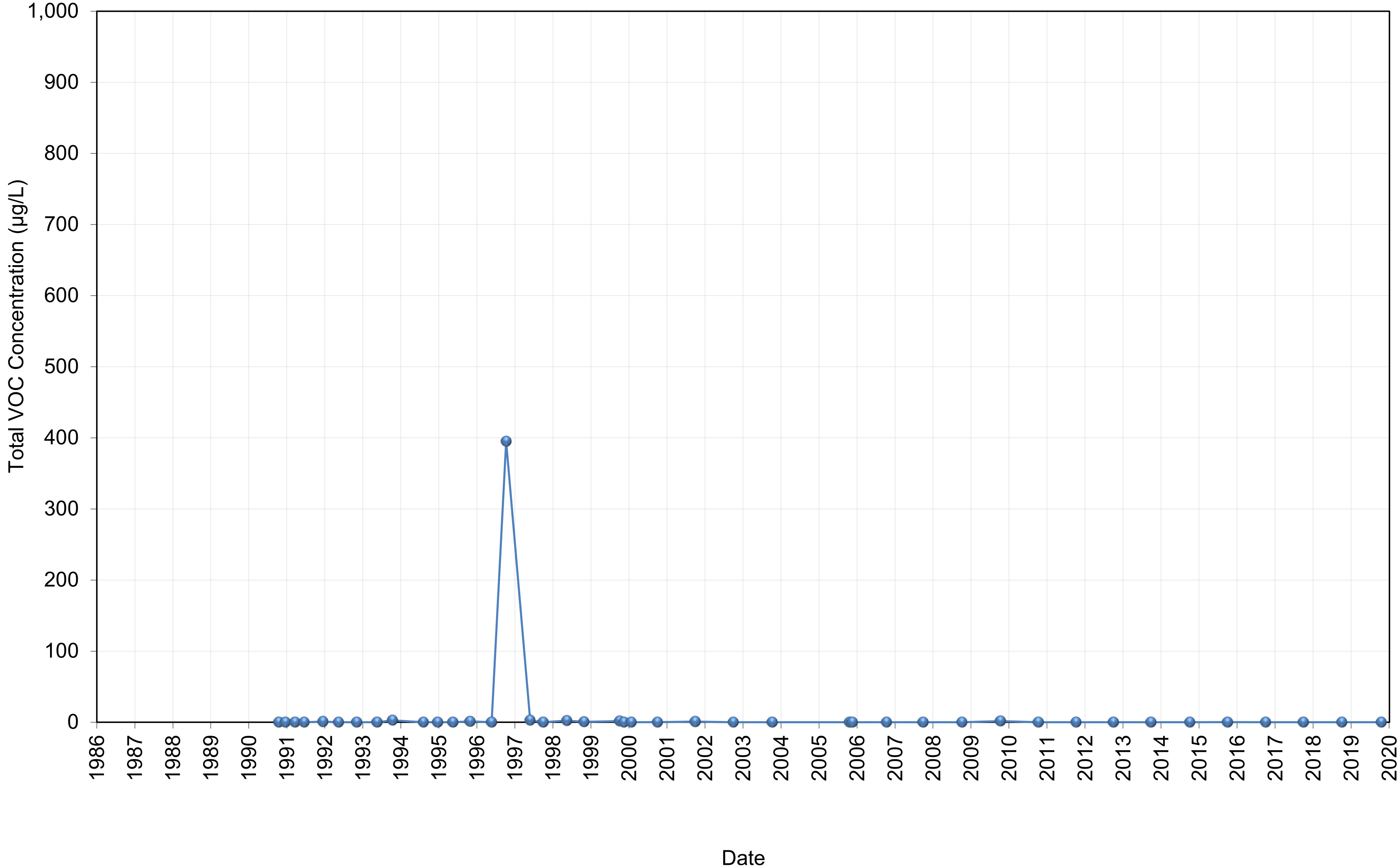
Historical Total VOC Concentrations
MW4D
Highway 96 Site
White Bear Township, Minnesota



GHD 002012 (71)

Figure 4.3

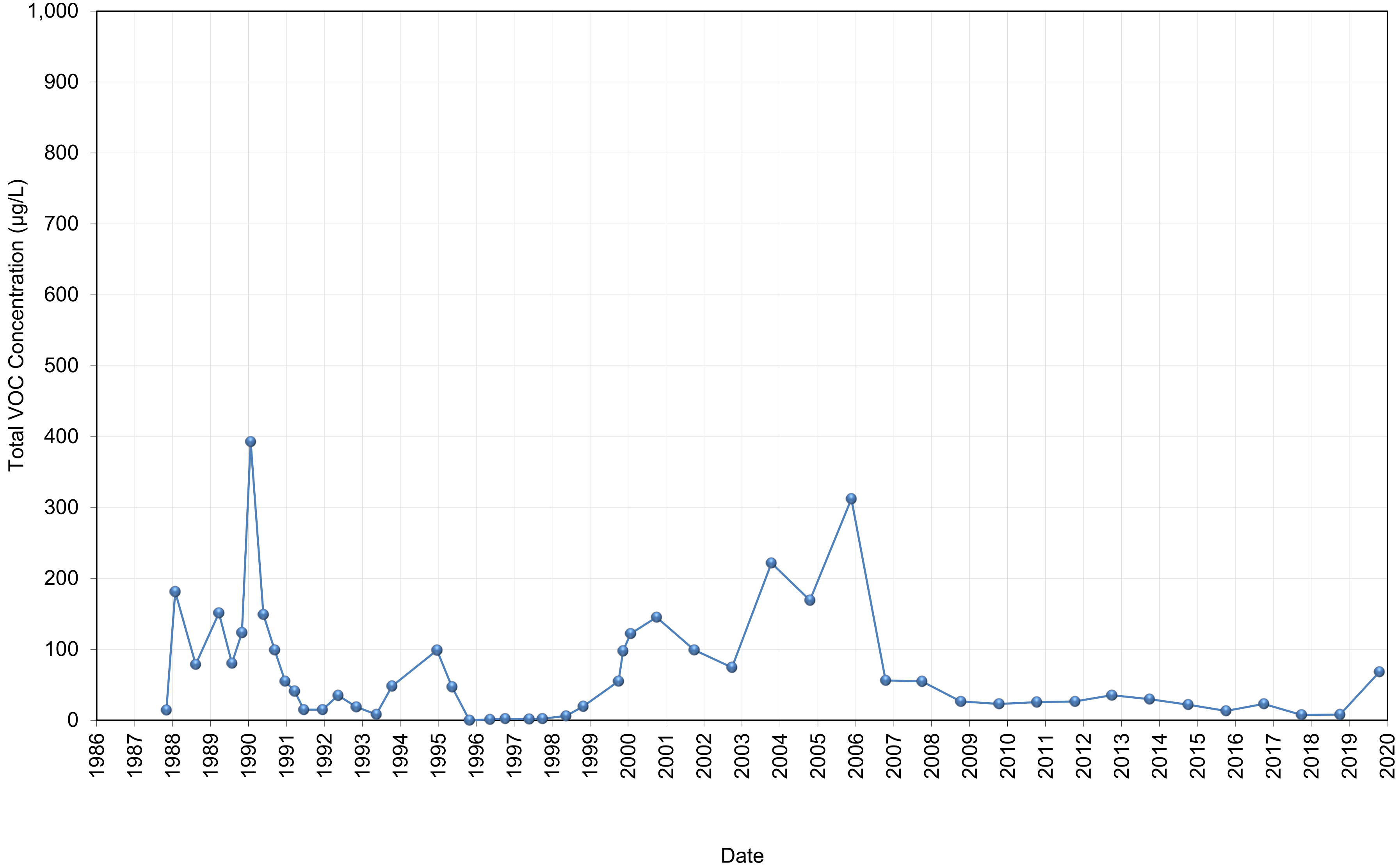
Historical Total VOC Concentrations
MW12D
Highway 96 Site
White Bear Township, Minnesota



GHD 002012 (71)

Figure 4.4

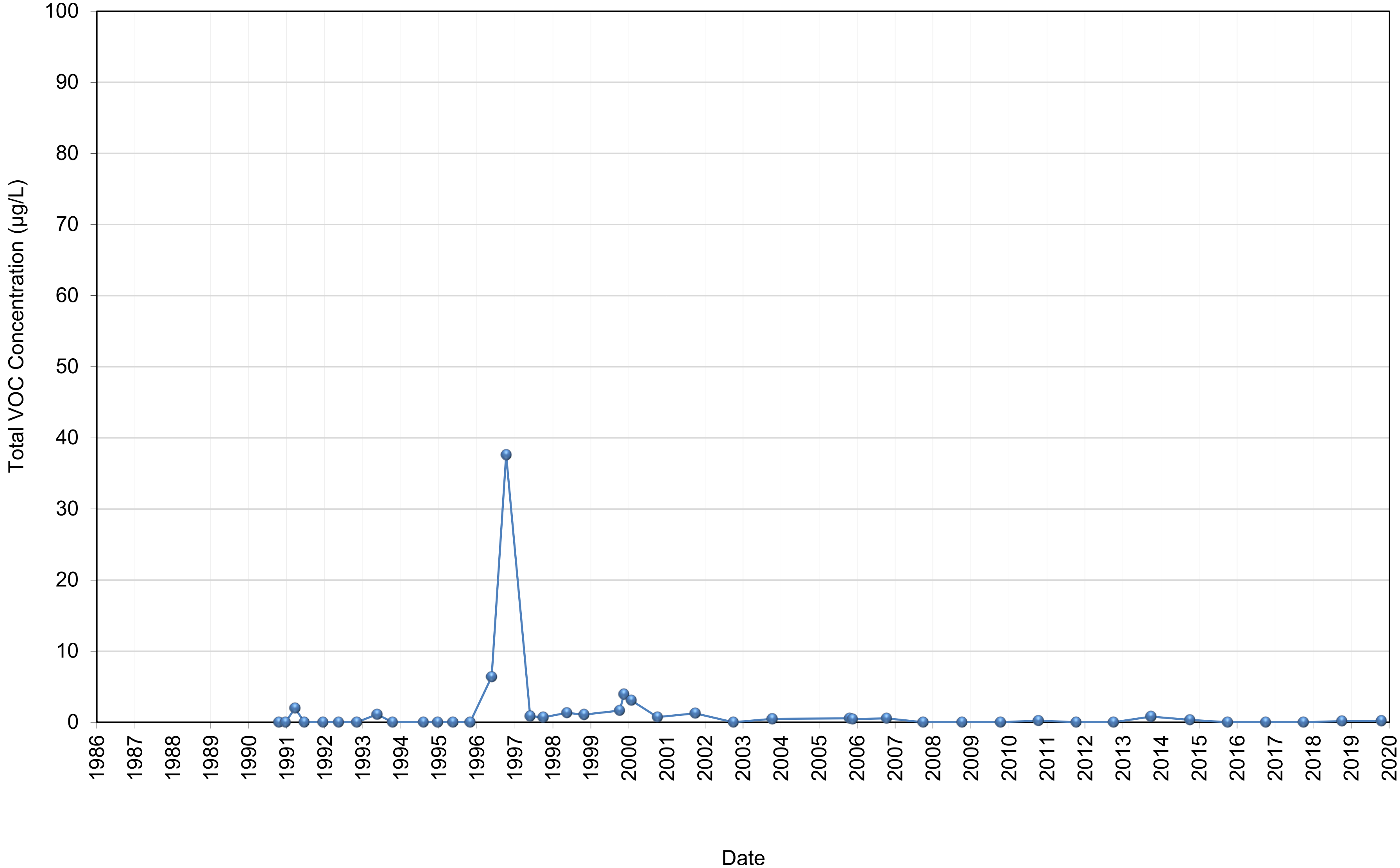
Historical Total VOC Concentrations
MW8B
Highway 96 Site
White Bear Township, Minnesota



GHD 002012 (71)

Figure 4.5

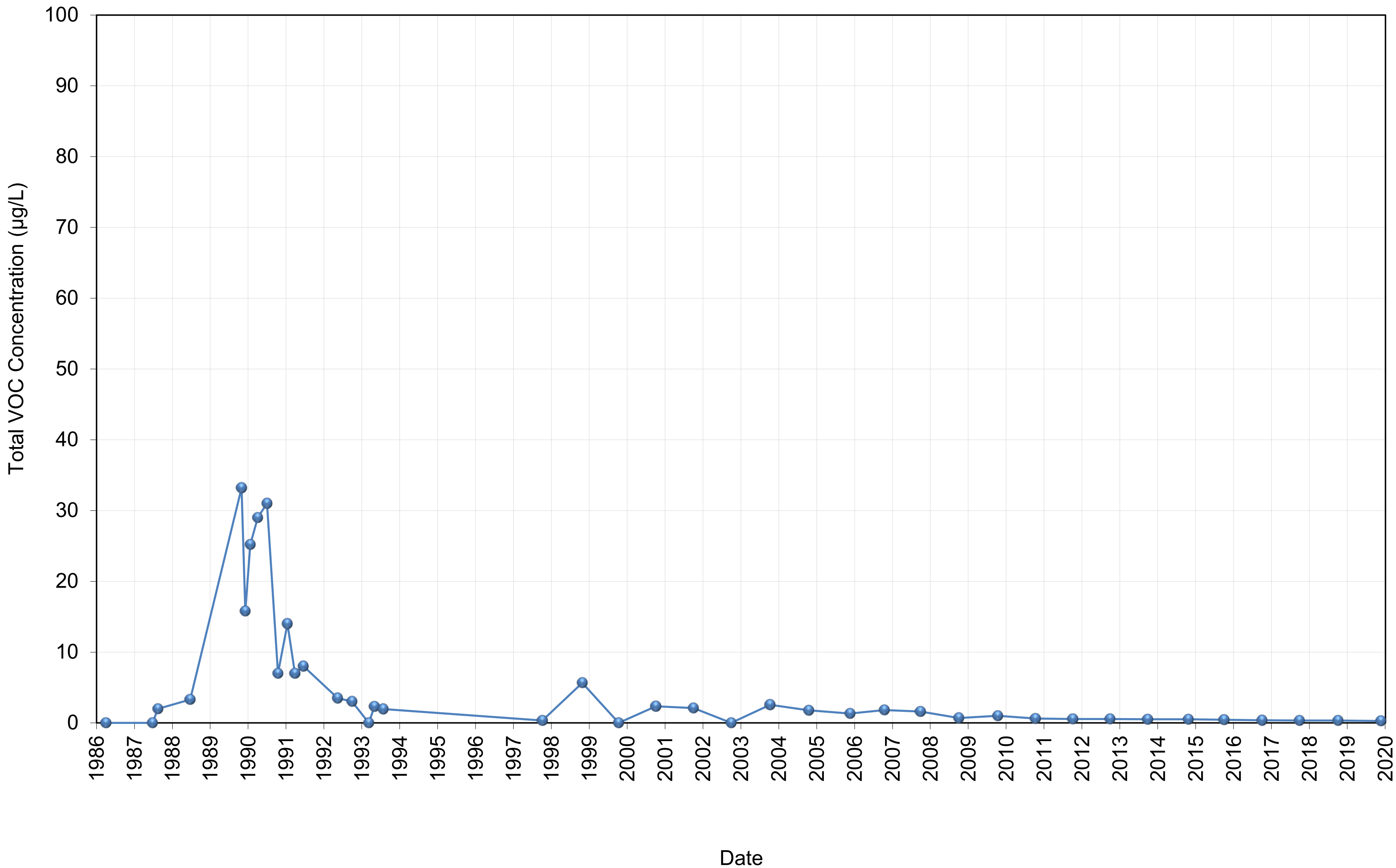
Historical Total VOC Concentrations
MW12B
Highway 96 Site
White Bear Township, Minnesota



