# Source Water Assessment Report for the Marquette Water Supply December 2003

*The City of Marquette Water Treatment Plant*
*Marquette, Michigan*

## Prepared for:

**City of Marquette Water Supply, WSSN 4120**

## Prepared by:

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**Michigan Source Water Assessment Report 24**

## Executive Summary

*The purpose of the Source Water Assessment is to analyze the sensitivity and determine susceptibility of a community's source of drinking water to potential sources of contamination.*

*Sensitivity is determined from the natural setting of the source water (raw water to the water treatment plant), and indicates natural protection afforded the source water. Using procedures established in the Great Lakes Protocol, Michigan Source Water Assessment Program, the deep, offshore intake for the Marquette Water Treatment Plant has a moderate degree of sensitivity to potential contaminants. When the effects of winds, lake currents, and the influence of the Dead River are considered, the Marquette intake is categorized as moderately sensitive.*

*Susceptibility identifies factors within the community's source water area that may pose a risk to the water supply. The susceptibility determination provides information with respect to listed facilities and land areas within the source water area that should be given greater priority and oversight in implementing a source water protection program. The source water area for the Marquette intake includes 9 potential contaminant sources, 33 listed potential contaminant sources within the susceptible area, plus urban and agricultural runoff from the Dead-Kelsey watershed into the Lake Superior. The potential contaminant sources, in combination with the moderately sensitive intake, indicate that the Marquette source water is moderately susceptible to potential contamination.*

*The Marquette source water is categorized as moderately susceptible, given potential contaminant sources within the source water area. However, it is noted that the City of Marquette Water Treatment Plant has effectively treated this source water to meet drinking water standards. The City of Marquette has instituted pollution prevention programs, but should be cognizant of additional potential threats to its source of drinking water that are identified in this report. This report explains the background and basis for these determinations.*

## Using this Assessment

Clean, safe drinking water is fundamental to the viability of any community. Protecting the drinking water **source** is a wise and relatively inexpensive investment in your community's future. The overall intent of this assessment is to provide background information for your community to use in developing a local source water protection program. The assessment benefits your community by providing the following:

- ***A basis for focusing limited resources within the community to protect the drinking water source(s).*** The assessment provides your community with information regarding activities within the **source water area** (**SWA**) that directly affect your water supply. It is within this SWA that a spill or improper use of **potential contaminants** may cause these contaminants to migrate toward the water **intake**. By examining where the source waters are most susceptible to contaminants, and where potential contaminants are located, the assessment clearly illustrates the potential risks that should be addressed.

- ***A basis for informed decision-making regarding land use within the community.***

  The assessment provides your community with a significant amount of information regarding where your drinking water comes from (the source) and what the risks are to the quality of that source. Knowing where the resource is allows your community planning authorities to make informed decisions regarding proposed land uses within the SWA that are compatible with both your drinking water resource and the vision of growth embraced by your community.

- ***A basis for dealing with future regulations.***

  The assessment has been designed to functionally meet proposed requirements for surface-water supplies. Information needed to address regulatory needs and requirements has been collected and made available to your community through this report.

This source water assessment also provides the basis for a locally developed, voluntary source water protection program. Communities interested in voluntarily developing source water protection programs should contact the Michigan Department of Environmental Quality (MDEQ) or visit the Department web page at http://www.michigan.gov/deq.

## Introduction

In 1996, Congress amended the **Safe Drinking Water Act** and provided resources for state agencies to conduct source water assessments by identifying SWAs, analyzing the **sensitivity** of the source to natural conditions, conducting contaminant source inventories, and determining the **susceptibility** of the source to potential contamination. Delineations, sensitivity analyses, contaminant inventories, and susceptibility determinations comprise a "source water assessment." Assessments will be completed for every public water supply source in Michigan. To support this effort, the MDEQ Water Division established a partnership with the U.S. Geological Survey (USGS) to develop a method for conducting source water assessments for surface water supplies (Sweat and others, 2000; Sweat and others, 2001)**.**

The requirements for public water supplies in Michigan to meet United States Environmental Protection Agency (USEPA) **maximum contaminant levels (MCLs)** provide some degree of assurance of safe drinking water; however, all systems are vulnerable to potential contamination. One of the best ways to ensure safe drinking water is to develop a local program designed to protect the source of drinking water against potential contamination. Not only does this add a margin of safety, but it also raises the awareness of consumers and/or the community of the risks of drinking water contamination. It is expected that source water assessment results will provide a basis for developing a source water protection program.

