Source Water Assessment Report for the City of Traverse City Water Supply April 2004

City of Traverse City Water Treatment Plant
Traverse City, Michigan

Prepared for:
City of Traverse City Water Supply; WSSN 6640

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Michigan Source Water Assessment Report 14

Executive Summary

The purpose of the Source Water Assessment is to provide information about the affects of environment on a community's drinking water source. The assessment seeks to analyze the natural sensitivity of the source water and determine the susceptibility of the source water to potential contamination. This information will help communities make important decisions about how to protect their drinking water.

Sensitivity is determined from the natural setting of the source water (raw water entering 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 Michigan Department of Environmental Quality (MDEQ) has examined the effects of wind and lake currents, the possible influence of Mitchell Creek, and urban runoff. From this examination, the MDEQ has determined that the offshore intake for the Traverse City Water Treatment Plant has a moderate degree of sensitivity to potential contaminants.

Susceptibility identifies factors within the community's source water area that may pose a risk to the water supply, even though the level of such risk may be low. The susceptibility determination provides information about facilities and land areas in the vicinity of the source water that have the potential to contaminate the water supply. These potential contamination sites have been previously identified by the MDEQ, the U.S. Environmental Protection Agency, or other organizations as possible sources of concern and they should be given greater priority and oversight in the implementation of a source water protection program. These sites have the potential to cause contamination, but are not likely to do so if managed properly. The source water area for the Traverse City intake includes 48 potential contaminant sources, at least 2 of which discharge directly to the East Arm of Grand Traverse Bay, plus urban and agricultural runoff. The potential contaminant sources, in combination with the moderately sensitive intake, indicate that the Traverse City source water has moderate susceptibility to potential contamination.

The Traverse City source water is categorized with moderate susceptibility, given land uses and potential contaminant sources within the source water area. However, it is noted that historically, the city of Traverse City water treatment plant has effectively treated this source water to meet drinking water standards. The city of Traverse City 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

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, *in press*).

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 Traverse City is located in Grand Traverse County, about 250 miles (mi) northwest of Detroit, Michigan, on the shore of Grand Traverse Bay (fig. 1). Besides serving a city residential population of 14,532, the water supply also serves an estimated 8,000 residents in Garfield Township and 750 in Peninsula Township. The Traverse City water supply's original intake was construct in West Bay in the 1890s. In 1965, a new intake was installed in East Bay with a low service pump station and filtration plant rated at 5 million gallons per day (MGD). An upflow clarifier was installed in the WTP along with an additional filter in 1971. In 1993, the WTP was converted to direct filtration and expanded to 20 MGD with a firm capacity of 19 MGD through the addition of two flocculators, two filters and new, low and high service pumps.

East Bay – Traverse City WTP Source Water

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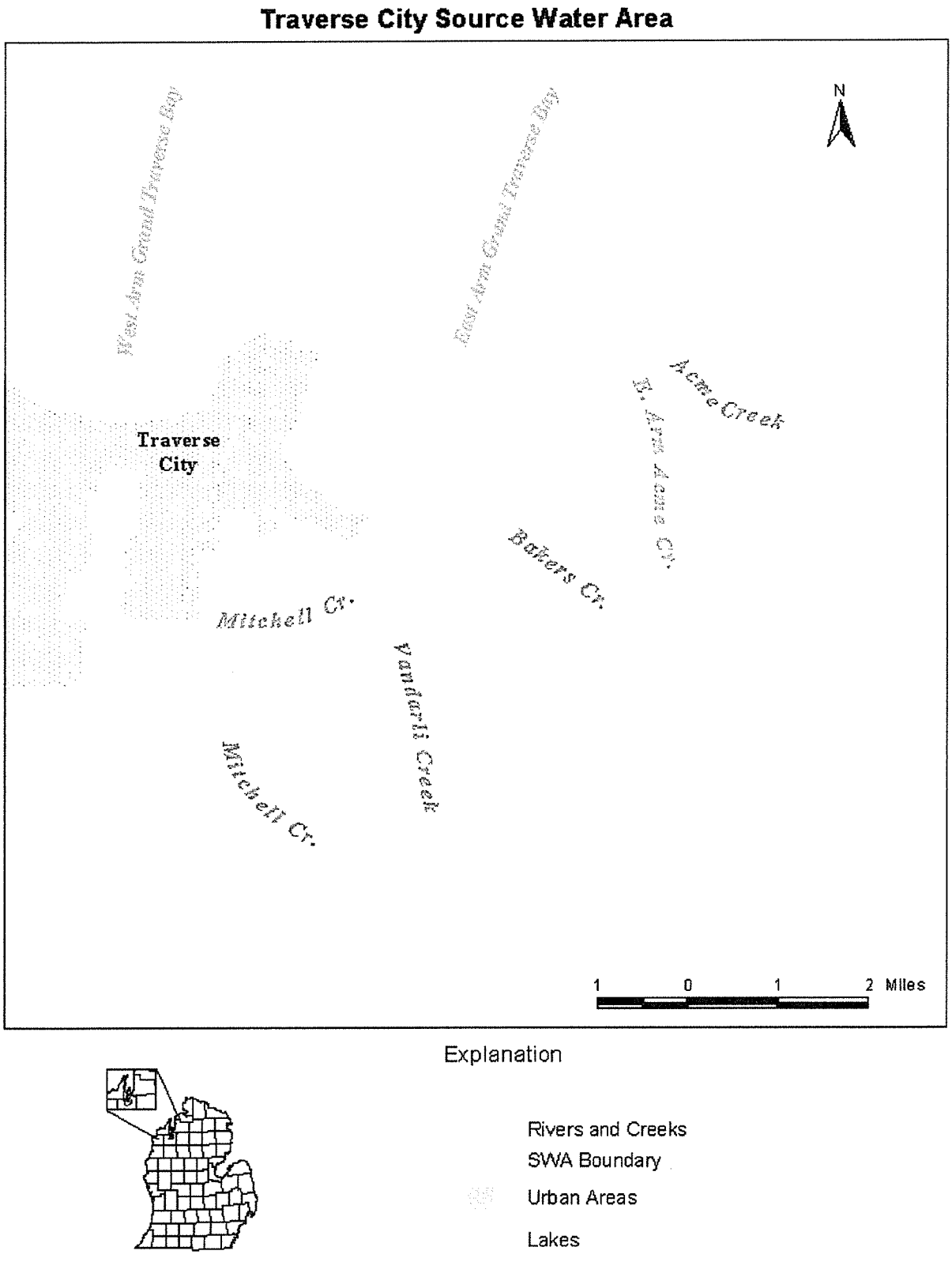


