A portion of Manitowoc's source water area draining into Lake Michigan
Photograph courtesy of E. Spencer

Source Water Assessment
For Manitowoc Public Utilities

Manitowoc, Wisconsin

May 7, 2003

A report provided by the
Wisconsin Department of Natural Resources
Bureau of Drinking Water and Groundwater

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Summary

The 1996 amendments to the Safe Drinking Water Act require that States complete source water assessments for all public drinking water systems. The primary purpose of this assessment is to determine the relative susceptibility of Manitowoc's source water to contamination. For this assessment, susceptibility is defined as the likelihood that a contaminant of concern will enter a public water supply at a level that may result in adversely impacting human health. Source water is untreated water from streams, rivers, lakes, and groundwater aquifers. A susceptibility determination is based on a stepwise synthesis of information regarding the well or surface water intake vulnerability and the source water's sensitivity to a potential source of a contaminant of concern. All drinking water systems that rely on surface water are considered at least moderately susceptible to contamination, if not highly susceptible. This is due to the ease with which surface water can be contaminated relative to groundwater.

Affordable, safe drinking water is essential to the health, development and stability of all communities. Conventionally, treatment has been the only step in maintaining safe drinking water for surface water systems. The quality of treated drinking water is a function of the pretreatment water quality. Little concern has been paid to a preventive approach of protecting the source water. 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.

The City of Manitowoc is located in eastern Wisconsin along Lake Michigan. The majority of drinking water supplied to Manitowoc Public Utilities more than 33,000 customers is treated source water from Lake Michigan. During periods of high water demand and maintenance, two nearshore groundwater wells are used to supply drinking water. There is also an inactive nearshore well.

A source water area is the area that contributes source water to the public drinking water system. Lake Michigan drains approximately 45,600 square miles. Due to its size and diverse land uses, assessing the entire Lake Michigan source water area is not a practical method for determining the individual susceptibility of Manitowoc's surface water system. In an attempt to improve source water quality at a practical scale, the WDNR delineated source water areas for the surface water system based on local watersheds that may specifically impact source water entering Manitowoc's intakes. It is important to note that a source water area is only one potential factor in the quality and susceptibility of source water. Other factors may include unmanageable, lake-wide episodic events that have little to do with human activities.

Located in Eastern Wisconsin, Manitowoc's source water area for the surface water intakes includes portions of Manitowoc, Southeastern Brown, Eastern Calumet, Northeastern Fond du Lac and Northeastern Sheboygan Counties. The 656 square mile source water area is drained by the Sevenmile-Silver Creek, the Lower Manitowoc River, the Branch River, the North Branch Manitowoc River and the South Branch Manitowoc River Watersheds. Soils of the source water area are characteristically clayey loams. Topography ranges from hilly in the middle portions of the source water area to broad flat sloping plains in the eastern and western portions of the source water area. Agriculture is the predominant land cover. The soils, topography and land cover of the source water area coupled with historical clearing and draining of forest and wetland areas cause large amounts of precipitation and meltwater to flow overland. This overland flow results in contaminated surface water and drastically fluctuating stream flow.

Manitowoc Public Utilities has reliably provided high quality drinking water to its customers. Treatment of the source water from Lake Michigan includes microfiltration and chlorination. Source water from Ranney wells is chlorinated prior to distribution. The total capacity of the Manitowoc Public Utilities is 18 million gallons of drinking water per day.

The source water for the surface water intake was determined to have a moderate level of susceptibility to contamination and not significantly impacted by manageable local factors. Manitowoc's source water at the primary surface water intake is generally a factor of Lake Michigan water quality. Unaffected Lake Michigan water quality is near drinking water quality. Occasional fluctuations in source water quality may result from late summer easterly windstorms.

While not significantly impacting source water quality at the intake, the source water area does contribute to the overall water quality of Lake Michigan. With this in mind, watershed protection in the source water

area should focus on preventing non-point source pollution from agricultural and urban runoff. More information on source water protection can be found at http://www.epa.gov/safewater/protect.html.