## Background

The City of Marquette is located in Marquette County, on the southern shore of Lake Superior, in the upper peninsula of Michigan (fig. 1). Besides serving city residents, the water supply also serves portions of Marquette Township for a total population served of 22,000. In 1869, the city of Marquette constructed a pump station which provided Lake Superior water to 271 customers. This pump station was destroyed by fire and a new facility was constructed in 1890. The present WTP, constructed in 1979 and upgraded in 1997 utilizing 8 microfiltration arrays. The WTP intake line is a 42-inch (in) diameter steel pipe, 600 feet in length that narrows to 36" and extends another 2500 feet (ft) offshore in 55 ft of water. The pipe terminates in three large intake bells with two-inch openings. A copper screen protects the intake bells (City of Marquette, 2003). Three low service pumps deliver raw water from a shorewell through the treatment processes. Total low service pumping capacity is 13.4 million gallons per day (MGD). Treatment includes micron straining, microfiltration, chlorination and fluoridation. Chemicals added to the water include chlorine generated on site (disinfection), fluoride (dental health), and sodium hydroxide (pH adjustment) . The WTP has four high service pumps and is rated at 12.7 MGD. Three ground level reservoirs are located on site with a total capacity of 3,000,000 gallons (gal). There is a 200,000 gal tower at the west end of Marquette Township. The average daily flow is 3.1 MGD (City of Marquette, 2003).

***Low service Pumps***

***Raw Water Strainers***

***Continuous Microfiltration Units***

***High Service Pumps***

*Photos from City of Marquette Website*

Water treatment plants are periodically inspected to identify construction, maintenance, operational or source defects that could make them vulnerable to contamination, particularly from contaminants that are microbial in nature, such as fecal coliforms. Water suppliers are provided a sanitary survey report that notes any deficiencies in the system, and the State may direct the system to make necessary corrections. The sanitary survey is an important part of a safe drinking water program.

## Climate

The Marquette water supply is located in the Northern Upper Peninsula hydrologic province (Rheaume, 1991), in the Lake Superior and Dead-Kelsey watersheds (USGS, 1974, 1982). The region experiences temperate summers with moderate winters. The Marquette Weather Bureau station reports that the average annual precipitation for the climatic years 1870-2000 was 30.7 inches and the average from the past 5 years is 28.7 inches with about 36 percent of that as snowfall between November and March (NOAA 2002, 2001, 2000, 1999, 1998, 1997, 1996, 1995). Annual average runoff for the Marquette SWA, extrapolated from Miller and Twenter (1986, fig. 1) is 16 to 18 inches with the higher runoff values closer to Lake Superior.

## Source Water Area Geology and Hydrology

The study area for evaluating the extent of the Marquette WTP SWA includes the Dead, Kelsey, Carp and Chocolay River watersheds and Lake Superior (fig. 1). The SWA surficial deposits are primarily thin to continuous glacial till over bedrock, with some areas of lacustrine sands and gravels, postglacial alluvium, and coarse-textured glacial till. Surficial deposits are underlain by igneous and metamorphic bedrock, in addition to regions of Jacobsville sandstone and Michigamme slate (Martin, 1955; Milstein, 1987). Soils underlying the Marquette SWA are primarily associations of the Champion, Grayling, Kalkaska, Keweenaw, Michigamme, Munising, Rubicon, and Tacoosh series (BASINS, 1998; MIRIS, 2000). They include loamy sands, sands, peat and mucks.

***Lake Superior – Marquette WTP Source Water***

Soil permeability is based on the calculated time of travel, in inches per hour (in/hr), for water to move vertically through a saturated soil zone. Soil thickness and permeability values are available in soil survey reports published by the National Cooperative Soil Survey and U.S. Department of Agriculture. Permeability ranges from less than 0.06 in/hr, rated as very slow, to more than 20 in/hr, rated as very rapid.

Very slowly permeable soils significantly reduce the movement of water through the soil zone and, as a result, allow greater time for natural degradation of contaminants. However, such soils also provide for rapid overland transport of contaminants directly to receiving waters, which in turn may affect the water supply intake. Erosion and transport of soils by surface waters can cause an increase in turbidity. In contrast, very rapidly permeable soils allow for rapid infiltration and passage through the soil zone from the surface. Such soils potentially allow rapid transport of contaminants with minimal contact-time available for contaminant breakdown.