GHD 002012 (71)

Figure 4.6

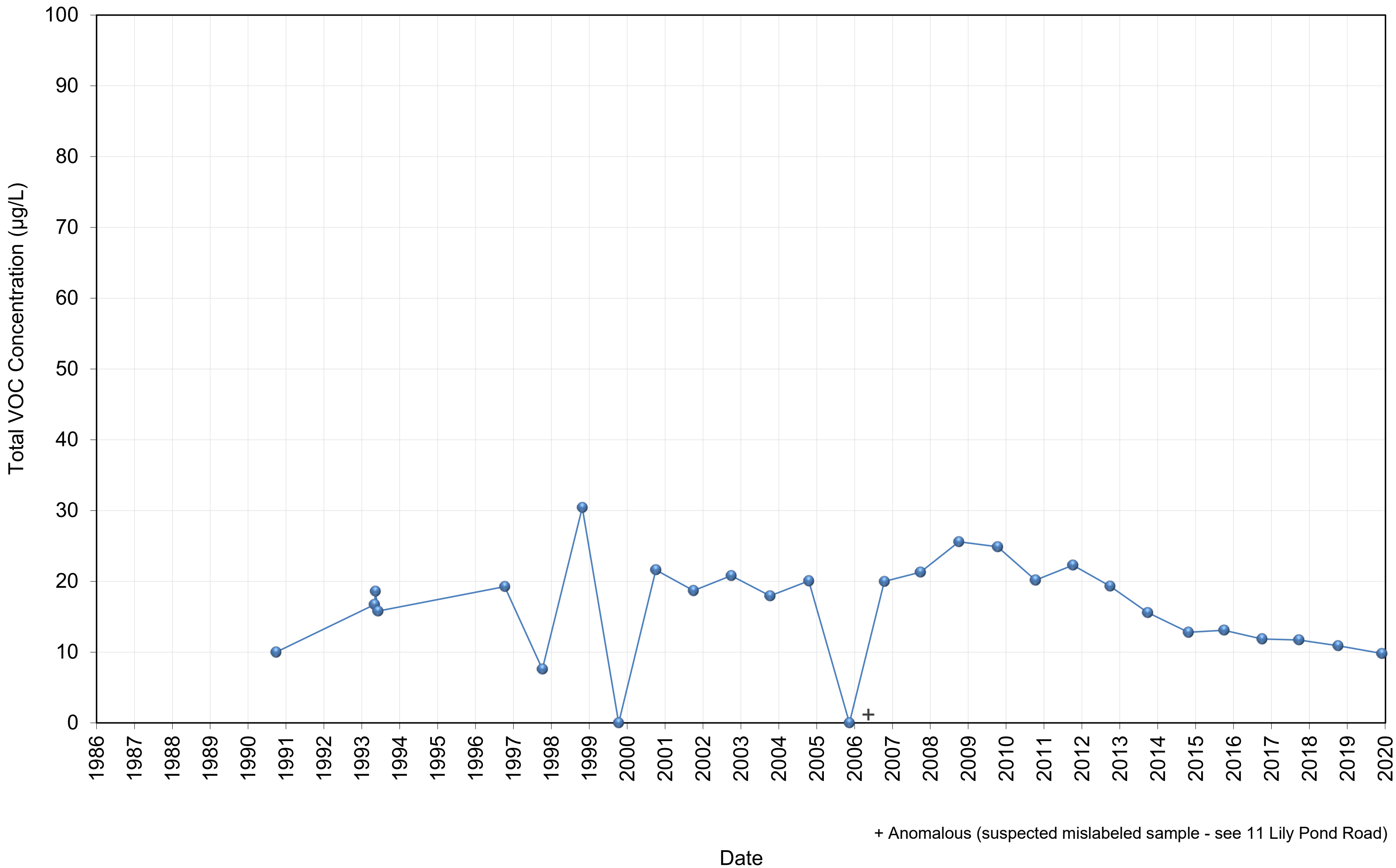
Historical Total VOC Concentrations
11 Robb Farm Road
Highway 96 Site
White Bear Township, Minnesota



GHD 002012 (71)

Figure 4.7

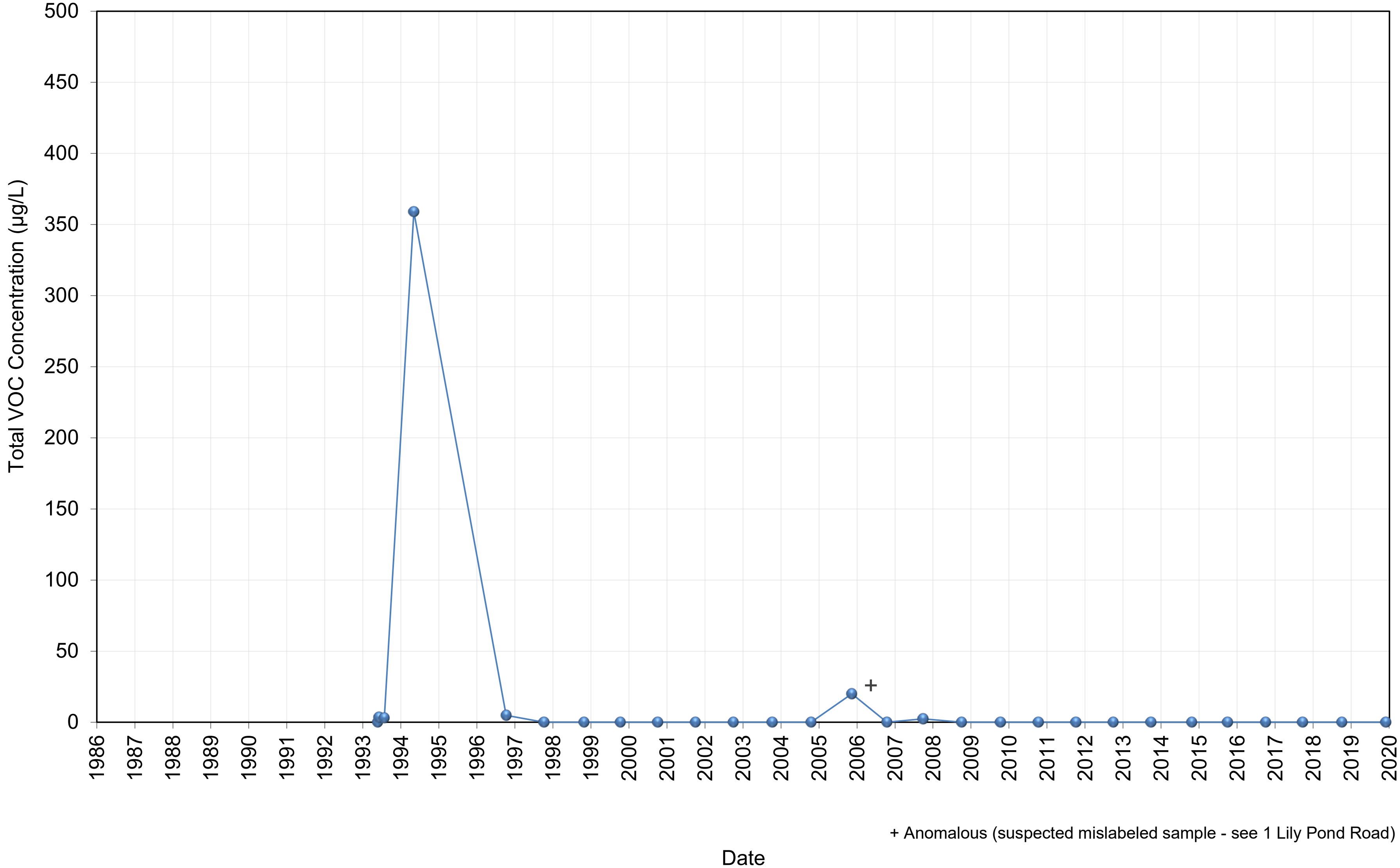
Historical Total VOC Concentrations
1 Lily Pond Road
Highway 96 Site
White Bear Township, Minnesota



GHD 002012 (71)

Figure 4.8

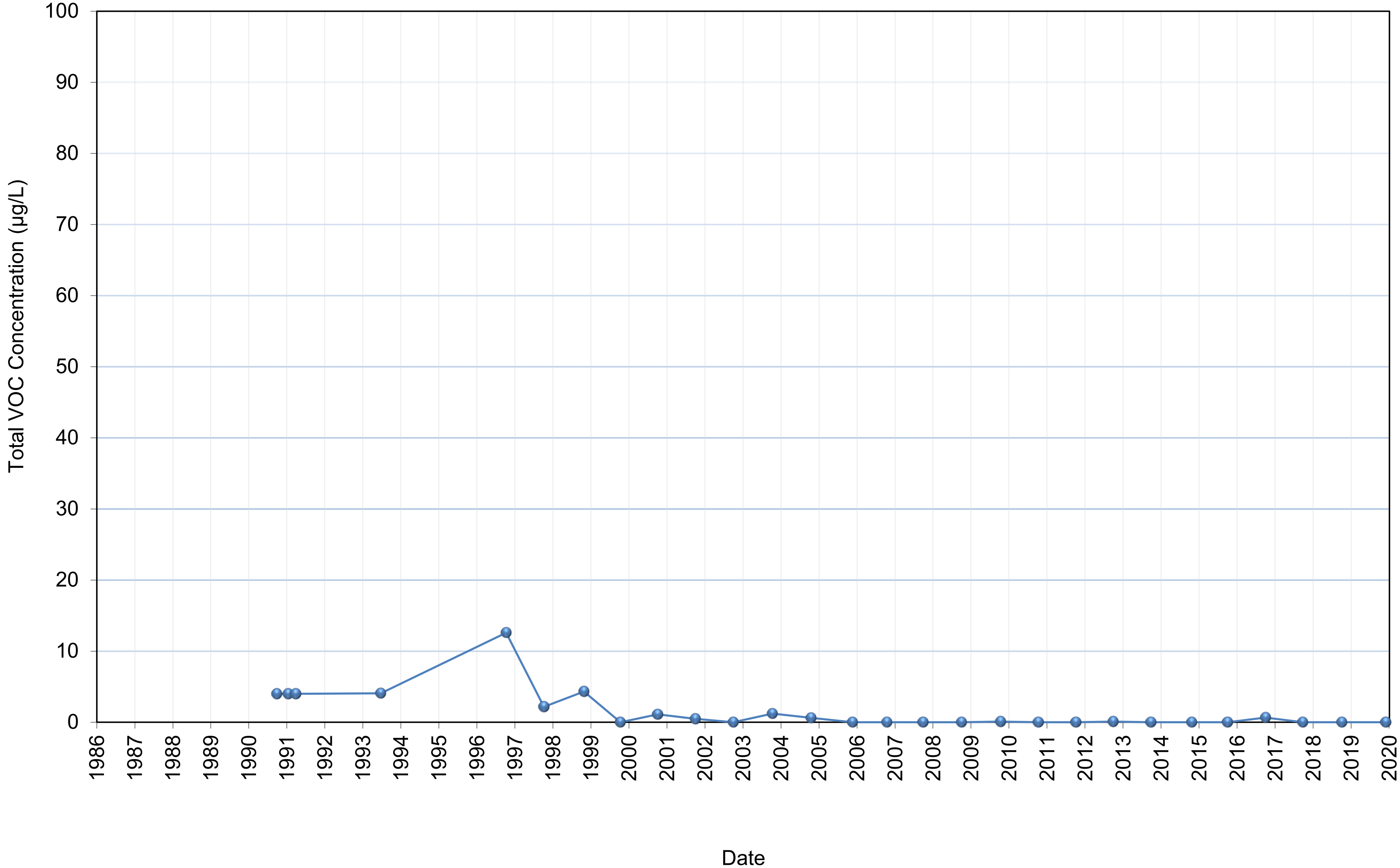
Historical Total VOC Concentrations
11 Lily Pond Road
Highway 96 Site
White Bear Township, Minnesota



GHD 002012 (71)