Figure 1. Source Water Area (SWA) for the evaluation of the Traverse City water Supply, Traverse City,

The WTP intake is located feet from shore in East Grand Traverse Bay. The intake crib is constructed of wood and has feet of submergence at its inlet. A 36-inch welded, steel pipe buried in the lake bottom connects the crib to the low service pump station. Chlorination was initiated at the intake in 1995 to control zebra mussels.

Water treatment plants are periodically inspected to identify construction, maintenance, and 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. The most recent sanitary survey of the Traverse City WTP was initiated in March 2002.

Climate

The Traverse City water supply is located in the North-Central Lower Peninsula hydrologic province (Rheaume, 1991). The region experiences temperate summers with moderate winters. The Traverse City weather station reports long-term average annual precipitation for the period 1903-2001 was about 30 in, with about 45 percent of that as snowfall between November and March. Annual average runoff for the Traverse City SWA, extrapolated from Miller and Twenter (1986, fig. 1) is 14 inches to 16 inches, with runoff values increasing from east to west.

Source Water Area Geology and Hydrology

The study area for evaluating the extent of the Traverse City WTP SWA includes Mitchell and Acme creek watersheds, in addition to East Arm Grand Traverse Bay (fig. 1). The SWA consists of eolian or wind made deposits in the northeastern portion of the SWA, lakebed deposits in the western portions of the SWA, and end moraines and glacial outwash in the eastern portion of the SWA. These landforms are underlain by shales from the Antrim, Bedford, Coldwater, Ellsworth, and Sunbury Groups (Martin, 1955; Milstein, 1987). Soils in the Traverse City SWA are primarily from the Emmet-Leelanau and Coventry-Karlin associations. They include loamy sands, sandy loams, mucks, peats and sands (U.S. Department of Agriculture, 1966; BASINS, 1998).

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 (1987). 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. 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. Erosion and transport of soils by surface waters can cause an increase in turbidity. Mean, area-weighted, depth-integrated permeabilities for the Traverse City SWA range from 4.63 to as much as 13.0 in/hr. The mean permeability is 7.78 in/hr (Schneider and Erickson, undated, series of 5 maps; BASINS, 1998;). Soils are generally moderately rapid to rapidly permeable throughout the SWA (fig. 2; U.S. Department of Agriculture, 1966; BASINS, 1998). Soils with rapid permeability are close to Grand Traverse Bay and in the southeastern portion of the SWA (Lusch and others, 1992; BASINS, 1998).

The Traverse City SWA contains an area of about 45.5 square miles (mi^2) and is directly connected to Grand Traverse Bay. The most significant tributaries to Grand Traverse Bay from the SWA are Mitchell and Acme creeks, with drainage areas of about 16 mi^2 and 13 mi^2, respectively. No gauging stations are operated in the SWA by the USGS (Blumer and others, 2001, p. xii).

Mitchell Creek Discharge to East Bay

Under ambient conditions, currents in the lower, east Arm of Grand Traverse Bay are, typically, counterclockwise from west to east and north. Sustained strong winds from the west affect bay currents, causing increases in near shore turbidity. Sustained winds from the northwest through northeast can cause flow from the northern portion of the bay to pass over the intake, causing slight 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.