Mean, area-weighted, depth-integrated permeabilities for the Marquette SWA range from 1.5 to as much as 17.8 in/hr. The mean permeability is 7.0 in/hr (Schneider and Erickson, undated, series of 5 maps; BASINS, 1998; MIRIS, 2000). Soils range from moderately permeable in the southeastern tip of the SWA to moderately rapid and

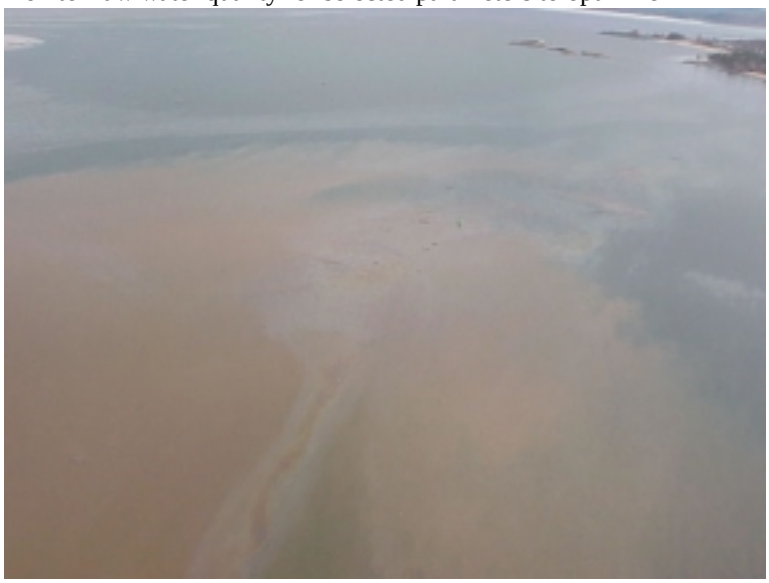
rapidly permeable across much of the remainder of the SWA (fig. 2; Lusch and others, 1992; BASINS, 1998; MIRIS, 2000).

The Marquette SWA contains 497.6 square miles ($mi^2$) and is directly connected to Lake Superior. The most significant tributary to Lake Superior from the SWA is the Dead River. Between 1899 and 2002 as many as 5 stream gages were operated in the Marquette SWA by the USGS (Blumer and others, 2002). Currently there is one gage operated in the Marquette SWA. Annual mean discharge at the Mclure Storage Basin Release near Marquette gaging station was 168 cubic feet per second (cfs) between 1990and 2001, and ranged from 140 to 240 cfs.

Under ambient conditions, currents in Lake Superior are, typically, from the northwest and pass over the Marquette WTP intake. Water from the Dead River flows southeast from its mouth, away from the intake. Under certain wind conditions, however, lake currents can be altered causing changes in water quality and chemistry at the intake.

## History of Raw Water Quality at the Source

Public water supplies are required to routinely monitor raw water quality for selected parameters to optimize treatment, and to monitor treated water quality for a list of contaminants that is determined by MDEQ and the Safe Drinking Water Act. A detection of any contaminant may indicate that a pathway exists for contaminants to reach the intake. It is important to realize that the results from a given sample only provide information regarding the water quality at the time the sample was collected. Water quality can change with time for a number of reasons. The fact that a water sample does not contain contaminants is no guarantee that contamination will not occur in the future. Conversely, the detection of a contaminant in the past does not indicate that it will occur in the future.



***Sediment and Oil Plume in Marquette WTP Source Water Area Resulting from Dead River Dam Failures***
*(May 15, 2003 Photo from city of Marquette Website)*

The Marquette WTP records show that daily water use between 1995 and 2000 has fluctuated between 1.58 and 5.66 MGD, with a daily average use of 2.99 MGD.

Water quality and meteorological conditions are routinely monitored at the Marquette WTP. Records of raw water quality at the WTP from January 1997 through May 20, 2003 shows an average turbidity of 0.33 nephelometric turbidity units (NTU) with a daily average range of 0.18 to 6.38 NTU. Raw water pH ranged from 6.67 to 8.22 units with an average of 7.3 units while total coliform bacteria counts ranged from not detected to 224 counts per 100 ml. The WTP did report an unusually high turbidity reading of 17 NTU on May 17, 2003 which corresponded to the Dead River dam breaches several days earlier.

An analysis of wind direction, water and air temperature, precipitation, discharge from the Dead River, and source water chemistry indicates that there may be an indirect correlation between wind direction and turbidity, and perhaps wind direction and total coliform bacteria. This may occur because sustained winds from the northeast shift the circulation pattern in the Lake near the intake and cause water from the Dead River to pass over the intake. This potential increase in turbidity and total coliforms requires careful monitoring of the treatment process.

The Marquette WTP routinely monitors treated water for the presence of total coliform bacteria , turbidity, chlorine plus regulated inorganic and organic chemical contaminants. A review of the water supply's 2001 and 2002

Consumer Confidence Report indicates the city of Marquette water supply meets all drinking water standards regulated under the Safe Drinking Water Act.