The Manitowoc Waterworks system is susceptible to contamination by volatile organic compounds (VOCs), ethylene dibromide (EDB), nitrate, arsenic, and nickel. The system has moderate susceptibility to contamination by synthetic organic compounds (SOCs) and microbes. Groundwater protection activities should focus on obtaining additional information on the potential sources of contamination in the area to evaluate and manage their risk. Other efforts should include implementing a wellhead protection plan, and identifying and managing improperly abandoned wells or other features that may provide direct pathways for contamination to enter the aquifer. More information on Wisconsin's wellhead protection program is available at http://www.dnr.state.wi.us/org/water/dwg/gw/wellhead.htm.

A paper copy of the detailed assessment is available at the Manitowoc Public Library. An electronic version of the detailed assessment is accessible on the Wisconsin Department of Natural Resources website at http://www.dnr.state.wi.us/org/water/dwg/gw/SWP.HTM.

Introduction

In 1996, the U.S. Congress amended the Safe Drinking Water Act to provide resources for states to conduct Source Water Assessments. Information about Wisconsin's Source Water Assessment Program can be found on the Wisconsin Department of Natural Resources (WDNR) website mentioned in the Executive Summary. In cooperation with other Great Lakes states, WDNR has developed a method--Wisconsin's Source Water Assessment Program, Appendix R (Assessment Protocol for Great Lake Sources)--for conducting Source Water Assessments for water supplies that use the Great Lakes as their water source. A source water assessment involves identifying a source water area, analyzing the sensitivity of the source to natural conditions, conducting potential contaminant source inventories and determining the susceptibility of the source to contamination.

The requirements for public water supplies in Wisconsin to meet U.S. Environmental Protection Agency maximum contaminant levels (MCLs) provide a base level of assurance of safe drinking water. However, all systems are vulnerable to some degree to potential contamination. With this in mind, susceptibility determinations were made qualitatively relative to other systems.

Purpose of this Assessment

The purpose of this source water assessment is to determine the susceptibility of Manitowoc's source of drinking water to contamination and to make recommendations on how to help protect this valuable resource.

Safe, affordable drinking water in ample supply is essential to the health, development and stability of all communities. Conventionally, treatment has been the only step in maintaining safe drinking water for surface water systems and little concern has been paid to a preventive approach of protecting the source water. The quality and cost of treated drinking water is often a function of pretreatment source water quality.

Source water quality can be improved through the implementation of a source water protection program. A source water protection program is composed of four steps: assessment, planning, implementation and long term management. By assessing localized impacts on source water quality, this assessment completes the first step in a source water protection program. For more information on completing a source water protection program please visit http://www.epa.gov/safewater/protect/protect.html on the World Wide Web.

Source Water Contaminant Categories

Source water can be contaminated by microbial, inorganic, synthetic organic, volatile organic, precursors of disinfection by-products and radioactive contaminants. These contaminants can enter source water through various means. Pathways of contamination can be split into two major categories, point source pollution and nonpoint source pollution. Point source pollution includes specific, identifiable dischargers of contaminants. Examples of these include industrial and municipal wastewater outfalls. Point source dischargers are more easily regulated and held accountable for contaminating source water. Nonpoint source pollution comes from no specific source and diffusely enters source water. Examples of nonpoint source pollution include runoff from land cover and atmospheric deposition.

This assessment describes these general contaminant categories associated with potential contaminant sources. For a more detailed description of contaminants associated with potential contaminant sources please visit http://www.epa.gov/OGWDW/swp/sources1.html on the World Wide Web. For information on health effects and methods of protection from particular chemical contaminants please visit http://www.epa.gov/safewater/hfacts.html on the World Wide Web.

- *Microbial contaminants*, such as viruses and bacteria may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife. Microbial contaminants can lead to widespread acute illnesses in customers of a contaminated drinking water system. Examples of microbial contaminants include *Giardia*, *Cryptosporidium* and *E. coli*.