The Traverse City WTP records show that water use between 1998 and 2001 fluctuated between 4.6 and 4.96 MGD, with a maximum day flow of 13.01 MGD during this period. Following is a summary of raw water quality from the WTP for the period October 1995 through September 2000.

Parameter	Average	Minimum	Maximum
Turbidity	0.33 NTU	0.09 NTU	1.10 NTU
Chloride	8.6 mg/l	7.0 mg/l	10.0 mg/l
pH	8.14	7.0	8.6
Alkalinity	109	105	114
Coliform Bacteria	4.8 cnts/100 ml	0.0	100 cnts/100 ml

These minor variations in raw water quality are most likely associated with changes to circulation patterns in Grand Traverse Bay, which can cause sediments near the intake to be suspended in the water column due to wind patterns and wave action. Coliform counts are typically zero during the winter months and increase during warmer weather. Periodic scans of raw water for volatile organic contaminants have been negative. No color problems were reported for raw water. While not regulated, esthetic parameters such as taste and odors associated with algae blooms are also a source water concern for the Traverse City WTP.

Natural occurring, thermal inversions in Grand Traverse Bay can also cause treatment problems for the plant. Thermal inversions are typically associated with heating of the surface of the Bay in spring, and cooling of the surface of the bay in the fall or early winter. Both events cause density differences in the Bay that cause the water to turnover and mix, often stirring up bottom sediments and detritus. In addition, rapidly fluctuating bay temperatures and very cold water can be issues for treatment at the WTP.

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.deq.state.mi.us/dwr. 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, *in press*) 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