Figure 4.9

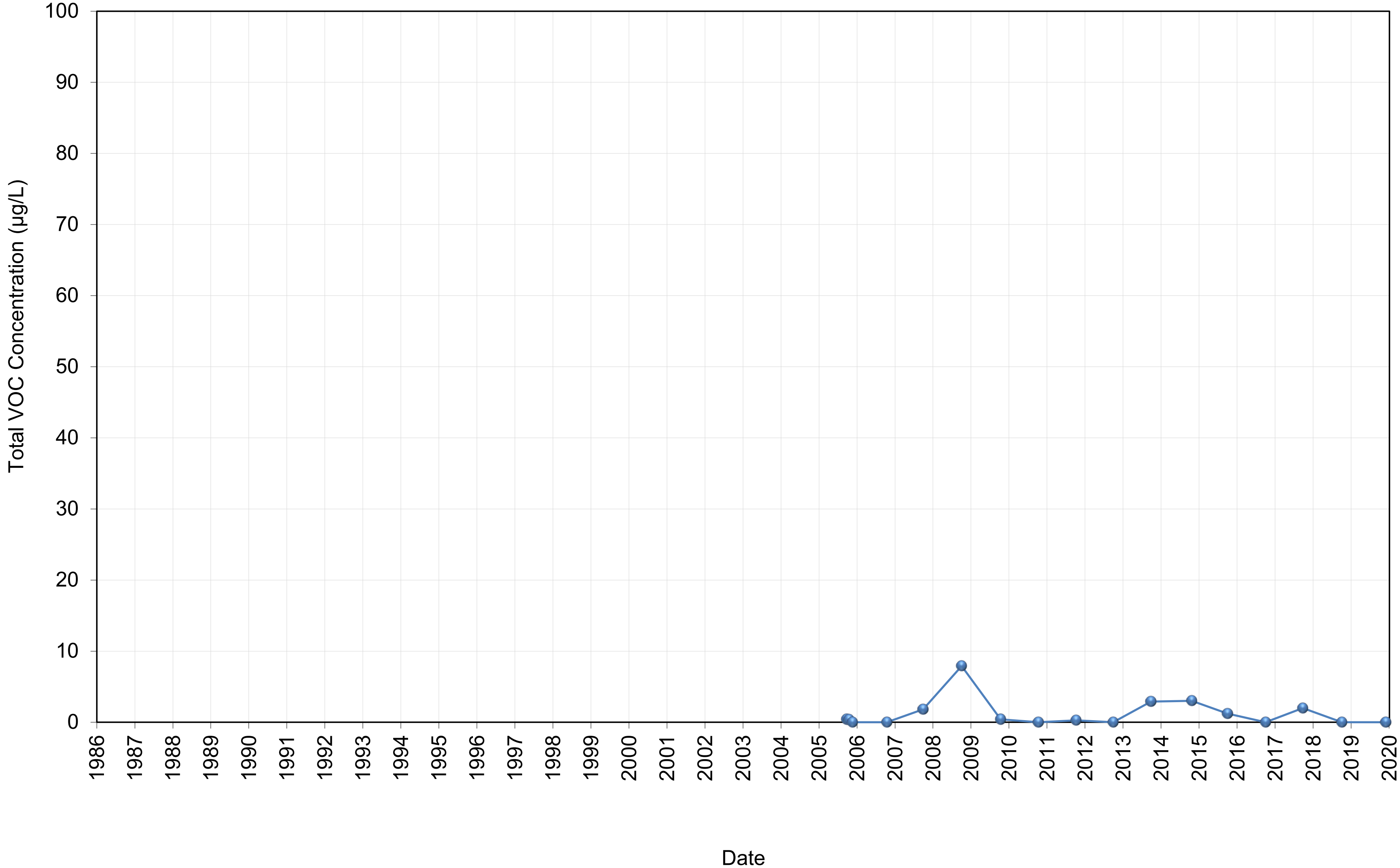
Historical Total VOC Concentrations
6 Blue Goose Road
Highway 96 Site
White Bear Township, Minnesota



GHD 002012 (71)

Figure 4.10

Historical Total VOC Concentrations
MW17L
Highway 96 Site
White Bear Township, Minnesota



GHD 002012 (71)

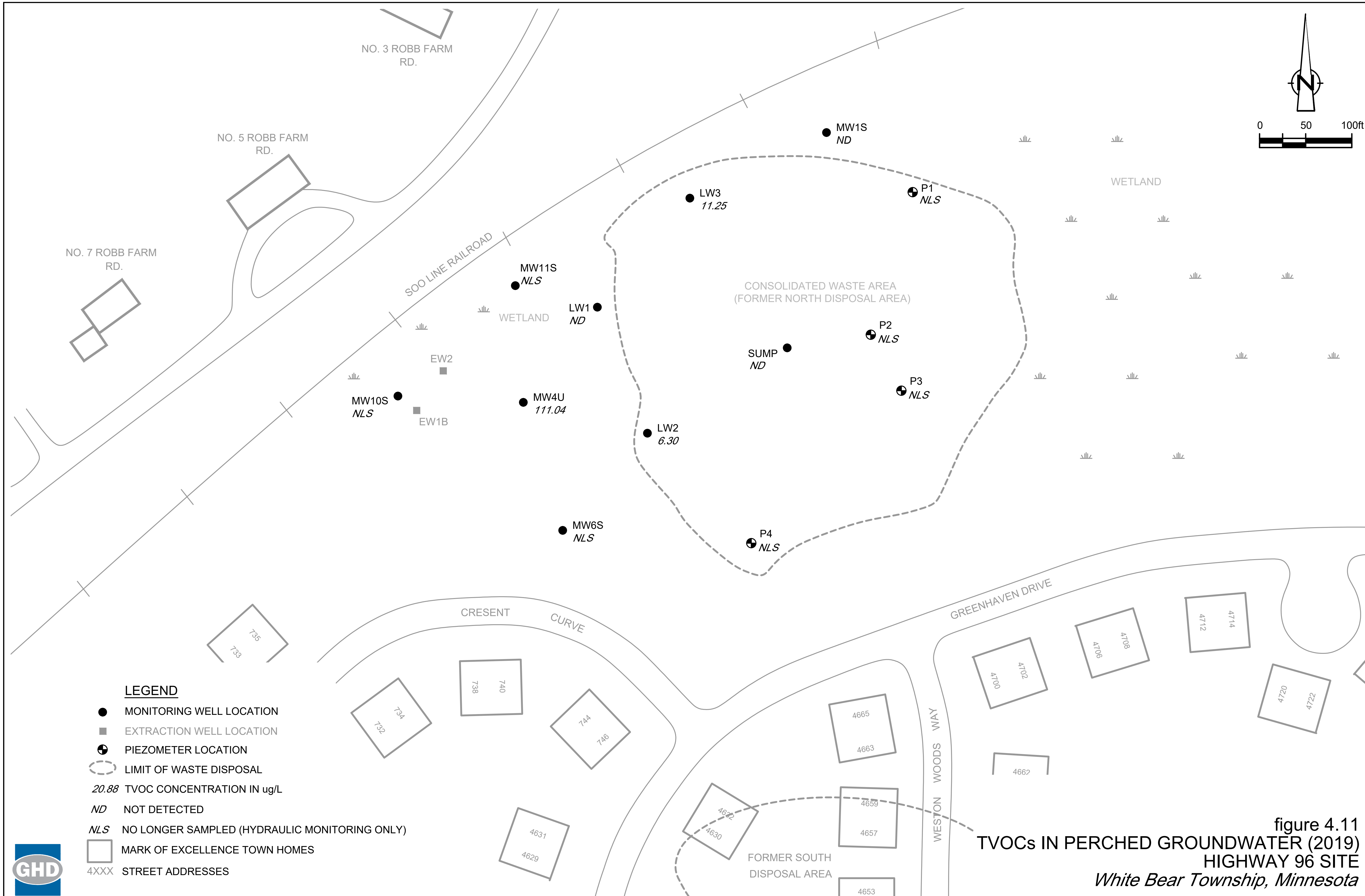


figure 4.11
TVOCs IN PERCHED GROUNDWATER (2019)
HIGHWAY 96 SITE
White Bear Township, Minnesota

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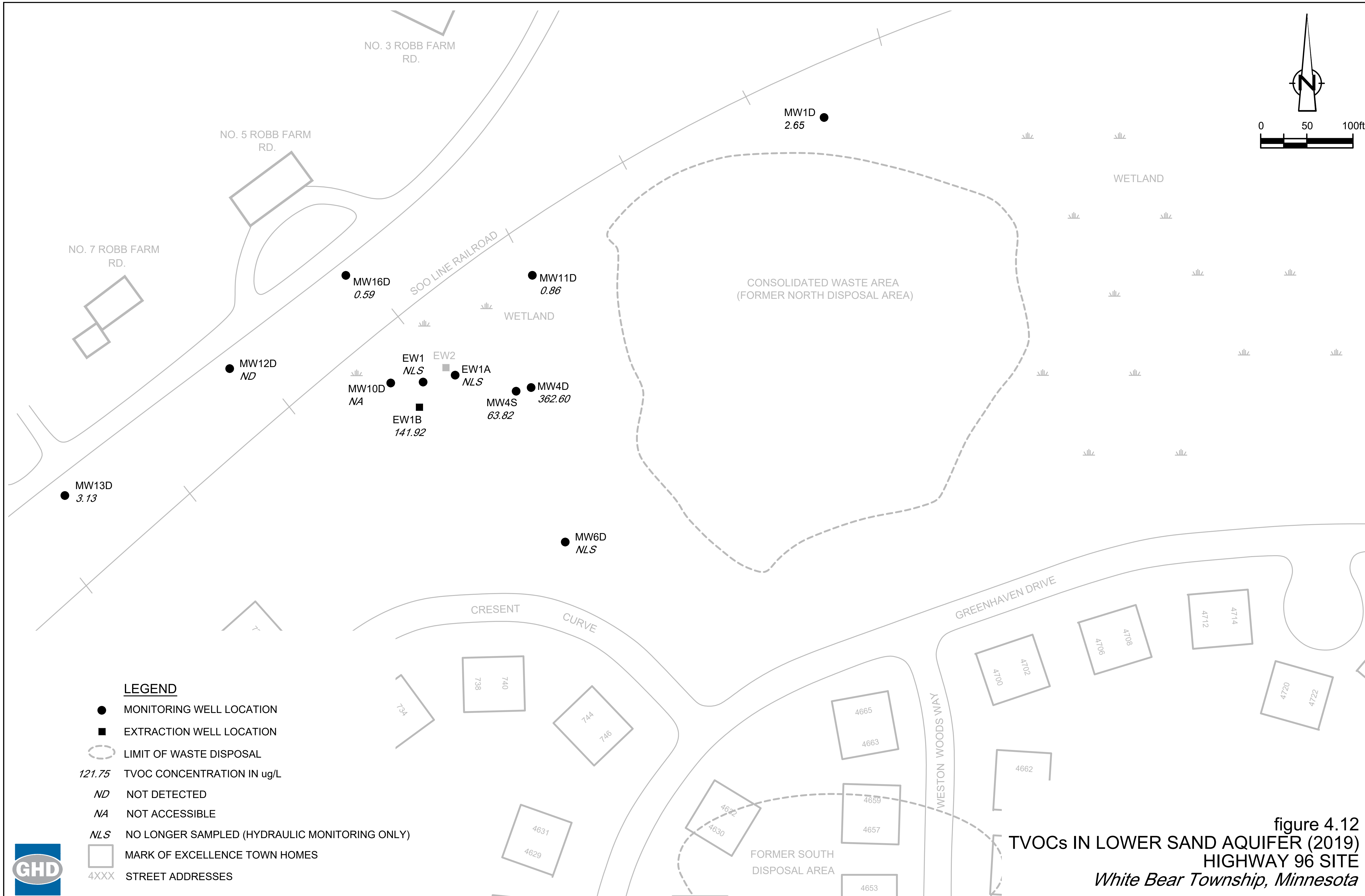

figure 4.12
TVOCs IN LOWER SAND AQUIFER (2019)
HIGHWAY 96 SITE
White Bear Township, Minnesota

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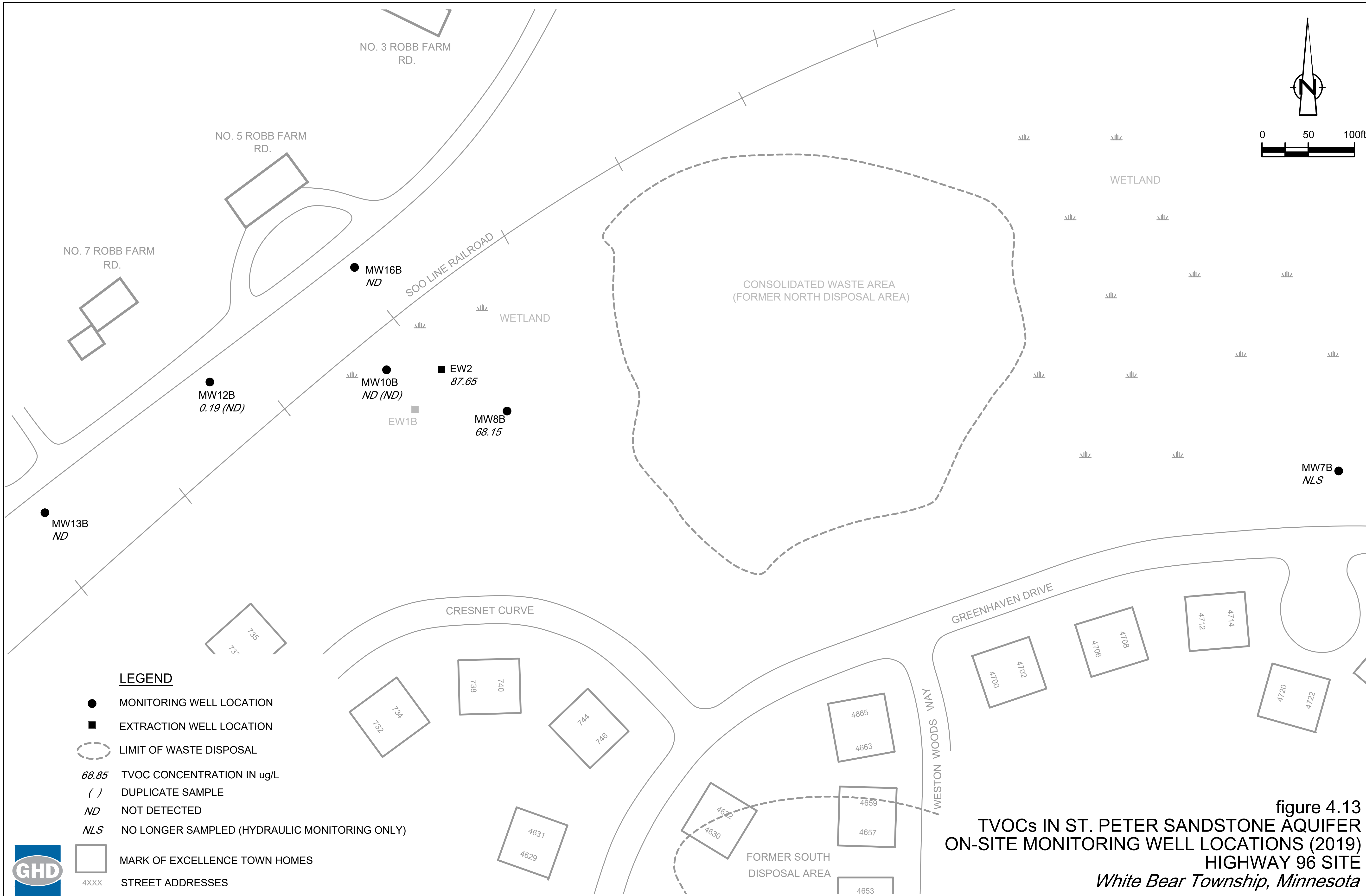