## Source Water Assessment Methodology

Technical guidelines for completing source water assessments are contained in the Michigan **Source Water Assessment Program**, Assessment Protocol for Great Lakes Sources (Protocol) (MDEQ, 1999, Appendix L) available at http://www.michigan.gov/deq. In general, an assessment is a process for evaluating a drinking water supply and the potential for its treated water to exceed an MCL due to raw water contamination. A source water assessment considers the SWA, potential sources of contamination within the SWA, conditions of the water supply intake, and susceptibility to contaminants in order to identify potential risks to drinking water quality. Although the Protocol provides the minimum requirements and instructions on how to conduct an assessment, each water supply is unique with respect to how the process is carried out, due to local conditions and information. Sweat and others (2000, 2001) have developed and documented the methodology used in the preparation of this assessment.

## Delineating Source Water Areas

Delineation of the SWA is accomplished by using **geographic information system** (GIS) software to map the watershed(s) that have the potential to affect source water at the intake. Using information from the water supply, a **critical assessment zone** (CAZ) is defined for the intake (MDEQ, 1999, Appendix L). A buffer is then created along any shoreline intersected by the CAZ, and from the edge of the CAZ to the mouth of any river(s) that might influence the intake. Finally, the buffer is extended along the shoreline of any river(s) that might influence the intake, from the mouth of the river to its headwaters. The area defined by the CAZ, river and shoreline buffers is termed the **susceptible area.** The susceptible area within the SWA defines locations where a water supply should focus its management strategies and resources to benefit the drinking water resources.

Using the Great Lakes Protocol and the Marquette water supply information:

3100 (the length of the intake in ft.) x 55 (the depth of the intake in ft.) = 170,500 (unitless)

This results in rating the intake as moderately sensitive, with a CAZ of 1,000 ft (MDEQ, 1999, Appendix L, fig. 4).

- There is no shoreline susceptible area because the CAZ does not intersect the shoreline.
- The CAZ for the Marquette intake is shown on (fig. 3):

## Contaminant Source Inventory

Past, current, and potential future sources of contaminants were inventoried to identify several categories of potential sources of contaminants including microorganisms (bacteria, oocysts, and viruses), inorganic compounds (nitrates and metals), organic compounds (solvents, petroleum compounds, pesticides), and disinfection by-product precursors (trihalomethanes, haloacetic acids).

It is important to remember that sites and areas identified by this process are only **potential contaminant sources** (PCS) to the drinking water. Environmental contamination is not likely to occur when potential contaminants are used and managed properly. In addition, assumptions were made about particular types of land uses and risks associated with those land uses. Assumptions are discussed further in the results portion of this report.

The process for completing the inventory included several steps, which are summarized as follows:

1. Reviewed readily available land use maps and historical/current aerial photographs.
2. Plotted relevant information from applicable state and federal regulatory databases including the following lists:
   - MDEQ leaking underground storage tank (LUST) sites;
   - MDEQ registered underground storage tank (UST) sites;
   - MDEQ Environmental Cleanup Site Information System (ECSI) sites;



Figure 2. Soil permeability for the Marquette water-supply intake source water area, Marquette, MI.

- MDEQ Source Information System (for water discharge permit sites including National Pollutant Discharge Elimination System (NPDES) permits, Water Pollution Control Facility (WPCF) permits, storm water discharge permits, and on-site sewage (septic) system permits);
- MDEQ Underground Injection Control (UIC) database;