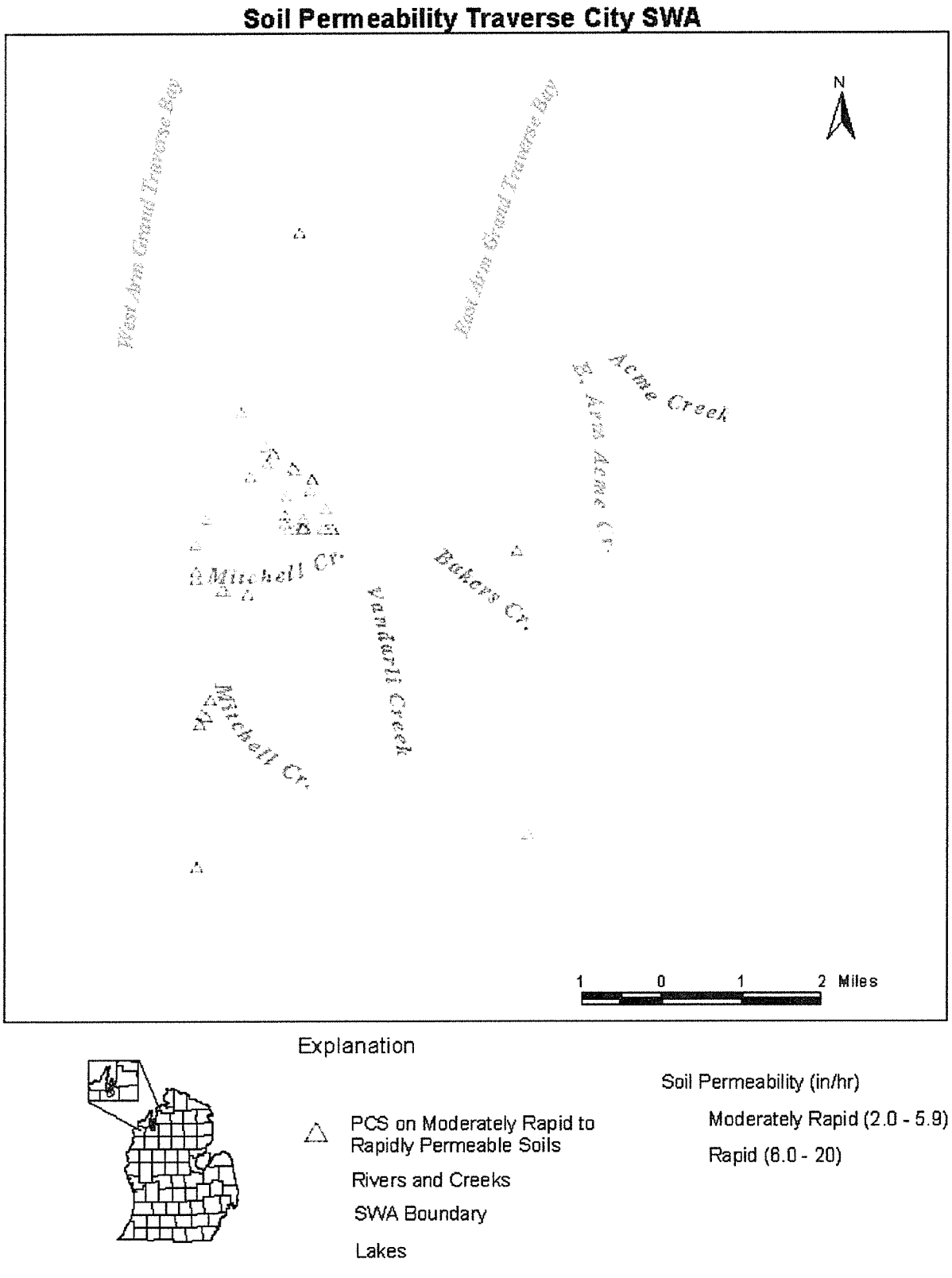


Figure 2. Source water (SWA) permeability map with Potential Contaminant Sources (PSC) for the Traverse City water supply, Traverse City, Michigan.

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 Traverse City water supply information:

- The CAZ for the Traverse City intake is calculated as:

  (the length of the intake in ft.) x (the depth of the intake in ft.) = (unitless)
  This results in rating the intake as moderately sensitive, with a CAZ of 1,000 ft (MDEQ, 1999, Appendix L; fig. 3). The CAZ does not intersect the shoreline and there is no shoreline buffer.

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 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;
   - 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;
   - 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 2.01.
   - 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);
   - U.S. EPA Toxic Chemical Release Inventory System (TRIS); and
   - U.S. EPA Oil Pollution Act of 1990 Spill Response Atlas.
3. Met with public water supply and community officials on October 12, 2000 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.