LEGEND

- MONITORING WELL LOCATION
- EXTRACTION WELL LOCATION
- LIMIT OF WASTE DISPOSAL
- *68.85* TVOC CONCENTRATION IN ug/L
- *( )* DUPLICATE SAMPLE
- *ND* NOT DETECTED
- *NLS* NO LONGER SAMPLED (HYDRAULIC MONITORING ONLY)
- MARK OF EXCELLENCE TOWN HOMES
- 4XXX STREET ADDRESSES

figure 4.13
TVOCs IN ST. PETER SANDSTONE AQUIFER
ON-SITE MONITORING WELL LOCATIONS (2019)
HIGHWAY 96 SITE
White Bear Township, Minnesota

N:\CA\Waterloo\Legacy\CAD\drawings\02000s\02012\02012-REPORTS\002010-01(071)\002010-01(071)GN\02012-01(071)GN-015.DWG

LEGEND

- TEST EXTRACTION WELL LOCATION
- MONITORING WELL LOCATION
- * CONVERTED RESIDENTAL MONITORING WELL LOCATION
- 10.90 TVOC CONCENTRATION IN ug/L
- ND NOT DETECTED
- ( ) DUPLICATE SAMPLE
- CONNECTED TO MUNICIPAL WATER SUPPLY
- VOCS DETECTED (INCLUDING VINYL CHLORIDE)
- VOCS DETECTED (VINYL CHLORIDE NOT DETECTED)
- VOCS NOT DETECTED

GHD

figure 4.14
TVOCs IN ST. PETER SANDSTONE AQUIFER
OFF-SITE MONITORING WELL LOCATIONS (2019)
HIGHWAY 96 SITE
White Bear Township, Minnesota

N:\CA\Waterloo\Legacy\CAD\drawings\02000s\02012\02012-REPORTS\002010-01(071)\002010-01(071)GN\02012-01(071)GN-016.DWG

LEGEND

- ● MONITORING WELL LOCATION
- * CONVERTED RESIDENTAL MONITORING WELL LOCATION
- *ND* NOT DETECTED
- *( )* DUPLICATE SAMPLE
- CONNECTED TO MUNICIPAL WATER SUPPLY
- VOCS DETECTED (INCLUDING VINYL CHLORIDE)
- VOCS DETECTED (VINYL CHLORIDE NOT DETECTED)
- VOCS NOT DETECTED

figure 4.15

TVOCs IN PRAIRIE DU CHIEN AQUIFER (2019)

HIGHWAY 96 SITE

White Bear Township, Minnesota

GHD

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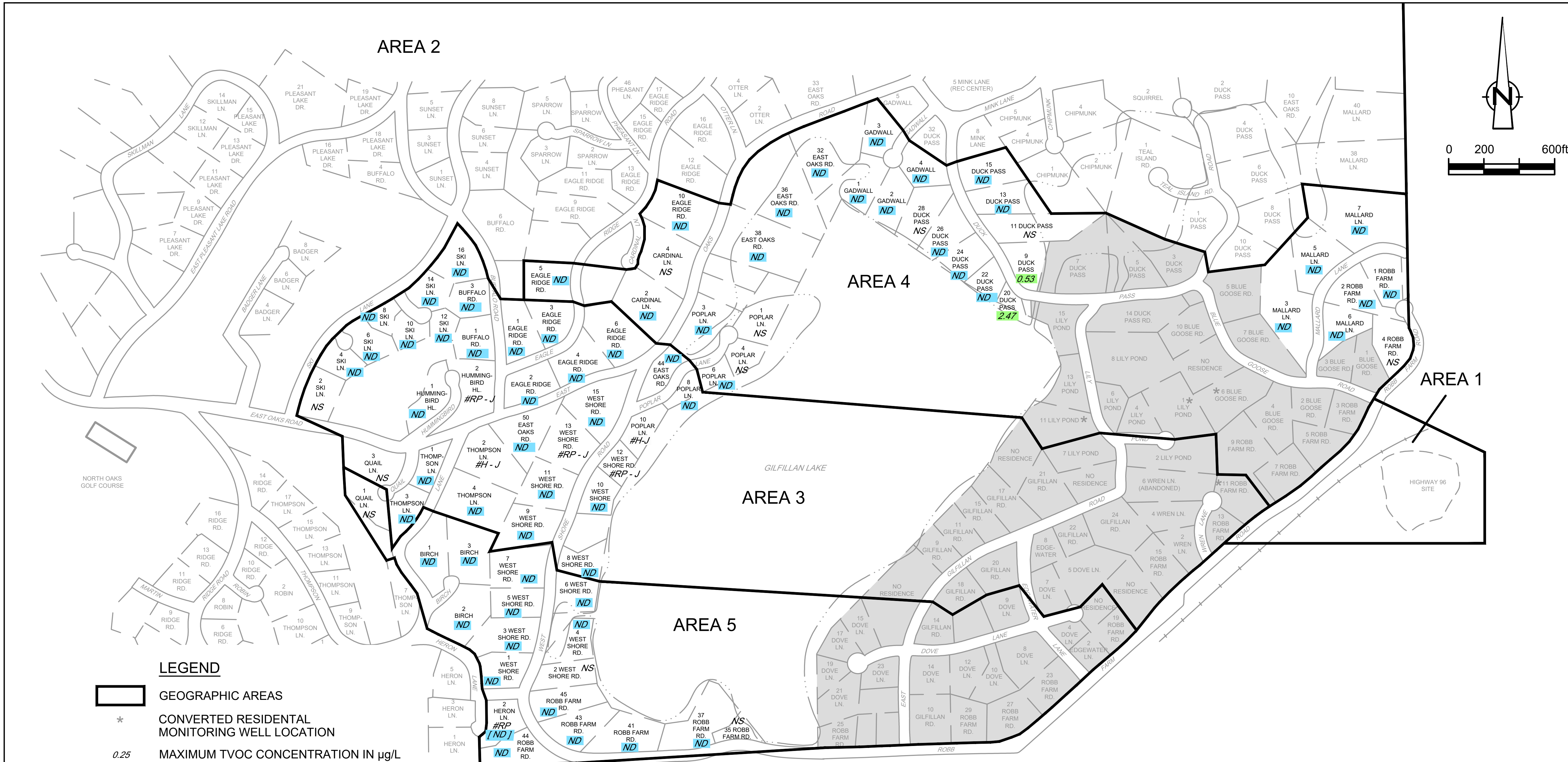
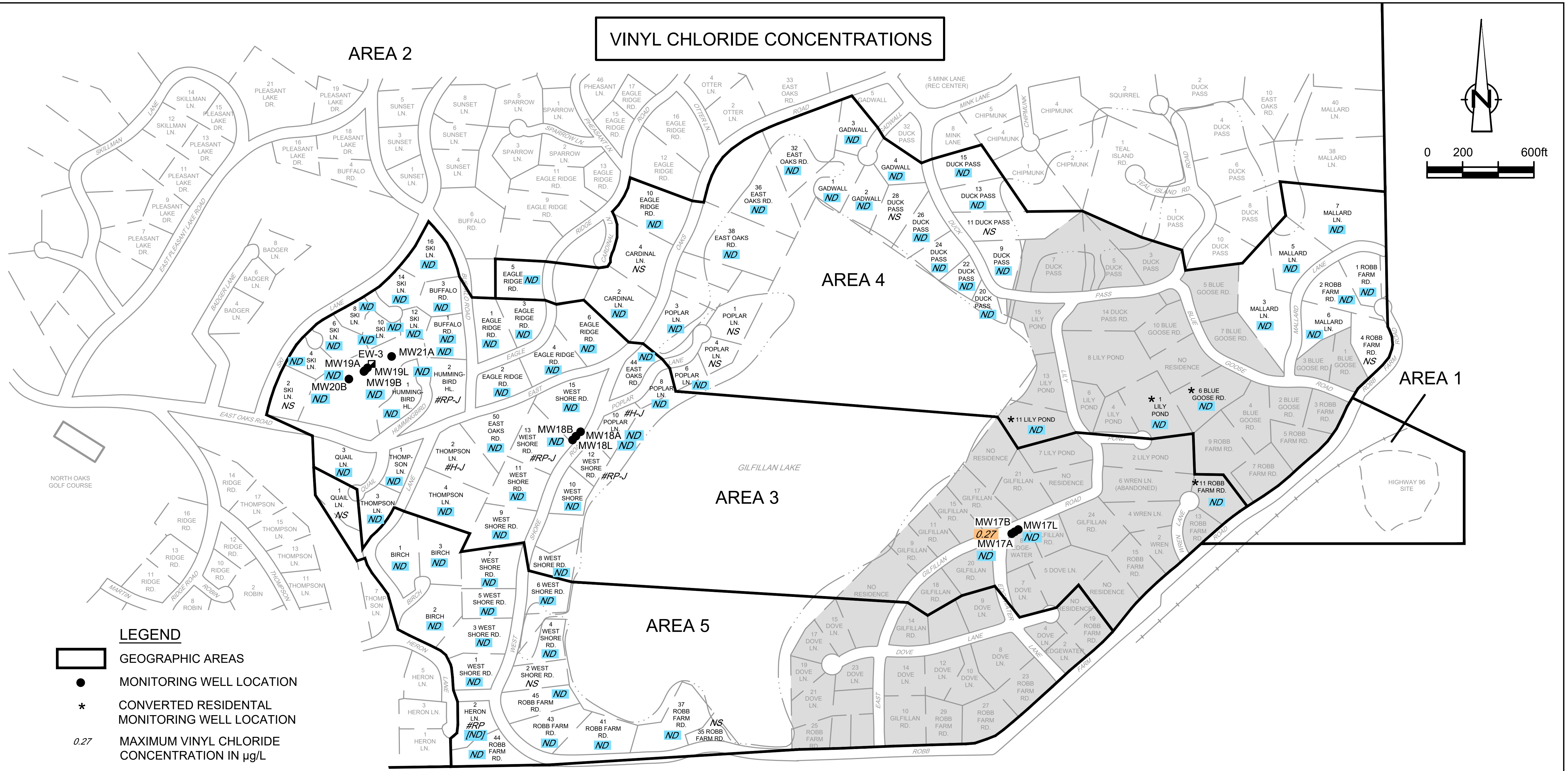


LEGEND

- GEOGRAPHIC AREAS
- * CONVERTED RESIDENTAL MONITORING WELL LOCATION
- *0.25* MAXIMUM TVOC CONCENTRATION IN µg/L
- *ND* NOT DETECTED
- *NS* NOT SAMPLED (NO RESPONSE/DECLINED/WATER OFF)
- *[ ]* NEW (DEEPER) WELL RESULT
- *#RP* REPLACEMENT WELL INSTALLED BY RPs [PRAIRIE DU CHIEN AQUIFER] (OLD WELL ABANDONED)
- *#RP-J* REPLACEMENT WELL INSTALLED BY RPs [EXTENDED INTO JORDAN AQUIFER AT HOMEOWNERS EXPENSE] (OLD WELL ABANDONED)
- *#H-J* NEW WELL INSTALLED BY HOMEOWNER [JORDAN AQUIFER] (OLD WELL ABANDONED)
- CONNECTED TO MUNICIPAL WATER SUPPLY
- VOCS DETECTED (INCLUDING VINYL CHLORIDE) [DETECTION(S) IN RESIDENTIAL WELL SAMPLE ABOVE HEALTH STANDARD(S)]
- VOCS DETECTED (INCLUDING VINYL CHLORIDE) [ALL DETECTION(S) IN RESIDENTIAL WELL SAMPLE BELOW HEALTH STANDARD(S)]
- VOCS DETECTED (VINYL CHLORIDE NOT DETECTED) [ALL DETECTION(S) IN RESIDENTIAL WELL SAMPLE BELOW HEALTH STANDARD(S)]
- VOCS NOT DETECTED

figure 4.16

MAXIMUM TVOC CONCENTRATIONS IN RESIDENTIAL WELLS (2019)
HIGHWAY 96 SITE
White Bear Township, Minnesota



LEGEND

- GEOGRAPHIC AREAS
- ● MONITORING WELL LOCATION
- * CONVERTED RESIDENTAL MONITORING WELL LOCATION
- *0.27* MAXIMUM VINYL CHLORIDE CONCENTRATION IN µg/L
- *ND* NOT DETECTED (DETECTION LIMIT ≤ 0.086 µg/L)
- *NS* NOT SAMPLED (NO RESPONSE/DECLINED/WATER OFF)
- *[ ]* NEW (DEEPER) WELL RESULT
- *#RP* REPLACEMENT WELL INSTALLED BY RPs [PRAIRIE DU CHIEN AQUIFER] (OLD WELL ABANDONED)
- *#RP-J* REPLACEMENT WELL INSTALLED BY RPs [EXTENDED INTO JORDAN AQUIFER AT HOMEOWNERS EXPENSE] (OLD WELL ABANDONED)
- *#H-J* NEW WELL INSTALLED BY HOMEOWNER [JORDAN AQUIFER] (OLD WELL ABANDONED)
- CONNECTED TO MUNICIPAL WATER SUPPLY
- VINYL CHLORIDE DETECTED IN RESIDENTIAL WELL SAMPLE ABOVE HEALTH STANDARD
- VINYL CHLORIDE DETECTED
- VINYL CHLORIDE NOT DETECTED

figure 4.17

MAXIMUM VINYL CHLORIDE CONCENTRATIONS IN OFF-SITE MONITORING WELL AND RESIDENTIAL WELL LOCATIONS (2019)
HIGHWAY 96 SITE
White Bear Township, Minnesota