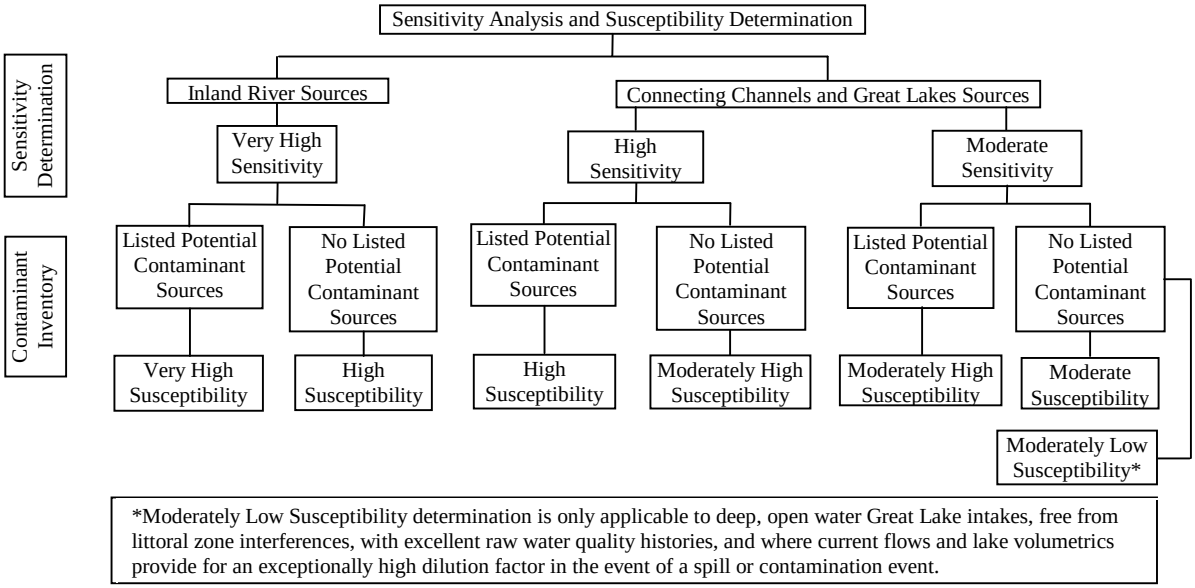



**Figure 4**. Surface-water source sensitivity analyses and susceptibility determinations.

- MDEQ Active Solid Waste Disposal Permits list;
- Michigan Department of Transportation (MDOT) - Hazardous Materials database;
- State Fire Marshall registry of above-ground fuel storage tank sites;
- State Fire Marshall Hazardous Material Handlers and Hazardous Material Incidents (HAZMAT) sites;
- U.S. EPA BASINS software, version 2.1.
- U.S. EPA Envirofacts database;
- U.S. EPA Resource Conservation Recovery Act (RCRA) generators or notifiers list;
- U.S. EPA RCRA Treatment, Storage, and Disposal Facility (TSDF) Permits list;
- U.S. EPA National Priorities List (NPL);
- U.S. EPA Comprehensive Environmental Response, Compensation and Liability Information System (CERCLA) List;
- U.S. EPA RCRA Corrective Action Activity List (CORRACTS);
- U.S. Department of Transportation (DOT) Hazardous Materials Information Reporting System (HMIRS); and
- U.S. EPA Toxic Chemical Release Inventory System (TRIS).
- U.S. EPA Oil Pollution Act of 1990 Spill Response Atlas

3. Met with public water supply and community officials on May 21, 2003 to identify potential sources not listed elsewhere in databases or on maps and completed a preliminary inventory form to be used in completing the SWA base map. Subsequent contacts by email and telephone on numerous occasions to request additional data, clarify data, and discuss results.
4. Land use and/or ownership (for example, residential/municipal; commercial/industrial; agricultural/forest; and other land uses) was mapped and evaluated in relation to PCS, soil characteristics, and proximity to the intake.
5. Conducted an informal field inventory to locate additional PCS.

6. Completed final inventory form of PCS and plotted locations of PCS on the base map.

The purpose of the inventory is three fold: first, to provide information on the location of PCS, especially those within the susceptible area; second, to provide an effective means of educating the public about PCS; and third, to provide a reliable basis for developing a management plan to reduce potential contaminant risks to the Marquette water supply.

***Storm Drain North of the Marquette WTP***

The inventory process attempts to identify potential point-source contaminants within the SWA. It does not include an attempt to identify specific potential contamination problems at specific sites, such as facilities that do not safely store potentially hazardous materials. However, assumptions were made about particular types of land use. For example, it is assumed that rural residences associated with farming operations have specific potential contamination sources such as fuel storage, chemical storage and mixing areas, and machinery repair shops. It should also be noted that although the inventory depicts existing agricultural uses (crops grown), these are likely to undergo continual change due to normal crop rotation practices. What is irrigated farmland now may be non-irrigated farmland next year, or vice versa.

The results of the inventory were analyzed in terms of current, past, and future land uses and their relationship to the susceptible area and the supply intake. In general, land uses and PCS that are closest to the supply intake pose the greatest threat to a safe drinking water supply. Inventory results are summarized in tables 1and 2 (appendix) and are shown on figure 4.

**Table 1**. Potential contaminant sources in the source water area

| Type of Potential Contaminant Source (PCS) | Number of PCS | Number of PCS in Susceptible Area |
|---|---|---|
| Hazardous or solid waste site permits | 73 | 25 |
| Industrial facility discharge site permits | 10 | 5 |
| National priority list sites | 0 | 0 |
| Permit compliance system | 6 | 3 |
| Toxic release inventory permits | 0 | 0 |

Many PCS are readily identifiable because they have a single discharge point, and often a permit is required for these discharges. However, other PCS have diffused, poorly defined discharge locations. These are known as non-point discharges because they occur over large areas and may not be quantifiable by readily accepted methods. These non-point source discharges are difficult to identify and control, and consequently to quantify, yet they are a major source of water pollution (Carpenter and others, 1998). Non-point sources also include atmospheric deposition over water and land, and include urban, rural, and agricultural runoff from areas such as lawns, golf courses, farm fields, pastures, parking lots and roadways. Runoff from these areas can contain many types of pollutants including sediments, metals, organic and inorganic chemicals, viral and bacterial pathogens, pharmaceuticals, and animal wastes. Transportation also represents a non-point source of contamination. Trucking, railroads, and shipping all transport potential contaminants through the SWA. An accident causing a spill could lead to potential contaminants entering a storm sewer, or in the case of shipping, directly discharge to Lake Superior, possibly near the water intake. Non-point sources of concern to the Marquette water supply are primarily from agriculture in the Marquette SWA, and from industrial, commercial, and residential sources in Marquette and surrounding communities.