Critical Assessment Zone (CAZ) for Traverse City SWA Intake

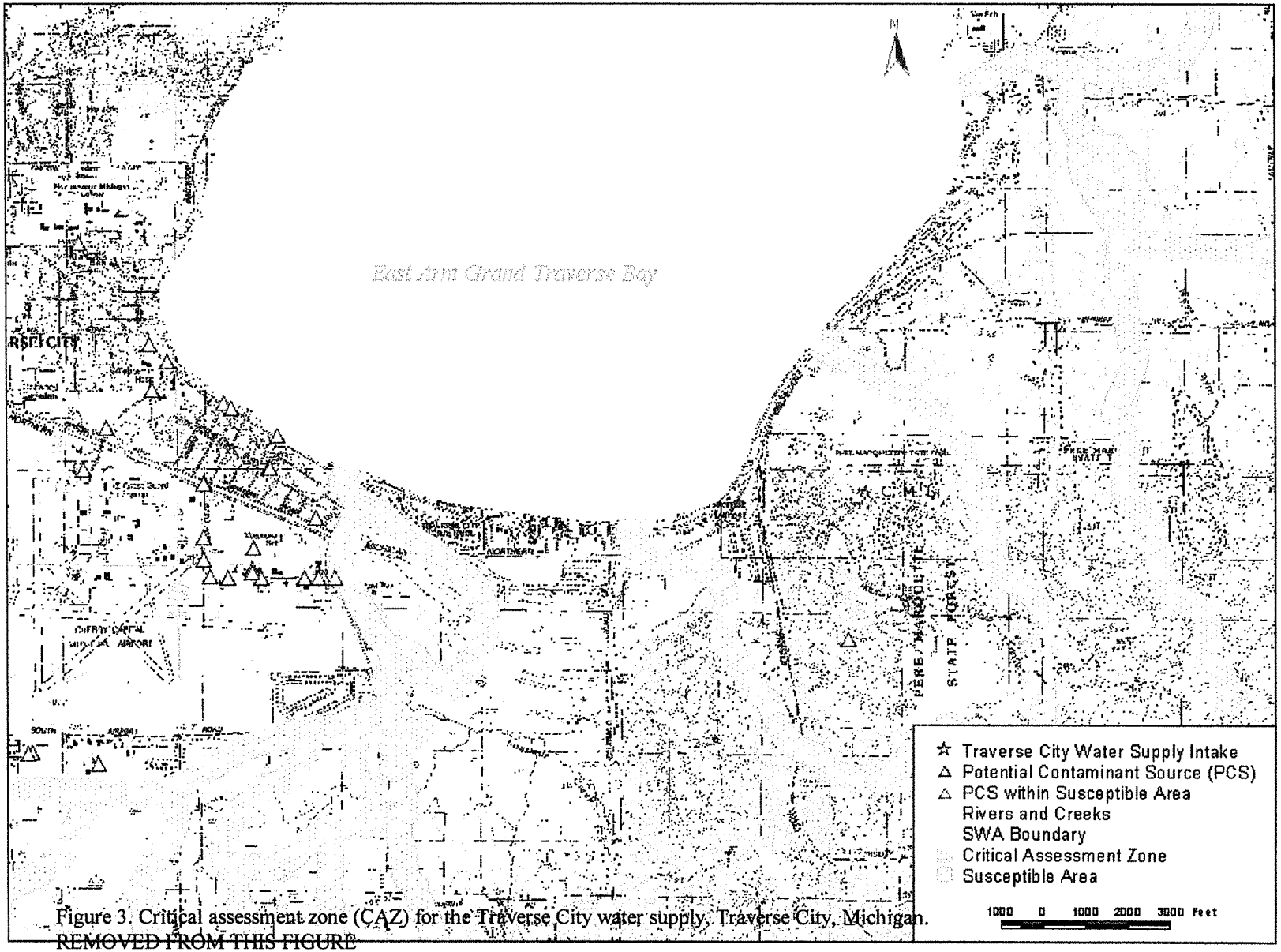


Figure 3. Critical assessment zone (CAZ) for the Traverse City water supply, Traverse City, Michigan. ~~REMOVED FROM THIS FIGURE~~

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 intakes.
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 Traverse City water supply.

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 1 and 2 and are shown on figure 4.

Table 1. Potential contaminant sources (July 2002) in the Traverse City source-water area, Michigan.

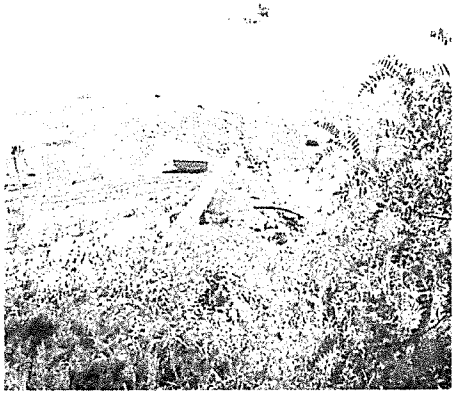
Type of Potential Contaminant Source	Number of PCS	Number of PCS within the CAZ and susceptible area	Number of PCS with Direct Discharge to Grand Traverse Bay
Hazardous or Solid Waste Site Permits	39	1	--
Industrial Facilities Discharge Site Permits	2	0	1
National Priority List Sites	1	0	--
Permit Compliance System Permits	3	0	1
Toxic Release Inventory Permits	3	1	--

Table 2. Potential-contaminant source-inventory results (July 2002), Traverse City source-water area, Michigan

Site Name	City	ID Number	Reason for Permit	Reason for listing as Potential Contaminant Source
BORIDE PRODUCTS INC	TRAVERSE CITY	MID005518360	On-Site Storage	Hazardous or Solid Waste Site
BURWOOD PRODUCTS CO INC	TRAVERSE CITY	MID006025100		
SWANSON CHET SALES	TRAVERSE CITY	MID017420704		
TRAVERSE MOTORS BODY AND PAINT SHOP	TRAVERSE CITY	MID017420944		
MARSH BILL BUICK GMC	TRAVERSE CITY	MID017421132	On-Site Storage	Hazardous or Solid Waste Site
C-LAND EXCAVATING INC	TRAVERSE CITY	MID047146287		
VILLAGE PRESS INC	TRAVERSE CITY	MID049242076		
OLMSTED PRODUCTS CO	TRAVERSE CITY	MID049266091		
JANTEC INC	TRAVERSE CITY	MID054313358		
NISH NAH BEE INDUSTRIES INC	TRAVERSE CITY	MID060179165		
BORIDE PRODUCTS INC	TRAVERSE CITY	MID092952662		
ONE HOUR MARTINIZING	TRAVERSE CITY	MID097808125		
CENTURY SUN METAL TREATING INC	TRAVERSE CITY	MID270010408		