GHD

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Tables

Table 1.1

Monitoring Well Network
Highway 96 Site
White Bear Township, Minnesota

Location	Operable Unit [1]	Geographic Area [2]	Hydraulic Monitoring Frequency [3]	Sampling Frequency [3]	Analytical Parameters (Method) VOCs (8260)	Analytical Parameters (Method) VOCs (524.2)	Analytical Parameters (Method) Chloride (300.0A)
Perched Groundwater Unit							
LW1	OU2	Area 1	Annually	Annually	X	-	X
LW2	OU2	Area 1	Annually	Annually	X	-	X
LW3	OU2	Area 1	Annually	Annually	X	-	X
MW1S	OU2	Area 1	Annually	Annually	X	-	X
MW4U	OU2	Area 1	Annually	Annually	X	-	X
MW6S	OU2	Area 1	Annually	-	-	-	-
MW10S	OU2	Area 1	Annually	-	-	-	-
MW11S	OU2	Area 1	Annually	-	-	-	-
P1	OU2	Area 1	Annually	-	-	-	-
P2	OU2	Area 1	Annually	-	-	-	-
P3	OU2	Area 1	Annually	-	-	-	-
P4	OU2	Area 1	Annually	-	-	-	-
SUMP	OU2	Area 1	Annually	Annually	X	-	X
Glacial Drift (Lower Sand) Aquifer							
EW1	OU2	Area 1	Annually	-	-	-	-
EW1A	OU2	Area 1	Annually	-	-	-	-
EW1B *	OU2	Area 1	Annually	Annually	X	-	X
MW1D	OU2	Area 1	Annually	Annually	X	-	X
MW4D	OU2	Area 1	Annually	Annually	X	-	X
MW4S	OU2	Area 1	Annually	Annually	X	-	X
MW6D	OU2	Area 1	Annually	-	-	-	-
MW10D	OU2	Area 1	Annually	Annually	X	-	X
MW11D	OU2	Area 1	Annually	Annually	X	-	X
MW12D [c]	OU2	Area 1	Annually	Annually	X	-	X
MW13D [c]	OU2	Area 1	Annually	Annually	X	-	X
MW16D [c]	OU2	Area 1	Annually	Annually	X	-	X
Upper St. Peter Sandstone Aquifer							
EW2 *	OU2	Area 1	Annually	Annually	X	-	X
MW7B	OU2	Area 1	Annually	-	-	-	-
MW8B	OU2	Area 1	Annually	Annually	X	-	X
MW10B [c]	OU2	Area 1	Annually	Annually	X	-	X
MW12B [c]	OU2	Area 1	Annually	Annually	X	-	X
MW13B [c]	OU2	Area 1	Annually	Annually	X	-	X
MW16B [c]	OU2	Area 1	Annually	Annually	X	-	X
MW17A	OU4	Area 3 - East	Annually	Annually	-	X	X
MW18A	OU4	Area 3 - West	Annually	Annually	-	X	X
MW19A	OU4	Area 3 - West	Annually	Annually	-	X	X
MW21A	OU4	Area 3 - West	Annually	Annually	-	X	X

Table 1.1

Monitoring Well Network
Highway 96 Site
White Bear Township, Minnesota

Location	Operable Unit (1)	Geographic Area (2)	Hydraulic Monitoring Frequency (3)	Sampling Frequency (3)	Analytical Parameters (Method) VOCs (8260)	VOCs (524.2)	Chloride (300.0A)
Basal St. Peter Sandstone Aquifer							
EW3	OU4 [v]	Area 3 - West	Annually [v]	Annually [v]	-	X	X
MW17B	OU4	Area 3 - East	Annually	Annually	-	X	X
MW18B	OU4	Area 3 - West	Annually	Annually	-	X	X
MW19B	OU4	Area 3 - West	Annually	Annually	-	X	X
MW20B	OU4	Area 3 - West	Annually	Annually	-	X	X
6 Blue Goose Road #	OU4	Area 4 - East	Annually	Annually	-	X	X
1 Lily Pond Road #	OU4	Area 4 - East	Annually	Annually	-	X	X
11 Lily Pond Road #	OU4	Area 4 - East	Annually	Annually	-	X	X
11 Robb Farm Road #	OU4	Area 4 - East	Annually	Annually	-	X	X
38 East Oaks Road [a]	OU4	Area 4 - West	Annually [v]	See Table 1.2	-	See Table 1.2	
6 West Shore Road [a]	OU4	Area 5 - West	Annually [v]	See Table 1.2	-	See Table 1.2	
Prairie du Chien Aquifer							
MW17L	OU4	Area 3 - East	Annually	Annually	-	X	X
MW18L	OU4	Area 3 - West	Annually	Annually	-	X	X
MW19L	OU4	Area 3 - West	Annually	Annually	-	X	X

Notes:

(1) - As stipulated in the Minnesota Pollution Control Agency's (MPCA's) Minnesota Decision Document (MDD) for the Highway 96 Site, signed October 7, 1993, and subsequent amendments.
(2) - See Site Figure(s)
(3) - Conducted in October
- Converted Residential Monitoring Well
* - Pumping Well
a - Active Residential Well
c - Compliance Well
v - Performed Voluntarily (no specific MPCA requirement)

Table 1.2

Residential Well Network
Highway 96 Site
White Bear Township, Minnesota

Location	Operable Unit [1]	Geographic Area [2]	Sampling Frequency [1][3]	Analytical Parameters (Method) VOCs (524.2)	Chloride (300.0A)
Birch Lane					
1 Birch Lane	OU4	Area 5	Every Five Years [4]	X	X
2 Birch Lane	OU4	Area 5	Every Five Years [4]	X	X
3 Birch Lane	OU4	Area 5	Every Five Years [4]	X	X
Buffalo Road					
1 Buffalo Road	OU4	Area 3	Annually	X	X
3 Buffalo Road	OU4	Area 3	Annually	X	X
Cardinal Lane					
2 Cardinal Lane	OU4	Area 4	Every Five Years [4]	X	X
4 Cardinal Lane	OU4	Area 4	Every Five Years [4]	X	X
Duck Pass Road					
9 Duck Pass Road	OU4	Area 4	Every Five Years [4]	X	X
11 Duck Pass Road	OU4	Area 4	Every Five Years [4]	X	X
13 Duck Pass Road	OU4	Area 4	Every Five Years [4]	X	X
15 Duck Pass Road	OU4	Area 4	Every Five Years [4]	X	X
20 Duck Pass Road	OU4	Area 4	Every Five Years [4]	X	X
22 Duck Pass Road	OU4	Area 4	Every Five Years [4]	X	X
24 Duck Pass Road	OU4	Area 4	Every Five Years [4]	X	X
26 Duck Pass Road	OU4	Area 4	Every Five Years [4]	X	X
28 Duck Pass Road	OU4	Area 4	Every Five Years [4]	X	X
Eagle Ridge Road					
1 Eagle Ridge Road	OU4	Area 3	Annually	X	X
2 Eagle Ridge Road	OU4	Area 3	Annually	X	X
3 Eagle Ridge Road	OU4	Area 3	Annually	X	X
4 Eagle Ridge Road	OU4	Area 3	Annually	X	X
5 Eagle Ridge Road	OU4	Area 4	Every Five Years [4]	X	X
6 Eagle Ridge Road	OU4	Area 3	Annually	X	X
10 Eagle Ridge Road	OU4	Area 4	Every Five Years [4]	X	X
East Oaks Road					
32 East Oaks Road	OU4	Area 4	Every Five Years [4]	X	X
36 East Oaks Road	OU4	Area 4	Every Five Years [4]	X	X
38 East Oaks Road	OU4	Area 4	Every Five Years [4]	X	X
44 East Oaks Road	OU4	Area 3	Annually	X	X
50 East Oaks Road	OU4	Area 3	Annually	X	X

Table 1.2

Residential Well Network
Highway 96 Site
White Bear Township, Minnesota

Location	Operable Unit (1)	Geographic Area (2)	Sampling Frequency (1)(3)	Analytical Parameters (Method)	
				VOCs (524.2)	Chloride (300.0A)
Gadwall Lane					
1 Gadwall Lane	OU4	Area 4	Every Five Years (4)	X	X
2 Gadwall Lane	OU4	Area 4	Every Five Years (4)	X	X
3 Gadwall Lane	OU4	Area 4	Every Five Years (4)	X	X
4 Gadwall Lane	OU4	Area 4	Every Five Years (4)	X	X
Heron Lane					
2 Heron Lane (New Well)	OU4	Area 5	Every Five Years (4)	X	X
Hummingbird Hill					
1 Hummingbird Hill	OU4	Area 3	Annually	X	X
Mallard Lane					
3 Mallard Lane	OU4	Area 4	No Longer Sampled	-	-
5 Mallard Lane	OU4	Area 4	No Longer Sampled	-	-
6 Mallard Lane	OU4	Area 4	No Longer Sampled	-	-
7 Mallard Lane	OU4	Area 4	No Longer Sampled	-	-
Poplar Lane					
1 Poplar Lane	OU4	Area 4	Every Five Years (4)	X	X
3 Poplar Lane	OU4	Area 4	Every Five Years (4)	X	X
4 Poplar Lane	OU4	Area 4	Every Five Years (4)	X	X
6 Poplar Lane	OU4	Area 4	Every Five Years (4)	X	X
8 Poplar Lane	OU4	Area 3	Annually	X	X
Quail Lane					
1 Quail Lane	OU4	Area 5	Every Five Years (4)	X	X
3 Quail Lane	OU4	Area 3	Annually	X	X
Robb Farm Road					
1 Robb Farm Road	OU4	Area 4	No Longer Sampled	-	-
2 Robb Farm Road	OU4	Area 4	No Longer Sampled	-	-
4 Robb Farm Road	OU4	Area 4	No Longer Sampled	-	-
35 Robb Farm Road	OU4	Area 5	Every Five Years (4)	X	X
37 Robb Farm Road	OU4	Area 5	Every Five Years (4)	X	X
41 Robb Farm Road	OU4	Area 5	Every Five Years (4)	X	X
43 Robb Farm Road	OU4	Area 5	Every Five Years (4)	X	X
44 Robb Farm Road	OU4	Area 5	Every Five Years (4)	X	X
45 Robb Farm Road	OU4	Area 5	Every Five Years (4)	X	X

Table 1.2

Residential Well Network
Highway 96 Site
White Bear Township, Minnesota

Location	Operable Unit [1]	Geographic Area [2]	Sampling Frequency [1][3]	Analytical Parameters (Method)	
				VOCs (524.2)	Chloride (300.0A)
Ski Lane					
2 Ski Lane	OU4	Area 3	Annually	X	X
4 Ski Lane	OU4	Area 3	Annually	X	X
6 Ski Lane	OU4	Area 3	Annually	X	X
8 Ski Lane	OU4	Area 3	Annually	X	X
10 Ski Lane	OU4	Area 3	Annually	X	X
12 Ski Lane	OU4	Area 3	Annually	X	X
14 Ski Lane	OU4	Area 3	Annually	X	X
16 Ski Lane	OU4	Area 3	Annually	X	X
Thompson Lane					
1 Thompson Lane	OU4	Area 3	Annually	X	X
3 Thompson Lane	OU4	Area 3	Annually	X	X
4 Thompson Lane	OU4	Area 3	Annually	X	X
West Shore Road					
1 West Shore Road	OU4	Area 5	Every Five Years [4]	X	X
2 West Shore Road	OU4	Area 5	Every Five Years [4]	X	X
3 West Shore Road	OU4	Area 5	Every Five Years [4]	X	X
4 West Shore Road	OU4	Area 5	Every Five Years [4]	X	X
5 West Shore Road	OU4	Area 5	Every Five Years [4]	X	X
6 West Shore Road	OU4	Area 5	Every Five Years [4]	X	X
7 West Shore Road	OU4	Area 5	Every Five Years [4]	X	X
8 West Shore Road	OU4	Area 3	Annually	X	X
9 West Shore Road	OU4	Area 3	Annually	X	X
10 West Shore Road	OU4	Area 3	Annually	X	X
11 West Shore Road	OU4	Area 3	Annually	X	X
15 West Shore Road	OU4	Area 3	Annually	X	X

Notes:

(1) - As stipulated in the Minnesota Pollution Control Agency's (MPCA's) Minnesota Decision Document (MDD) for the Highway 96 Site, signed 10/7/1993, and subsequent amendments signed 8/26/2008 and 12/30/2019.