In general, PCS within the susceptible area pose greater risks than those outside the susceptible area. The presence of PCS within the SWA indicates potential sources of chemicals that could, if improperly managed or released, impact the water quality at the intake. Small quantities of these chemicals, in some cases a gallon or less, can significantly affect the supply. Also of concern is the location and distribution of these sources with respect to highly permeable soils. The susceptible area consists of primarily forested land. Overlaying the PCS locations and the moderately rapid to rapidly permeable soil map for the Marquette SWA indicates that 89 of the located PCS are located on or very near to areas with moderately rapid to rapidly-permeable soils. All PCS within the SWA should be addressed; the susceptibility determination, however, provides the water supply with the tools to focus resources where the greatest risk occurs. The results of the PCS inventory performed for Marquette water supply is shown on figure 5 and is summarized as a function of PCS locations

relative to the susceptible area. The inventory results indicate that there are 32 PCS, holding 33 permits for discharge, within the susceptible area (table 2).

**Table 2.** Potential contaminant source inventory results

| Site Name | Identification Number | Reason for Permit | Reason for Listing as Potential Contaminant Source |
|---|---|---|---|
| ASSOCIATION CONSTRUCTORS | MID985657741 | On-site Storage | Hazardous and Solid Waste |
| BAGMAN INC PROPERTY | MI0000185041 | | |
| CHOICE ADVANTAGE BODY SHOP | MID086183563 | | |
| CLIFFS DOW DISPOSAL SITE | MID980608970 | | |
| COURTESY SUBARU | MID985660125 | | |
| FABCO EQUIPMENT INC | MID017228966 | | |
| FIRST NATIONAL BANK AND TRUST | MID985598838 | | |
| FIRST OF AMERICA BANK | MID985618248 | | |
| FREI CHEVROLET INC | MID017229451 | | |
| HARVEY MINI 1 | MI0001859115 | | |
| ISHPEMING AREA WASTEWATER [a] | MID153543491 | | |
| MARQUETTE CITY OF | MID985598770 | | |
| MARQUETTE PUBLIC SERVICE | MID017230095 | | |
| MICH STATE HOUSE OF CORRECTIONS | MID083302935 | | |
| MIDAS M P R SVCS INC | MI0000120493 | | |
| MIDOT BRIDGE I-75 OVER PINE RIVER | MID985661818 | | |
| MIDOT BRIDGE M-28 OVER CHOCOOLY RIVER | MID985636851 | | |
| NORTHERN MICHIGAN UNIVERSITY | MID985621549 | | |
| NORTHERN SEPTIC TANK SVC INC | MID985595354 | | |
| ODOVERO CONSTRUCTION INC | MID017230400 | | |
| SHERWIN WILLIAMS CO | MID985656883 | | |
| UP MOTORS INC | MID030196422 | | |
| UPS | MID985650480 | | |
| WISC ELEC PWR CO PRESQUE ISLE PWR PLT | MID079972535 | | |
| WISCONSIN CENTRAL RR | MID985657451 | | |
| CALLAHAN MINING CORP | MI0041807 | Process, Treatment and Waste Waters | Industrial Facilities Discharge Site |
| ISHPEMING CITY OF WWTP | MI0021369 | | |
| ISHPEMING TWP WSTEWTR TRMT FAC | MI0023248 | | |
| MARQUETTE CITY OF | MI0023531 | | |
| NEGAUNEE WWTP | MI0021296 | | |
| CALLAHAN MINING-ISHPEMING TWP | MI0001591221 | Waste Water, Dust, and Process Water | Permit Compliance System |
| ISHPEMING AREA WWTP [a] | MID153543491 | | |
| NEGAUNEE WWTP | MID000871756 | | |

*Note: Subscripts denote multiple permits.*

The U.S. Environmental Protection Agency (USEPA) has identified 3 **impaired water bodies** in the Marquette SWA on its Clean Water Act 303(d) list. The parameter of concern listed for all 3 impaired water bodies is mercury.

## Sensitivity Analysis

Sensitivity is the natural ability of a SWA to provide protection against the contamination of the water supply intake, and includes physical attributes of lakes, rivers, and soils. The sensitivity analysis requires consideration of several different variables related to the natural environment, for example:

- Water quality history of the source.
- Distribution of moderately rapid to rapidly-permeable soils.
- Nature of the intake, including: depth, distance from shore, age, and materials used.
- Surface water flow patterns in vicinity of intake.