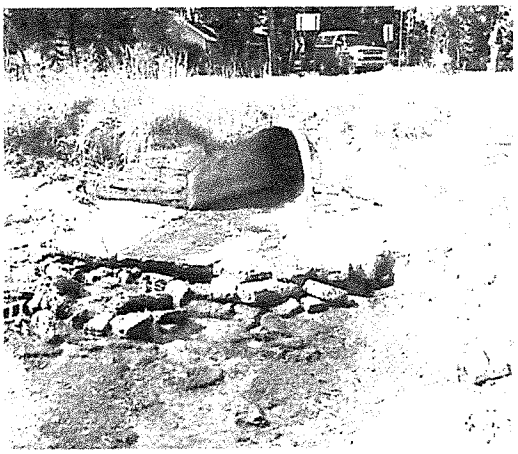
Site Name	City	ID Number		
Site Name	City	ID Number		
BORIDE ENGINEERED ABRASIVES	TRAVERSE CITY	MID982063307		
GRAND TRAVERSE STAMPING	TRAVERSE CITY	MID982639890		
GRAND TRAVERSE CTY DPW GARAGE	TRAVERSE CITY	MID985567148		
NISH NAH BEE PLASTICS	TRAVERSE CITY	MID985570365		
MUNSON COMMUNITY HEALTH CENTER	TRAVERSE CITY	MID985572809		
MARSH BILL CHRY PLYM DODGE	TRAVERSE CITY	MID985574474		
EMRO MARKETING 6257	TRAVERSE CITY	MID985576933		
JACKLIN STEEL SUPPLY CO	TRAVERSE CITY	MID985584523		
HARBOUR AIR INC	TRAVERSE CITY	MID985610971		
BRIAR HILL SHELL STATION	TRAVERSE CITY	MID985621895		
ALCOTEC	TRAVERSE CITY	MID985627926		
KRAUS JW	TRAVERSE CITY	MID985633007		
TWIN CITY OPTICAL CO	TRAVERSE CITY	MID985642628		
NORTHWESTERN MICHIGAN COLLEGE	TRAVERSE CITY	MID985644152		
COURTADES TRADING POST	TRAVERSE CITY	MID985653773		
TRAVERSE CITY RECORD EAGLE	TRAVERSE CITY	MID985655745		
CAMTEC INC	TRAVERSE CITY	MID985664309		
L O M CORP	TRAVERSE CITY	MIT270010333		
WATEROUS-TRAVERSE CITY IRON WORKS	TRAVERSE CITY	MIT270013030		
ORCHARD MANAGEMENT CORP	TRAVERSE CITY	MI0000361451		
DE BRUYN CONCRETE PRODUCTS	TRAVERSE CITY	MI0000384305		
GAS COMPRESSION SERVICES INC	TRAVERSE CITY	MI0000936724		
TELLUREX CORP	TRAVERSE CITY	MIR000000885		
OLMSTED PRODUCTS CO	TRAVERSE CITY	MIR000014514		
TRAVERSE CITY WFP	TRAVERSE CITY	MI0004979	Process, Treatment, and Waste Waters	Industrial Facilities Discharge Site
GRAND TRAVERSE OVERALL SUPPLY	TRAVERSE CITY	MI0038385		
WATEROUS TRAVERSE CITY GRAY IRON INC.	TRAVERSE CITY	MIT270013030	Superfund Site	National Priority List Site
EMRO-TRAVERSE CITY-MUNSON AVE	TRAVERSE CITY	MI0051608	Waste Water, Dust and Process Water	Permit Compliance System
ALCOTEC WIRE CO	TRAVERSE CITY	MI0053368		
TRAVERSE CITY WFP	TRAVERSE CITY	MI0004979		
CENTURY SUN METAL TREATING INC.	TRAVERSE CITY	MID270010408	Release or Manufacture of Toxic Compounds	Toxic Release Inventory
ALCOTEC WIRE CO.	TRAVERSE CITY	MID985627926		
NORCOM INC.	TRAVERSE CITY	MI0001489426		

Many PCS are readily identifiable because they have a single discharge point, and often a permit is required. 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 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. Specific nonpoint source discharges of concern in the Traverse City SWA are storm sewer outfalls from Eighth Street, Front Street and at the South Park. The discharge from Mitchell Creek also presents concerns related to agricultural, golf course, and residential runoff.

WTP Lagoon Discharge to East Bay



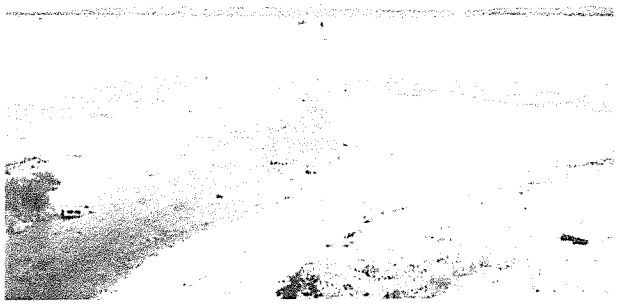
Eighth Street Storm Sewer Outfall to East Bay

Transportation also represents a non-point source of contamination. Trucking, railroads, and boating 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 boating, directly discharge to Grand Traverse Bay, possibly near the water intake. Non-point sources of concern to the Traverse City water supply are primarily from agriculture and livestock in the Traverse City SWA, and from industrial, commercial, and residential sources in Traverse City and surrounding communities. Volatile organic contaminants in groundwater originating from the airports also poses a potential threat as it enters the East Bay.

The U.S. Environmental Protection Agency (USEPA) has not identified any **impaired water bodies** in the Traverse City SWA on its Clean Water Act 303(d) list (MDEQ, 2001).

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, affect the water quality at the intake. A small quantity 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. Overlaying the PCS locations and the soil permeability map for the Traverse City SWA indicates that all 48 of the located PCS are located on or very near to areas with moderate to rapidly permeable soils (fig. 2).

The SWA consists of primarily agricultural, forested, and urban land (fig. 4). The results of the PCS inventory performed for the Traverse City water supply are shown on figure 4 and are summarized as a function of PCS locations within the SWA relative to land use. Inventory results indicate that there are 48 PCS within the SWA, at least 2 of which discharge directly to Grand Traverse Bay (tables 1, 2).