(2) - See Site Figure(s)

(3) - Sampling events conducted in October

(4) - Next scheduled event is in 2024

Table 3.1

2019 Groundwater Elevations
Highway 96 Site
White Bear Township, Minnesota

Location	TOC (ft. AMSL)	October 23-24, 2019	
		WL (ft BTOC)	GWE (ft. AMSL)
Perched Groundwater Unit			
LW1	938.86	4.70	934.16
LW2	945.66	7.52	938.14
LW3	944.82	9.06	935.76
MW1S	950.65	13.63	937.02
MW4U	939.65	23.69	915.96
MW6S	948.44	16.42	932.02
MW10S	935.94	3.26	932.68
MW11S	936.34	3.18	933.16
P1	941.70	2.72	938.98
P2	946.11	7.26	938.85
P3	947.11	4.35	942.76
P4	948.16	8.26	939.90
SUMP	946.71	7.27	939.44
Glacial Drift (Lower Sand) Aquifer			
EW1	936.66	35.20	901.46
EW1A	938.67	37.25	901.42
EW1B * (On)	939.99	62.42	877.57
MW1D	951.02	48.22	902.80
MW4D	940.48	38.69	901.79
MW4S	940.33	32.92	907.41
MW6D	948.15	45.18	902.97
MW10D	935.94	NM	NM
MW11D	935.40	27.32	908.08
MW12D	940.52	32.77	907.75
MW13D	937.66	32.23	905.43
MW16D	940.70	38.13	902.57
Upper St. Peter Sandstone Aquifer			
EW2 * (On)	938.67	37.76	900.91
MW7B	942.91	39.08	903.83
MW8B	940.91	39.27	901.64
MW10B	936.64	35.00	901.64
MW12B	939.89	38.28	901.61
MW13B	938.34	36.85	901.49
MW16B	940.71	38.70	902.01
MW17A	914.58	15.28	899.30
MW18A	925.39	29.96	895.43
MW19A	913.56	21.20	892.36
MW21A	909.03	16.53	892.50

Table 3.1

2019 Groundwater Elevations
Highway 96 Site
White Bear Township, Minnesota

Location	TOC (ft. AMSL)	October 23-24, 2019	
		WL (ft BTOC)	GWE (ft. AMSL)
Basal St. Peter Sandstone Aquifer			
EW3	913.88	25.48	888.40
MW17B	914.50	21.62	892.88
MW18B	925.24	32.93	892.31
MW19B	913.33	25.71	887.62
MW20B	915.04	26.32	888.72
6 Blue Goose Road #	954.15	57.80	896.35
1 Lily Pond Road #	930.88	31.11	899.77
11 Lily Pond Road #	928.54	34.11	894.43
11 Robb Farm Road #	942.63	42.67	899.96
38 East Oaks Road ^	926.25	35.79	890.46
6 West Shore Road ^	920.20	29.15	891.05
Prairie du Chien Aquifer			
MW17L	914.65	24.44	890.21
MW18L	925.44	38.05	887.39
MW19L	914.18	29.17	885.01

Notes:

ft. AMSL - Feet Above Mean Sea Level
ft. BTOC - Feet Below Top of Casing
GWE - Groundwater Elevation
NM - Not Measured (inaccessible)
TOC - Top of Casing
WL - Water Level
* - Pumping Well
    - EW1B: 3.5 gpm [typically ~10 gpm - see Table 3.3]
    - EW2: 10.2 gpm
- Converted Residential Monitoring Well
^ - Active Residential Well

Table 3.2

2019 Operation and Maintenance Activities
Highway 96 Site
White Bear Township, Minnesota

Date	Location	Event	Remedy	Contractor
1/11/2019	EW2	Repairs	Replaced clogged pressure gauge.	GHD (S. Roste)
7/16/2019	Landfill Cap, Pump House, Ski Lane Ravine	Routine Maintenance	Trimmed around vents/probes/wells; Mowed landfill cap, around pump house, and Ski Lane Ravine.	GHD (B. Lardy, W. Opheim)
7/31/2019	Landfill Cap	Routine Maintenance	Install T-post markers near wells, paint/repaint T-posts with fluorescent paint.	GHD (W. Opheim)
8/21/2019	Pump House	Routine Maintenance	Replaced latch lock on pump house; Added additional sealant around ceiling vent.	GHD (W. Opheim)
10/23/2019	Landfill Cap	Annual Inspection	Conducted annual landfill cap inspection.	GHD (K. Jenkin)
11/8/2019	EW1B	Operational Adjustment	Pumping rate dropped to <5 gpm due to scale buildup and biofouling; Pump shut down for troubleshooting/repairs.	GHD (W. Opheim)
11/13/2019	EW1B/EW2	Repairs, Operational Adjustments	Cleaned EW1B flow meter/discharge piping, restarted pump, set interim pumping rate to 5 gpm and scheduled well rehabilitation; Increased pumping rate of EW2 to 17 gpm to compensate for EW1B.	GHD (S. Roste, W. Opheim)
11/15/2019	Pump House	Repairs	Replaced broken wall heater.	GHD (S. Roste)
12/10/2019 - 12/12/2019	EW1B, EW2	Routine Performance Assessment	Conducted specific capacity checks to establish pre-rehab baseline.	GHD (S. Roste, W. Opheim)
12/17/2019 - 12/20/2019	EW1B, EW2, Sump	Routine Well Rehabilitation, Routine Maintenance	EW1B/EW2: Performed mechanical treatment (jet/surge/airlift); performed chemical treatment (EW1B only); cleaned/tested/repaired pumps; snaked discharge lines; replaced totalizers; replaced pressure gauges; replaced pump protection control box (EW1B only). Sump: Pulled pump; Capped discharge and electrical lines; Removed piping and components.	GHD (S. Roste, R. Aamot, W. Opheim) SDE (Sub-Driller)

Table 3.3

2019 Groundwater Extraction Rates
Highway 96 Site
White Bear Township, Minnesota

	Average Pumping Rate		
Month	**EW1B (gpm)**	**EW2 (gpm)**	**Combined EW * (gpm)**
January	9.4	10.6	20.0
February	9.9	9.5	19.3
March	7.6	9.9	17.5
April	12.1	9.8	21.9
May	10.3	11.2	21.5
June	10.1	10.8	20.9
July	10.3	10.0	20.3
August	9.5	10.0	19.5
September	9.2	10.8	20.0
October	4.3 (1)	10.9	15.1
November	3.4 (1)	14.6 (2)	18.0
December	5.7 (3)	13.0 (2)(3)	18.7
Annual Average	**8.5**	**10.9**	**19.4**

Notes:

* - Combined pumping rate of EW1B and EW2 to be maintained between 13 and 20 gpm, as outlined in CRA's letter to MPCA dated July 9, 2010.

(1) - Well rehabilitation scheduled

(2) - Pumping rate temporarily increased to compensate for reduced rate at EW1B

(2) - Well rehabilitation conducted December 17-20, 2019 (see Table 3.2)

Table 4.1

Historical Groundwater Sampling Event Summary
Highway 96 Site
White Bear Township, Minnesota

Round	Date	Sampled By	Event Description
1	January 1986	USEPA	Samples from monitoring and residential wells
2	June 1987	CRA	Samples from leachate, monitoring, and residential wells
3	January 1988	CRA	Samples from leachate, monitoring, and residential wells
4	August 1988	CRA	Samples from leachate, monitoring, and residential wells
5	March 1989	CRA	Samples from leachate, monitoring, and residential wells
6	July 1989	CRA	Samples from leachate, monitoring, and residential wells
7	October 1989	CRA	Samples from leachate, monitoring, and residential wells
8	January 1990	CRA	Samples from leachate, monitoring, and residential wells
9	May 1990	CRA	Samples from leachate, monitoring, and residential wells
10	September 1990	CRA	Samples from leachate, monitoring, and residential wells
11	December 1990	CRA	Samples from leachate, monitoring, and residential wells
12	March 1991	CRA	Samples from leachate, monitoring, and residential wells
13	June 1991	CRA	Samples from leachate, monitoring, and residential wells
14	December 1991	CRA	Samples from leachate, monitoring, and residential wells
15	May 1992	CRA	Samples from leachate, monitoring, and residential wells
16	November 1992	CRA	Samples from leachate, monitoring, and residential wells
17	May 1993	CRA	Samples from leachate, monitoring, and residential wells
18	October 1993	CRA	Samples from leachate, monitoring, and residential wells
19	January 1994	CRA	Samples from residential wells
20	April 1994	CRA	Samples from residential wells
21	May 1994	CRA	Samples from residential wells
22	August 1994	CRA	Samples from leachate and monitoring wells
23	November 1994	CRA	Samples from residential wells
24	December 1994	CRA	Samples from leachate, monitoring, and residential wells
25	May 1995	CRA	Samples from leachate, monitoring, and residential wells
26	October 1995	CRA	Samples from leachate, monitoring, and residential wells
27	May 1996	CRA	Samples from leachate and monitoring wells
28	October 1996	CRA	Samples from leachate, monitoring, and residential wells
29	May 1997	CRA	Samples from leachate and monitoring wells
30	October 1997	CRA	Samples from leachate, monitoring, and residential wells
31	May 1998	CRA	Samples from leachate and monitoring wells
32	October 1998	CRA	Samples from leachate, monitoring, and residential wells
33	Oct/Nov 1999	CRA	Samples from pilot study, leachate, monitoring, and residential wells
34	Jan/Feb 2000	CRA	Samples from compliance point wells
35	October 2000	CRA	Samples from leachate, monitoring, and residential wells
36	November 2001	CRA	Samples from leachate, monitoring, and residential wells
37	October 2002	CRA	Samples from leachate, monitoring, and residential wells
38	October 2003	CRA	Samples from leachate, monitoring, and residential wells
39	October 2004	CRA	Samples from leachate, monitoring, and residential wells
40	January 2005	CRA	Samples from residential wells
41	February 2005	CRA/MPCA	Samples from residential wells

Table 4.1

Historical Groundwater Sampling Event Summary
Highway 96 Site
White Bear Township, Minnesota

Round	Date	Sampled By	Event Description
42	March 2005	CRA/MPCA	Samples from residential wells
43	April 2005	MPCA	Samples from residential wells
44	May 2005	CRA/MPCA	Samples from residential wells
45	June 2005	CRA/MPCA	Samples from residential wells
46	August 2005	CRA/MPCA	Samples from residential wells
47	October 2005	CRA	Samples from select monitoring wells
48	November 2005	CRA/MPCA	Samples from leachate, monitoring, and residential wells
49	December 2005	CRA	Samples from select monitoring wells
50	January 2006	CRA	Samples from select monitoring wells
51	February 2006	CRA/MPCA	Samples from residential wells
52	May 2006	CRA/MPCA	Samples from residential wells
53	October 2006	CRA/MPCA	Samples from leachate, monitoring, and residential wells
54	November 2006	CRA	Samples from select monitoring wells
55	January 2007	CRA	Samples from select monitoring wells
56	April 2007	CRA/MPCA	Samples from residential wells
57	October 2007	CRA/MPCA	Samples from leachate, monitoring, and residential wells
58	April/May 2008	CRA/MPCA	Samples from residential wells
59	September 2008	CRA	Samples from select monitoring wells
60	Oct/Nov 2008	CRA/MPCA	Samples from leachate, monitoring, and residential wells
61	April 2009	CRA/MPCA	Samples from residential wells
62	October 2009	CRA/MPCA	Samples from leachate, monitoring, and residential wells
63	April 2010	CRA/MPCA	Samples from residential wells
64	October 2010	CRA/MPCA	Samples from leachate, monitoring, and residential wells
65	April 2011	CRA/MPCA	Samples from residential wells
66	October 2011	CRA/MPCA	Samples from leachate, monitoring, and residential wells
67	April/May 2012	CRA/MPCA	Samples from residential wells
68	October 2012	CRA/MPCA	Samples from leachate, monitoring, and residential wells
69	May 2013	CRA/MPCA	Samples from residential wells
70	Sept/Oct 2013	CRA/MPCA	Samples from leachate, monitoring, and residential wells
71	April 2014	CRA/MPCA	Samples from residential wells
72	Sept/Oct 2014	CRA/MPCA	Samples from leachate, monitoring, and residential wells
73	April 2015	CRA/MPCA	Samples from residential wells
74	October 2015	GHD/MPCA	Samples from leachate, monitoring, and residential wells
75	April 2016	GHD/MPCA	Samples from residential wells
76	October 2016	GHD/MPCA	Samples from leachate, monitoring, and residential wells
77	April 2017	GHD/MPCA	Samples from residential wells
78	October 2017	GHD	Samples from leachate, monitoring, and residential wells
79	June 2018	GHD	Samples from residential wells
80	October 2018	GHD	Samples from leachate, monitoring, and residential wells
81	July 2019	GHD	Samples from residential wells
82	Oct/Nov/Dec 2019	GHD	Samples from leachate, monitoring, and residential wells

Table 4.2

2019 Groundwater Analytical Data Detections
Perched Groundwater Unit Monitoring Wells
Highway 96 Site
White Bear Township, Minnesota

Location	Sample ID	Analyte		Chloride	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	Acetone	Benzene	Chloroethane	cis-1,2-Dichloroethene	Dichlorodifluoromethane (CFC-12)	Dichlorofluoromethane
		Units		mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
		Date	QA/QC										
On-Site Monitoring Wells													
LW1	W-191024-KJ-07	10/24/2019		1.4	< 1.0	< 1.0	< 1.0	< 10	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0
LW2	W-191024-KJ-12	10/24/2019		8.5	< 1.0	< 1.0	< 1.0	14	2.5	1.7	0.29 J	< 1.0	0.85 J
LW3	W-191024-KJ-11	10/24/2019		19	0.72 J	< 1.0	0.31 J	< 10	1.0	< 1.0	0.29 J	7.7	0.51 J
MW1S	W-191024-KJ-13	10/24/2019		38	< 1.0	< 1.0	< 1.0	< 10	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0
MW4U	W-191024-KJ-04	10/24/2019		140	33	< 1.0	1.3	< 10	2.9	47	11	< 1.0	< 1.0
SUMP	W-191025-KJ-21	10/25/2019		2.3	< 1.0	< 1.0	< 1.0	< 10	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0

Table 4.2

2019 Groundwater Analytical Data Detections
Perched Groundwater Unit Monitoring Wells
Highway 96 Site
White Bear Township, Minnesota

Location	Sample ID	Date	QA/QC	Ethyl ether	Ethylbenzene	Isopropyl benzene	Tetrachloroethene	Toluene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl chloride	Xylenes (total)	Total VOCs
		Analyte Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
On-Site Monitoring Wells													
LW1	W-191024-KJ-07	10/24/2019		< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	ND
LW2	W-191024-KJ-12	10/24/2019		0.22 J	< 1.0	0.55 J	< 1.0	< 1.0	0.19 J	< 1.0	< 1.0	< 1.0	6.30
LW3	W-191024-KJ-11	10/24/2019		0.46 J	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	0.26 J	< 1.0	< 1.0	11.25
MW1S	W-191024-KJ-13	10/24/2019		< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	ND
MW4U	W-191024-KJ-04	10/24/2019		< 2.0	1.0	< 1.0	< 1.0	0.84 J	2.3	2.0	6.3	3.4	111.04
SUMP	W-191025-KJ-21	10/25/2019		< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	ND