To perform this analysis, USGS, MDEQ, and the operator of the Marquette WTP collected, researched, and analyzed information from the WTP, monthly operator reports, sanitary surveys, soil maps, published reports, and historical plant operation and raw water quality data. The Michigan SWAP has three categories of sensitivity for surface water sources ranging from moderately sensitive to very highly sensitive. Analysis of this information, using guidelines provided in Sweat and others (2000, 2001), indicates that the Marquette intake is in the middle of this range or highly sensitive (fig. 4). This means that the natural environment offers little protection against contamination of the water supply intake.

## Susceptibility Determination

Susceptibility is the relative potential for contamination to reach the public water supply intake used for drinking water purposes. Whereas the sensitivity of a water supply is the natural ability of the area to protect the intake against contamination, the susceptibility determination also takes into account other factors that will affect whether a contaminant reaches the intake. Whether or not a particular drinking water source becomes contaminated depends on three factors:

(1) The distribution of PCS;
(2) The source water area; and
(3) The natural protection, or sensitivity, of the source.

***Storm Sewer Outfall to City Harbor Southwest of WTP***

In conducting a susceptibility determination, the part of the SWA that yields water to the water supply system intake is identified by establishment of the susceptible area within the source water area. PCS within the susceptible area are then located. Based on the distribution of PCS within the susceptible area, the type of PCS, and the nature of the chemicals they use or store, PCS are analyzed for the risk they may represent to the water supply intake. Along with the presence and distribution of PCS, the sensitivity analysis is then used to determine the susceptibility of the water supply (fig. 4). This leads to a determination of whether the drinking water source is moderately susceptible, highly susceptible, or very highly susceptible to contamination (Sweat and others, 2001). It is important to understand that a system can have low sensitivity relative to some conditions (for example, intake construction and location), and high susceptibility because of other conditions (for example, the type of PCS). In Michigan, surface water sources of drinking water range from moderately-low to very-high susceptibility.

When a public water supply is determined to have a moderate, high, or very high susceptibility because of a particular condition or set of conditions, there is a significant risk of contamination of the drinking water source because of that condition or set of conditions. Although the susceptibility determination does not predict when or if contamination will actually occur, it does recognize conditions that are highly

favorable for contamination of the supply. In the event of a contaminant release to soils or surface water within the susceptible area, it is very likely that contamination at the intake would occur without completion of remedial actions.

If a public water supply's drinking water source is determined to be highly susceptible, it is recommended that the system identify the condition(s) that lead to the high susceptibility. Immediate steps should be taken to protect the source, and action should be considered to remedy the condition (for example, repairing or replacing faulty intake construction, working directly with facility operators to implement sound management practices, etc.).

All water supplies, regardless of their susceptibility, should consider identified factors that could lead to higher susceptibility in the future, and should prepare a strategy to protect the water supply source. Raising public awareness through signs and other education programs, encouraging proper intake construction and the use of best management practices in existing facilities are good ways of ensuring that a surface water source maintains its moderate susceptibility rating.

## Summary and Recommendations

The actual susceptibility of the drinking water source of a water supply depends on a number of contributing factors, some of which are only slightly related. Sensitivity is determined from the natural setting of the source and identifies the natural protection afforded to the source water. Susceptibility is determined by identifying those factors within the community's SWA that may pose a risk to the source water. The susceptibility determination provides information with respect to facilities within the SWA or land areas within the SWA that should be given greater priority and oversight in the implementation of a drinking water protection program.

**Sensitivity Analysis:** Based on criteria adopted in the Great Lakes Protocol of the Michigan Source Water Assessment Program, the deep, offshore intake for the Marquette Water Treatment Plant has a moderate degree of sensitivity to potential contaminants. When considering on shore winds and the Dead River influence, the Marquette intake is categorized as moderately sensitive.

**Susceptibility Determination:** The SWA for the Marquette intake includes 33 listed potential contaminant sources within the susceptible area, plus agricultural, urban, and industrial runoff from the Dead River SWA. Combining these potential contaminant sources with the moderately sensitive intake yields a moderate susceptibility determination for Marquette source water (fig. 5).

**Effective Treatment:** While it has been determined the Marquette source water is moderately susceptible to potential contamination, it is also noted the City of Marquette Water Treatment Plant has, historically, effectively treated this source water to meet drinking water standards with minimal complaints from the public. This assessment provides the City with a basis to institute a source water protection program as another tool to assure the continued safety of its water supply.