Front Street Storm Sewer Discharge to East Bay

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 to highly-permeable soils.
- Amount of available water from precipitation or runoff.
- Potential for runoff to affect the intake.
- 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 Traverse City 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 Brogren (1999) and Sweat and others (2000, 2002), indicates that the Traverse City intake is moderately sensitive (fig. 5). This means that the natural environment offers some limited 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.

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. 5). 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, *in press*). 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. The Traverse City WTP intake is located far enough from shore and in deep enough water that the CAZ is 1,000 (fig. 3). The Traverse City WTP intake is considered to have moderate susceptibility to potential contamination (fig. 5).

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 source water protection program.

Sensitivity Analysis: Based on criteria adopted in the Great Lakes Protocol of the Michigan Source Water Assessment Program, the offshore intake for the Traverse City water treatment plant has a moderate degree of sensitivity to potential contaminants. When considering off shore winds and shoreline influences, the Traverse City intake is categorized as moderately sensitive.

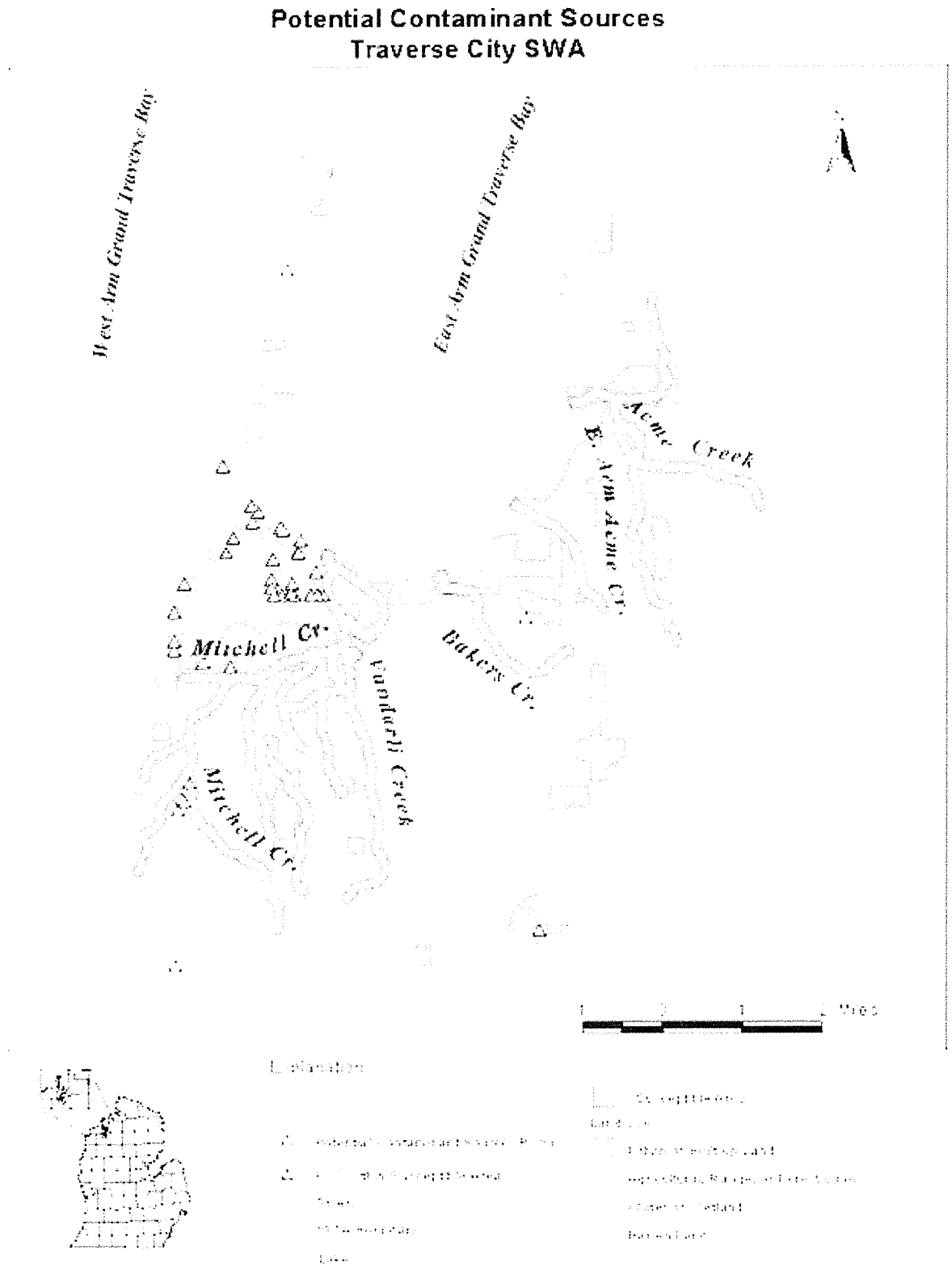


Figure 4. Contaminant Source Inventory for the Traverse City water supply, Traverse City.