Notes:

<	- Not detected above the noted reporting limit.
µg/L	- Micrograms per Liter
J	- Estimated
mg/L	- Milligrams per Liter
ND	- No Detections
QA/QC	- Quality Assurance/Quality Control Sample Type

Table 4.3

2019 Groundwater Analytical Data Detections
Lower Sand Aquifer Monitoring Wells
Highway 96 Site
White Bear Township, Minnesota

Location	Sample ID	Date	QA/QC	Chloride	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	Acetone	Benzene	Chloroethane	cis-1,2-Dichloroethene	Dichlorodifluoromethane (CFC-12)	Dichlorofluoromethane
		SCG [1]		NE	70	6	4	700	5	NE	70	1000	NE
		Units		mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
On-Site Monitoring Wells													
EW1B	W-190221-SR-01	02/21/2019		NA	9.6	0.45	0.38	< 10	0.34	3.8	21	3.2	2.6
EW1B	W-190425-SR-01	04/25/2019		NA	7.0	0.35	0.34	< 10	0.26	3.1	16	2.4	2.1
EW1B	W-190724-SR-01	07/24/2019		NA	6.9	0.44	0.38	< 10	0.25	3.2	14	2.1	2.6
EW1B	W-191108-SR-01	11/08/2019		56	4.2	0.61	< 2.0	< 20	< 2.0	2.0	14	1.2	2.3
MW1D	W-191024-KJ-14	10/24/2019		29	< 1.0	< 1.0	< 1.0	< 10	< 1.0	< 1.0	< 0.50	1.9	0.75 J
MW4D	W-191024-KJ-08	10/24/2019		270	120	< 5.0	9.7	< 50	6.3	130	36	4.3 J	20
MW4S	W-191024-KJ-10	10/24/2019		120	16	< 1.0	1.1	< 10	1.3	24	9.3	< 1.0	< 1.0
MW11D	W-191024-KJ-03	10/24/2019		30	0.52 J	< 1.0	< 1.0	< 10	< 1.0	< 1.0	0.34 J	< 1.0	< 1.0
Compliance Monitoring Wells [1]													
MW12D	W-191025-KJ-18	10/25/2019		50	< 1.0	< 1.0	< 1.0	< 10	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0
MW13D	W-191126-KJ-01	11/26/2019		47	2.0	< 1.0	< 1.0	< 10	0.18 J	< 1.0	0.95	< 1.0	< 1.0
MW16D	W-191025-KJ-22	10/25/2019		49	0.59 J	< 1.0	< 1.0	< 10	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0

Table 4.3

2019 Groundwater Analytical Data Detections
Lower Sand Aquifer Monitoring Wells
Highway 96 Site
White Bear Township, Minnesota

		Analyte		Ethyl ether	Ethylbenzene	Isopropyl benzene	Tetrachloroethene	Toluene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl chloride	Xylenes (total)	Total VOCs
		SCG [1]		1000	700	300	5	1000	100	5	2	10000	NE
		Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Location	**Sample ID**	**Date**	**QA/QC**										
On-Site Monitoring Wells													
EW1B	W-190221-SR-01	02/21/2019		< 2.0	< 1.0	< 1.0	0.59	< 1.0	1.8	75	10	< 1.0	128.76
EW1B	W-190425-SR-01	04/25/2019		< 2.0	< 1.0	< 1.0	0.37	< 1.0	1.5	68	6.7	< 1.0	108.12
EW1B	W-190724-SR-01	07/24/2019		< 2.0	< 1.0	< 1.0	0.46	< 1.0	1.7	73	5.9	< 1.0	110.93
EW1B	W-191108-SR-01	11/08/2019		< 4.0	< 2.0	< 2.0	0.51	< 2.0	3.8	110	3.3	< 2.0	141.92
MW1D	W-191024-KJ-14	10/24/2019		< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	2.65
MW4D	W-191024-KJ-08	10/24/2019		1.1 J	< 5.0	< 5.0	< 5.0	5.2	< 2.5	< 5.0	30	< 5.0	362.60
MW4S	W-191024-KJ-10	10/24/2019		< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	1.3	0.9 J	10	0.3 J	63.82
MW11D	W-191024-KJ-03	10/24/2019		< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	0.86
Compliance Monitoring Wells [1]													
MW12D	W-191025-KJ-18	10/25/2019		< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	ND
MW13D	W-191126-KJ-01	11/26/2019		< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0 U	< 1.0	< 1.0	3.13
MW16D	W-191025-KJ-22	10/25/2019		< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	0.59

Notes:

[1]	- Site Cleanup Goals (SCG) established in Table 1 of the 1993 Minnesota Decision Document (MDD); apply only Compliance Monitoring Wells.
(shaded)	- Shaded results exceed screening criteria, where applicable.
<	- Not detected above the noted reporting limit.
µg/L	- Micrograms per Liter
J	- Estimated
mg/L	- Milligrams per Liter
ND	- No Detections
NE	- Not Established
QA/QC	- Quality Assurance/Quality Control Sample Type
U	- Not detected at the associated reporting limit

Table 4.4

2019 Groundwater Analytical Data Detections
St. Peter Sandstone Aquifer Monitoring Wells
Highway 96 Site
White Bear Township, Minnesota

		Analyte		Chloride	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	Acetone	Benzene	Chloroethane	cis-1,2-Dichloroethene	Dichlorodifluoromethane (CFC-12)	Dichlorofluoromethane
		SCG [(1)]		NE	70	6	4	700	5	NE	70	1000	NE
		Units		mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Location	**Sample ID**	**Date**	**QA/QC**										
On-Site Monitoring Wells													
EW2	W-190221-SR-02	02/21/2019		NA	18	< 1.0	0.86	< 10	0.81	11	15	5.1	10
EW2	W-190425-SR-02	04/25/2019		NA	14	< 1.0	0.73	< 10	0.66	11	12	4.2	9.6
EW2	W-190724-SR-02	07/24/2019		NA	14	< 1.0	0.81	< 10	0.62	11	11	3.9	11
EW2	W-191108-SR-02	11/08/2019		52	19	< 1.0	1.0	< 10	0.71	14	15	4.5	11
MW8B	W-191024-KJ-06	10/24/2019		38	5.9	< 1.0	0.25 J	< 10	< 1.0	1.0	2.3	13	40
Compliance Monitoring Wells [(1)]													
MW10B	W-191023-KJ-01	10/23/2019		1.3	< 1.0	< 1.0	< 1.0	< 10	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0
MW10B	W-191023-KJ-02	10/23/2019	FD	1.3	< 1.0	< 1.0	< 1.0	< 10	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0
MW12B	W-191025-KJ-16	10/25/2019		12	0.19 J	< 1.0	< 1.0	< 10	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0
MW12B	W-191025-KJ-17	10/25/2019	FD	11	< 1.0	< 1.0	< 1.0	< 10 UJ	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0
MW13B	W-191126-KJ-02	11/26/2019		24	< 1.0	< 1.0	< 1.0	< 10	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0
MW16B	W-191025-KJ-19	10/25/2019		8.6	< 1.0	< 1.0	< 1.0	< 10	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0
Converted Residential Monitoring Wells													
BLU-06	W-191206-KJ-18	12/06/2019		7.9 J	< 0.50	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--
LIL-01	W-191206-KJ-12	12/06/2019		23.6 J	7.0	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	2.8	--
LIL-01	W-191206-KJ-14	12/06/2019	FD	24.1 J	7.0	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	2.8	--
LIL-11	W-191206-KJ-16	12/06/2019		6.2 J	< 0.50	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--
ROB-11	W-191126-KJ-01	11/26/2019		20.8	0.26 J	< 0.50	< 1.0	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--

Table 4.4

2019 Groundwater Analytical Data Detections
St. Peter Sandstone Aquifer Monitoring Wells
Highway 96 Site
White Bear Township, Minnesota

		Analyte		Chloride	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	Acetone	Benzene	Chloroethane	cis-1,2-Dichloroethene	Dichlorodifluoromethane (CFC-12)	Dichlorofluoromethane
		SCG [(1)]		NE	70	6	4	700	5	NE	70	1000	NE
		Units		mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Location	**Sample ID**	**Date**	**QA/QC**										
Off-Site Monitoring Wells													
EW3	W-191205-KJ-07	12/05/2019		30.2	< 0.50	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--
MW17A	W-191206-KJ-15	12/06/2019		133 J	< 0.50	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--
MW17B	W-191206-KJ-17	12/06/2019		42.1 J	< 0.50	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--
MW18A	W-191205-KJ-06	12/05/2019		65.8	< 0.50	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--
MW18B	W-191205-KJ-08	12/05/2019		48.2	< 0.50	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--
MW19A	W-191205-KJ-05	12/05/2019		77.6	< 0.50	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--
MW19B	W-191205-KJ-01	12/05/2019		28.9 J-	< 0.50	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--
MW20B	W-191205-KJ-02	12/05/2019		22.2	< 0.50	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--
MW21A	W-191205-KJ-11	12/05/2019		14.6 J	< 0.50	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--

Table 4.4

2019 Groundwater Analytical Data Detections
St. Peter Sandstone Aquifer Monitoring Wells
Highway 96 Site
White Bear Township, Minnesota

		Analyte		Ethyl ether	Ethylbenzene	Isopropyl benzene	Tetrachloroethene	Toluene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl chloride	Xylenes (total)	Total VOCs
		SCG [1]		1000	700	300	5	1000	100	5	2	10000	NE
		Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Location	**Sample ID**	**Date**	**QA/QC**										
On-Site Monitoring Wells													
EW2	W-190221-SR-02	02/21/2019		< 2.0	0.14	< 1.0	< 1.0	0.83	0.35	4.4	11	< 1.0	58.63
EW2	W-190425-SR-02	04/25/2019		< 2.0	0.21	< 1.0	< 1.0	0.95	0.25	3.2	10	0.24	67.04
EW2	W-190724-SR-02	07/24/2019		< 2.0	0.18	< 1.0	< 1.0	0.81	0.24	3.9	10	0.26	67.72
EW2	W-191108-SR-02	11/08/2019		< 2.0	0.24	< 1.0	< 1.0	0.96	0.32	5.6	15	0.32	87.65
MW8B	W-191024-KJ-06	10/24/2019		< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	5.7	< 1.0	68.15
Compliance Monitoring Wells [1]													
MW10B	W-191023-KJ-01	10/23/2019		< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	ND
MW10B	W-191023-KJ-02	10/23/2019	FD	< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	ND
MW12B	W-191025-KJ-16	10/25/2019		< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	0.19
MW12B	W-191025-KJ-17	10/25/2019	FD	< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	ND
MW13B	W-191126-KJ-02	11/26/2019		< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	ND
MW16B	W-191025-KJ-19	10/25/2019		< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.50	< 1.0	< 1.0	< 1.0	ND
Converted Residential Monitoring Wells													
BLU-06	W-191206-KJ-18	12/06/2019		< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	ND
LIL-01	W-191206-KJ-12	12/06/2019		< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	9.80
LIL-01	W-191206-KJ-14	12/06/2019	FD	< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	9.80
LIL-11	W-191206-KJ-16	12/06/2019		< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	ND
ROB-11	W-191126-KJ-01	11/26/2019		< 4.0	< 0.50	< 1.0	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	0.26

Table 4.4

2019 Groundwater Analytical Data Detections
St. Peter Sandstone Aquifer Monitoring Wells
Highway 96 Site
White Bear Township, Minnesota

		Analyte		Ethyl ether	Ethylbenzene	Isopropyl benzene	Tetrachloroethene	Toluene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl chloride	Xylenes (total)	Total VOCs
		SCG [(1)]		1000	700	300	5	1000	100	5	2	10000	NE
		Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Location	**Sample ID**	**Date**	**QA/QC**										
Off-Site Monitoring Wells													
EW3	W-191205-KJ-07	12/05/2019		< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	ND
MW17A	W-191206-KJ-15	12/06/2019		< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	ND
MW17B	W-191206-KJ-17	12/06/2019		< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	0.27	< 1.5	0.27
MW18A	W-191205-KJ-06	12/05/2019		< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	ND
MW18B	W-191205-KJ-08	12/05/2019		< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	ND
MW19A	W-191205-KJ-05	12/05/2019		< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	ND
MW19B	W-191205-KJ-01	12/05/2019		< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	ND
MW20B	W-191205-KJ-02	12/05/2019		< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	ND
MW21A	W-191205-KJ-11	12/05/2019		< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	ND

Notes:

(1)	- Site Cleanup Goals (SCG) established in Table 1 of the 1993 Minnesota Decision Document (MDD); apply only Compliance Monitoring Wells.
(shaded)	- Shaded results exceed screening criteria, where applicable.
<	- Not detected above the noted reporting limit.
µg/L	- Micrograms per Liter
FD	- Field Duplicate
J	- Estimated
J-	- Estimated - result may be biased low
mg/L	- Milligrams per Liter
ND	- No Detections
NE	- Not Established
QA/QC	- Quality Assurance/Quality Control Sample Type
UJ	- Not detected; associated reporting limit is estimated

Table 4.5

2019 Groundwater Analytical Data Detections
Prairie Du Chien Aquifer Monitoring Wells
Highway 96 Site
White Bear Township, Minnesota

		Analyte		Chloride	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	Acetone	Benzene	Chloroethane	cis-1,2-Dichloroethene	Dichlorodifluoromethane (CFC-12)	Dichlorofluoromethane
		Units		mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Location	**Sample ID**	**Date**	**QA/QC**										
Off-Site Monitoring Wells													
MW17L	W-191206-KJ-21	12/06/2019		25.3 J	< 0.50	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--
MW17L	W-191206-KJ-23	12/06/2019	FD	25.2 J	< 0.50	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--
MW18L	W-191205-KJ-10	12/05/2019		21.6 J	< 0.50	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--
MW19L	W-191205-KJ-09	12/05/2019		28.6 J	< 0.50	< 0.50	< 0.50	< 20.0	< 0.50	< 1.0	< 0.50	< 1.0	--

Table 4.5

2019 Groundwater Analytical Data Detections
Prairie Du Chien Aquifer Monitoring Wells
Highway 96 Site
White Bear Township, Minnesota