The results of this assessment and the recommendations based on these results are summarized as follows:

- ***Intake -*** The Marquette Water Supply was originally constructed in 1869. The current intake was installed in 1916 and draws water 3,100 ft from shore, under about 55 ft of water, making it a moderately sensitive intake.
- ***Soils –*** Using a mean, area-weighted, depth-integrated permeability estimation, the soil and subsoil material in the SWA range from 1.5 in/hr to as much as 17.8 in/hr. The mean permeability is 7.0 in/hr (Schneider and Erickson, undated, series of 5 maps; BASINS, 1998; MIRIS, 2000). About 92 percent of the soils in the Marquette SWA are moderately rapid to rapidly permeable. Eighty-nine (89) PCS are located on these soils. These factors combine to make the SWA, and thus the intake, highly sensitive. The community should take steps to evaluate current and future land use in areas of highly permeable soils, particularly those occurring within the susceptible area. Those PCS that have been identified either on or in close proximity to these soils should be informed of the sensitive nature of the area and encouraged to adopt best management practices designed to minimize the risk of a ground release. Residential areas that have been developed on these soils should be targeted for educational programs identifying steps that residents can take to protect the water supply.
- ***Historical Contaminant Detections -*** There have been no detections of synthetic or volatile organic contaminants in the systems raw water. Inorganic contaminants are typically at lake background levels. Nitrate concentrations are routinely below the detection limit. Positive coliform bacteria detections have occurred often associated with snowmelt, spring runoff, and discharge from the Dead River above median flow. The periodic presence of coliform bacteria is indicative of a relationship between runoff and soil conditions, causing the occasional presence of bacteria at detectable levels in the source water. These factors indicate that the SWA, and thus the intake, is moderately susceptible.
- ***Sanitary Survey –*** At the time of this assessment, a sanitary survey was not available for the WTP. It is important that the water supply continue to follow good management practices.
- ***Potential Contaminant Sources -*** Within the susceptible area, there are 32 PCS with 33 discharge permits. It is recommended that the community focus initially on PCS that are within the susceptible area as they pose the greatest potential threat to the water supply. These facilities should be made aware of free technical assistance that is available through MDEQ's pollution prevention programs. Through chemical inventory, waste reduction, and by increasing awareness of best management practices,

the risk these facilities pose to source waters can be reduced. The PCS inventory indicates that the source is moderately susceptible.

- ***Source Water Assessment*** **-** The Marquette source water assessment is based on these site-specific parameters:
  1. Definition of a Critical Assessment Zone around the intake for a moderately sensitive source;
  2. Definition of a SWA for the Dead River, its tributaries, and the shoreline near the intake;
  3. Wind and current patterns in Lake Superior near the Marquette WTP intake and their effects on source water quality; and
  4. Listed and nonlisted potential contaminant sources.
- ***Source Water Protection*** – The City has initiated source water protection activities with an Industrial Pretreatment Program incorporating management plans, chemical containment, and spill response, spill response training, plus catch basin and street cleaning programs.

The Marquette WTP and/or the community should assemble a team to assist in the development and implementation of a source water protection program that uses this assessment to further protect the Marquette source water area.

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## Glossary

Critical Assessment Zone (CAZ) – the area from the intake structure to the shoreline and inland, including a triangular water surface and a land area encompassed by an arc from the endpoint of the shoreline distance on either side of the on shore intake pipe location

Geographic Information System (GIS) – a system to capture, store, update, manipulate, analyze, and display all forms of geographically referenced information

Impaired water bodies -

Intake – the point at which source (raw) water is drawn into a pipe to be delivered to a water treatment plant

Lignins – an amorphous, cellulose-like, organic substance that acts as a binder for the cellulose fibers in wood and adds strength and stiffness to cell walls

Maximum Contaminant Level (MCL) – the maximum permissible level of a contaminant in water that is delivered to any user of a public water system

Potential Contaminant Sources (PCS) – listed and non-listed agricultural sites, businesses, and industries that have the potential to cause contaminants to be introduced into source water

Sensitivity – a measure of the physical attributes of the source area and how readily they protect the intake from contaminants

Source – the water body from which a water supplier gets its water

Source Water Area (SWA) – the land and water area upstream of an intake that has the potential to directly influence the quality of the water at the intake

Source Water Assessment Program (SWAP)– in Michigan, the process defined by the state Department of Environmental Quality to complete assessments of all the state's public water supplies

Susceptibility – the Susceptibility identifies factors that may pose a risk within the community's source water area

Susceptible Area – the area defined by the critical assessment zone and a buffer on either side of any drainages that contribute water to an intake

Synthetic Organic Contaminants (SOC) – Manmade organic chemical compounds such as pesticides, etc.

Tannins – naturally occurring phenolic compounds that precipitate proteins, alkaloids, and glucosides from solution that has a yellowish appearance

Volatile Organic Contaminants (VOC) – Unnatural, volatile organic chemical compounds such as gasoline components, solvents, degreasers, etc.