Susceptibility Determination: The SWA for the Traverse City intake includes 48 listed potential contaminant sources, plus agricultural, urban, and industrial runoff from the Traverse City SWA. However, the intake is far enough from shore that the susceptible area likely doesn't influence them. The moderately sensitive intake for the Traverse City WTP has a moderate susceptibility determination (fig. 5).

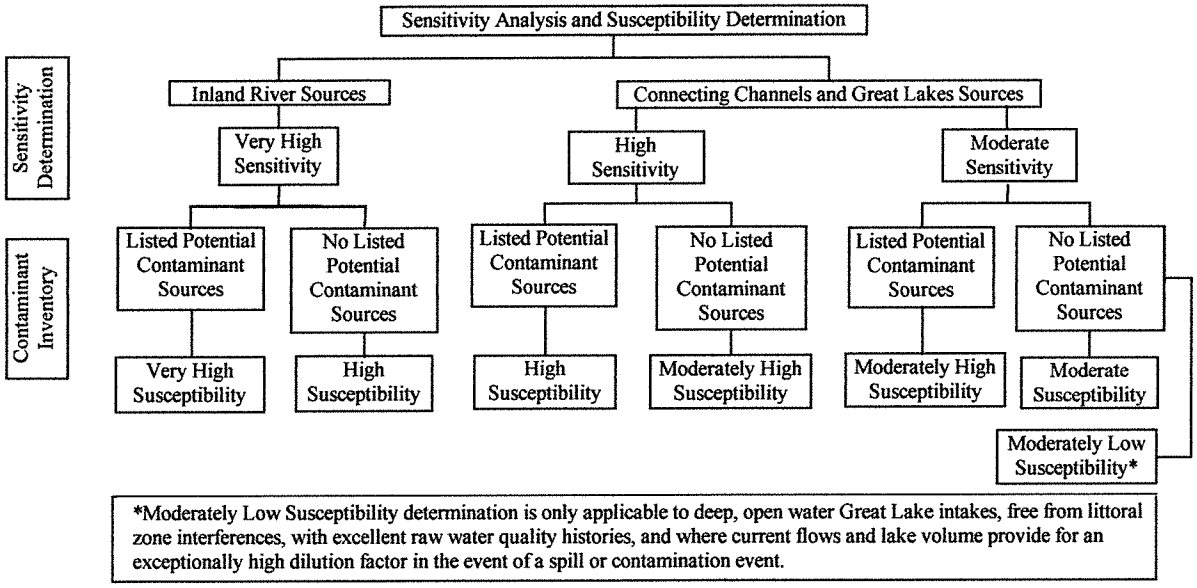


Figure 5. Surface-water source sensitivity analyses and susceptibility determination, Traverse City WTP, Michigan.

Effective Treatment: While it has been determined the Traverse City source water has moderate susceptibility to potential contamination, it is also noted the city of Traverse City water treatment plant has, historically, effectively treated this source water to meet drinking water standards. This assessment provides the WTP 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 Traverse City Water Supply was originally constructed in the 1890s with an intake in West Bay. The current surface-water intake in East Bay was installed in 1965, and draws water ft from shore in ft of water (1935 datum), 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 4.63 in/hr to as much as 13.00 in/hr. The mean permeability is 7.78 in/hr (Schneider and Erickson, undated, series of 5 maps; BASINS, 1998). About half of the soils in the Traverse City SWA are rapidly permeable. At least 23 PCS are located on these soils. These factors combine to make the SWA, and thus the intake, moderately 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 and are probably associated with snowmelt, spring runoff, and discharge from Mitchell Creek. The periodic presence of coliform bacteria before chlorination at the intake 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*** - The most recent sanitary survey is currently being drafted(Thurston, 2002). It is important that the water supply continue to follow good management practices as noted in sanitary surveys..
- ***Potential Contaminant Sources*** - A review of the PCS inventory and the moderately and highly permeable soil distribution indicates that the Traverse City SWA has at least 23 PCS located on highly permeable soils. is recommended that the community focus initially on PCS that are located on rapidly permeable soils and nearest any water bodies, 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 has moderate susceptibility.
- ***Source Water Assessment*** - The Traverse City source water assessment of moderate susceptibility is based on these site-specific parameters:
  1. Definition of a Critical Assessment Zone around the intake for a source with moderate sensitivity;
  2. Definition of a SWA for the Mitchell Creek watershed and the shoreline near the intake;
  3. Wind and current patterns in Grand Traverse Bay near the Traverse City 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 Traverse City 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 Traverse City 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 – As defined by USEPA and Clean Water Act 303(d) list

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.