		Analyte		Ethyl ether	Ethylbenzene	Isopropyl benzene	Tetrachloroethene	Toluene	trans-1,2-Dichloroethene	Trichloroethene	Vinyl chloride	Xylenes (total)	Total VOCs
		Units		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Location	**Sample ID**	**Date**	**QA/QC**										
Off-Site Monitoring Wells													
MW17L	W-191206-KJ-21	12/06/2019		< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	ND
MW17L	W-191206-KJ-23	12/06/2019	FD	< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	ND
MW18L	W-191205-KJ-10	12/05/2019		< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	ND
MW19L	W-191205-KJ-09	12/05/2019		< 4.0	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.40	< 0.20	< 1.5	ND

Notes:

<	- Not detected above the noted reporting limit.
µg/L	- Micrograms per Liter
FD	- Field Duplicate
J	- Estimated
mg/L	- Milligrams per Liter
ND	- No Detections
QA/QC	- Quality Assurance/Quality Control Sample Type

Table 4.6

2019 Groundwater Analytical Detections
Residential Wells
Highway 96 Site
White Bear Township, Minnesota

Address	Sample ID	Analyte		Chloride	1,1-Dichloroethane	Dichlorodifluoromethane (CFC-12)	Total VOCs
		HBG Value [(1)]		NE	80	500	NE
		HBG Basis [(1)]		-	RAA16	RAA17	-
		Units		mg/L	µg/L	µg/L	µg/L
		Date	QA/QC				
1 Birch Lane	W-191121-KJ-42	11/21/2019		9.7	< 0.50	< 1.0	ND
2 Birch Lane	W-191126-KJ-93	11/26/2019		15.6	< 0.50	< 1.0	ND
2 Birch Lane	W-191126-KJ-95	11/26/2019	FD	15.7	< 0.50	< 1.0	ND
3 Birch Lane	W-191119-KJ-18	11/19/2019		8.2	< 0.50	< 1.0	ND
1 Buffalo Road	W-190731-SR-27	07/31/2019		31	< 0.50	< 0.50	ND
3 Buffalo Road	W-190731-SR-26	07/31/2019		30	< 0.50	< 0.50	ND
3 Buffalo Road	W-191118-KJ-06	11/18/2019		34.5	< 0.50	< 1.0	ND
2 Cardinal Lane	W-191120-KJ-37	11/20/2019		32.6	< 0.50	< 1.0	ND
9 Duck Pass Road	W-191119-KJ-11	11/19/2019		43.3	0.50	< 1.0	0.50
9 Duck Pass Road	W-191119-KJ-13	11/19/2019	FD	40.7	0.53	< 1.0	0.53
13 Duck Pass Road	W-191119-KJ-15	11/19/2019		30.0	< 0.50	< 1.0	ND
15 Duck Pass Road	W-191121-KJ-44	11/21/2019		35.0	< 0.50	< 1.0	ND
20 Duck Pass Road	W-191120-KJ-30	11/20/2019		60.2	0.87	1.6	2.47
22 Duck Pass Road	W-191119-KJ-31	11/19/2019		33.8	< 0.50	< 1.0	ND
24 Duck Pass Road	W-191119-KJ-33	11/19/2019		8.7	< 0.50	< 1.0	ND
24 Duck Pass Road	W-191119-KJ-35	11/19/2019	FD	8.6	< 0.50	< 1.0	ND
26 Duck Pass Road	W-191119-KJ-17	11/19/2019		34.2	< 0.50	< 1.0	ND
1 Eagle Ridge Road	W-190731-SR-29	07/31/2019		24	< 0.50	< 0.50	ND
1 Eagle Ridge Road	W-191118-KJ-08	11/18/2019		27.2	< 0.50	< 1.0	ND
2 Eagle Ridge Road	W-190731-SR-32	07/31/2019		36	< 0.50	< 0.50	ND
2 Eagle Ridge Road	W-191118-KJ-10	11/18/2019		37.0	< 0.50	< 1.0	ND
3 Eagle Ridge Road	W-190731-SR-28	07/31/2019		29	< 0.50	< 0.50	ND
4 Eagle Ridge Road	W-190731-SR-30	07/31/2019		30	< 0.50	< 0.50	ND
4 Eagle Ridge Road	W-191119-KJ-12	11/19/2019		31.0	< 0.50	< 1.0	ND
5 Eagle Ridge Road	W-191119-KJ-19	11/19/2019		45.7	< 0.50	< 1.0	ND
6 Eagle Ridge Road	W-190731-SR-31	07/31/2019		44	< 0.50	< 0.50	ND
10 Eagle Ridge Road	W-191119-KJ-22	11/19/2019		16.5	< 0.50	< 1.0	ND
32 East Oaks Road	W-191120-KJ-51	11/20/2019		44.1	< 0.50	< 1.0	ND
36 East Oaks Road	W-191120-KJ-53	11/20/2019		30.7	< 0.50	< 1.0	ND
38 East Oaks Road	W-191120-KJ-39	11/20/2019		2.6 J	< 0.50	< 1.0	ND
44 East Oaks Road	W-190730-SR-18	07/30/2019		14	< 0.50	< 0.50	ND
44 East Oaks Road	W-191120-KJ-63	11/20/2019		17.8	< 0.50	< 1.0	ND
50 East Oaks Road	W-190730-SR-19	07/30/2019		36	< 0.50	< 0.50	ND
50 East Oaks Road	W-191119-KJ-20	11/19/2019		39.1	< 0.50	< 1.0	ND
1 Gadwall Lane	W-191120-KJ-45	11/20/2019		42.7	< 0.50	< 1.0	ND
1 Gadwall Lane	W-191120-KJ-47	11/20/2019	FD	43.4	< 0.50	< 1.0	ND
2 Gadwall Lane	W-191122-KJ-50	11/22/2019		38.2	< 0.50	< 1.0	ND
3 Gadwall Lane	W-191120-KJ-41	11/20/2019		32.2	< 0.50	< 1.0	ND
3 Gadwall Lane	W-191120-KJ-43	11/20/2019	FD	32.7	< 0.50	< 1.0	ND
4 Gadwall Lane	W-191120-KJ-49	11/20/2019		50.4	< 0.50	< 1.0	ND
2 Heron Lane [New Well]	W-191119-KJ-25	11/19/2019		19.8	< 0.50	< 1.0	ND
1 Hummingbird Hill	W-190731-SR-25	07/31/2019		27	< 0.50	< 0.50	ND
1 Hummingbird Hill	W-191121-KJ-34	11/21/2019		35.7	< 0.50	< 1.0	ND

Table 4.6

2019 Groundwater Analytical Detections
Residential Wells
Highway 96 Site
White Bear Township, Minnesota

Address	Sample ID	Analyte		Chloride	1,1-Dichloroethane	Dichlorodifluoromethane (CFC-12)	Total VOCs
		HBG Value (1)		NE	80	500	NE
		HBG Basis (1)		-	RAA16	RAA17	-
		Units		mg/L	µg/L	µg/L	µg/L
		Date	QA/QC				
3 Mallard Lane	W-191120-KJ-26	11/20/2019		26.2	< 0.50	< 1.0	ND
5 Mallard Lane	W-191120-KJ-24	11/20/2019		6.5	< 0.50	< 1.0	ND
6 Mallard Lane	W-191118-KJ-07	11/18/2019		3.2	< 0.50	< 1.0	ND
7 Mallard Lane	W-191118-KJ-09	11/18/2019		15.7	< 0.50	< 1.0	ND
3 Poplar Lane	W-191120-KJ-59	11/20/2019		34.8	< 0.50	< 1.0	ND
6 Poplar Lane	W-191119-KJ-23	11/19/2019		5.6	< 0.50	< 1.0	ND
8 Poplar Lane	W-190730-SR-11	07/30/2019		38	< 0.50	< 0.50	ND
8 Poplar Lane	W-190730-SR-12	07/30/2019	FD	39	< 0.50	< 0.50	ND
8 Poplar Lane	W-191120-KJ-55	11/20/2019		47.1	< 0.50	< 1.0	ND
1 Robb Farm Road	W-191119-KJ-21	11/19/2019		1.8	< 0.50	< 1.0	ND
2 Robb Farm Road	W-191126-KJ-101	11/26/2019		23.8	< 0.50	< 1.0	ND
37 Robb Farm Road	W-191121-KJ-46	11/21/2019		10.0	< 0.50	< 1.0	ND
41 Robb Farm Road	W-191121-KJ-48	11/21/2019		4.8	< 0.50	< 1.0	ND
43 Robb Farm Road	W-191120-KJ-32	11/20/2019		62.3	< 0.50	< 1.0	ND
44 Robb Farm Road	W-191119-KJ-29	11/19/2019		34.9	< 0.50	< 1.0	ND
45 Robb Farm Road	W-191121-KJ-91	11/21/2019		30.9	< 0.50	< 1.0	ND
4 Ski Lane	W-190729-SR-01	07/29/2019		39	< 0.50	< 0.50	ND
4 Ski Lane	W-191121-KJ-38	11/21/2019		44.3	< 0.50	< 1.0	ND
6 Ski Lane	W-190729-SR-02	07/29/2019		30	< 0.50	< 0.50	ND
6 Ski Lane	W-191118-KJ-01	11/18/2019		34.3	< 0.50	< 1.0	ND
8 Ski Lane	W-190729-SR-03	07/29/2019		32	< 0.50	< 0.50	ND
8 Ski Lane	W-191118-KJ-02	11/18/2019		31.5	< 0.50	< 1.0	ND
10 Ski Lane	W-190729-SR-05	07/29/2019		25	< 0.50	< 0.50	ND
10 Ski Lane	W-190729-SR-06	07/29/2019	FD	25	< 0.50	< 0.50	ND
10 Ski Lane	W-191118-KJ-03	11/18/2019		34.7	< 0.50	< 1.0	ND
12 Ski Lane	W-190729-SR-07	07/29/2019		25	< 0.50	< 0.50	ND
12 Ski Lane	W-191119-KJ-14	11/19/2019		47.1	< 0.50	< 1.0	ND
14 Ski Lane	W-190729-SR-08	07/29/2019		38	< 0.50	< 0.50	ND
14 Ski Lane	W-191118-KJ-04	11/18/2019		41.3	< 0.50	< 1.0	ND
16 Ski Lane	W-190729-SR-09	07/29/2019		42	< 0.50	< 0.50	ND
16 Ski Lane	W-191118-KJ-05	11/18/2019		29.4	< 0.50	< 1.0	ND
1 Thompson Lane	W-190731-SR-24	07/31/2019		33	< 0.50	< 0.50	ND
1 Thompson Lane	W-191121-KJ-36	11/21/2019		38.0	< 0.50	< 1.0	ND
3 Thompson Lane	W-190730-SR-20	07/30/2019		20	< 0.50	< 0.50	ND
3 Thompson Lane	W-191119-KJ-16	11/19/2019		26.1	< 0.50	< 1.0	ND
4 Thompson Lane	W-190731-SR-22	07/31/2019		140	< 0.50	< 0.50	ND
4 Thompson Lane	W-190731-SR-23	07/31/2019	FD	140	< 0.50	< 0.50	ND
4 Thompson Lane	W-191121-KJ-40	11/21/2019		162	< 0.50	< 1.0	ND
1 West Shore Road	W-191119-KJ-27	11/19/2019		29.2	< 0.50	< 1.0	ND
3 West Shore Road	W-191121-KJ-71	11/21/2019		8.1	< 0.50	< 1.0	ND
3 West Shore Road	W-191121-KJ-73	11/21/2019	FD	8.2	< 0.50	< 1.0	ND
4 West Shore Road	W-191121-KJ-67	11/21/2019		66.5	< 0.50	< 1.0	ND
4 West Shore Road	W-191121-KJ-69	11/21/2019	FD	65.2	< 0.50	< 1.0	ND

Table 4.6

2019 Groundwater Analytical Detections
Residential Wells
Highway 96 Site
White Bear Township, Minnesota

Address	Sample ID	Date	QA/QC	Chloride		1,1-Dichloroethane		Dichlorodifluoromethane (CFC-12)		Total VOCs
		HBG Value (1)		NE			80		500	NE
		HBG Basis (1)		-			RAA16		RAA17	-
		Units		mg/L			µg/L		µg/L	µg/L
5 West Shore Road	W-191126-KJ-97	11/26/2019		9.7		<	0.50	<	1.0	ND
6 West Shore Road	W-191121-KJ-75	11/21/2019		8.5		<	0.50	<	1.0	ND
7 West Shore Road	W-191121-KJ-79	11/21/2019		16.8		<	0.50	<	1.0	ND
8 West Shore Road	W-190730-SR-13	07/30/2019		5.2		<	0.50	<	0.50	ND
8 West Shore Road	W-191120-KJ-28	11/20/2019		5.5		<	0.50	<	1.0	ND
9 West Shore Road	W-190730-SR-14	07/30/2019		25		<	0.50	<	0.50	ND
9 West Shore Road	W-191121-KJ-81	11/21/2019		43.0		<	0.50	<	1.0	ND
10 West Shore Road	W-190730-SR-16	07/30/2019		30		<	0.50	<	0.50	ND
10 West Shore Road	W-191121-KJ-85	11/21/2019		39.0	J	<	0.50	<	1.0	ND
11 West Shore Road	W-190730-SR-15	07/30/2019		28		<	0.50	<	0.50	ND
15 West Shore Road	W-190730-SR-17	07/30/2019		40		<	0.50	<	0.50	ND
15 West Shore Road	W-191121-KJ-87	11/21/2019		54.1		<	0.50	<	1.0	ND

Notes:

(1) - Health-Based Guidance (HBG) established by the Minnesota Department of Health (MDH) for private wells. (where multiple guidance values are established, the lowest value is shown and used for initial screening)
[shaded] - Shaded results exceed screening criteria, where applicable.
< - Not detected above the noted reporting limit.
µg/L - Micrograms per Liter
FD - Field Duplicate
J - Estimated
mg/L - Milligrams per Liter
ND - No Detections
NE - Not Established
QA/QC - Quality Assurance/Quality Control Sample Type
RAA - Risk Assessment Advice (## year developed)

Appendices

about GHD

GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

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