- *Inorganic contaminants*, such as salts and metals can occur naturally or come from among other sources: urban storm water runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming. Among other detrimental health affects, inorganic contaminants can negatively impact various organs and the circulatory system in the human body. Some examples of inorganic contaminants include nutrients such as nitrogen and phosphorous and heavy metals such as cadmium, lead and mercury.

- *Synthetic organic contaminants*, such as industrial products, pesticides and herbicides may come from a variety of sources such as agriculture, storm water runoff, industrial activities, landfills, wastewater treatment facilities and residential areas. As well as being carcinogenic, synthetic organic contaminants can negatively impact the nervous system, liver and kidneys and affect development. Some examples of synthetic organic contaminants include atrazine, polychlorinated bi-phenyls and lindane.

- *Volatile organic contaminants*, such as petroleum products, solvents, cleaners and degreasers may come from industrial activities, petroleum production, gas stations, urban storm water runoff, wastewater treatment facilities and septic systems. As well as being carcinogenic, volatile organic contaminants can negatively impact the nervous system, liver and kidneys and affect development. Some examples of volatile organic contaminants include benzene, vinyl chloride and styrene.

- *Precursors of disinfection by-products* lead to the formation of carcinogenic by-products during source water treatment. Likely sources of dissolved organic carbon are from agricultural and urban storm water runoff. Some examples of precursors of disinfection by-products include dissolved organic carbon and bromide.

- *Radioactive contaminants*, can be naturally occurring or be the result of oil and gas production and mining activities. Radioactive contaminants are carcinogenic. Some examples of radioactive contaminants include radium and uranium.

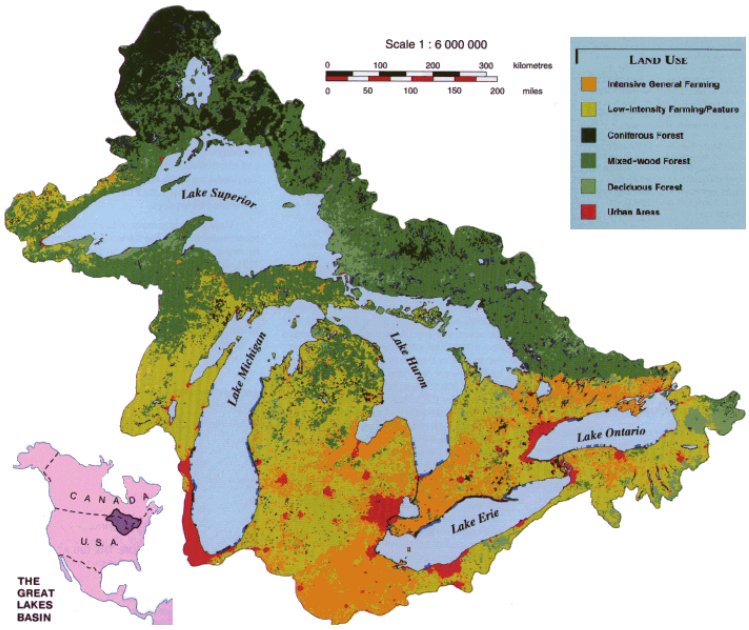
Source Water Assessment for the Manitowoc Surface Water System

Hydrologic Setting

Description of the Source Water Area

As shown in Figure 1, the Great Lakes drains more than 200,000 square miles of varying land uses. The size and variety of land uses found in this drainage basin make a basin-wide assessment impractical and ineffective at identifying impacts on Manitowoc's source water. In response to this, the WDNR identified smaller local source water areas that contribute source water to Lake Michigan in close proximity to the drinking water intakes. Source water areas are composed of one or more established watersheds that discharge near the surface water intakes. Source water areas for this assessment were delineated based on WDNR surface watersheds, not groundwater basins. Generally, groundwater basin boundaries are similar to their surface water counterparts but may vary due to geology.

Figure 1: Great Lakes Drainage Basin and Land Use



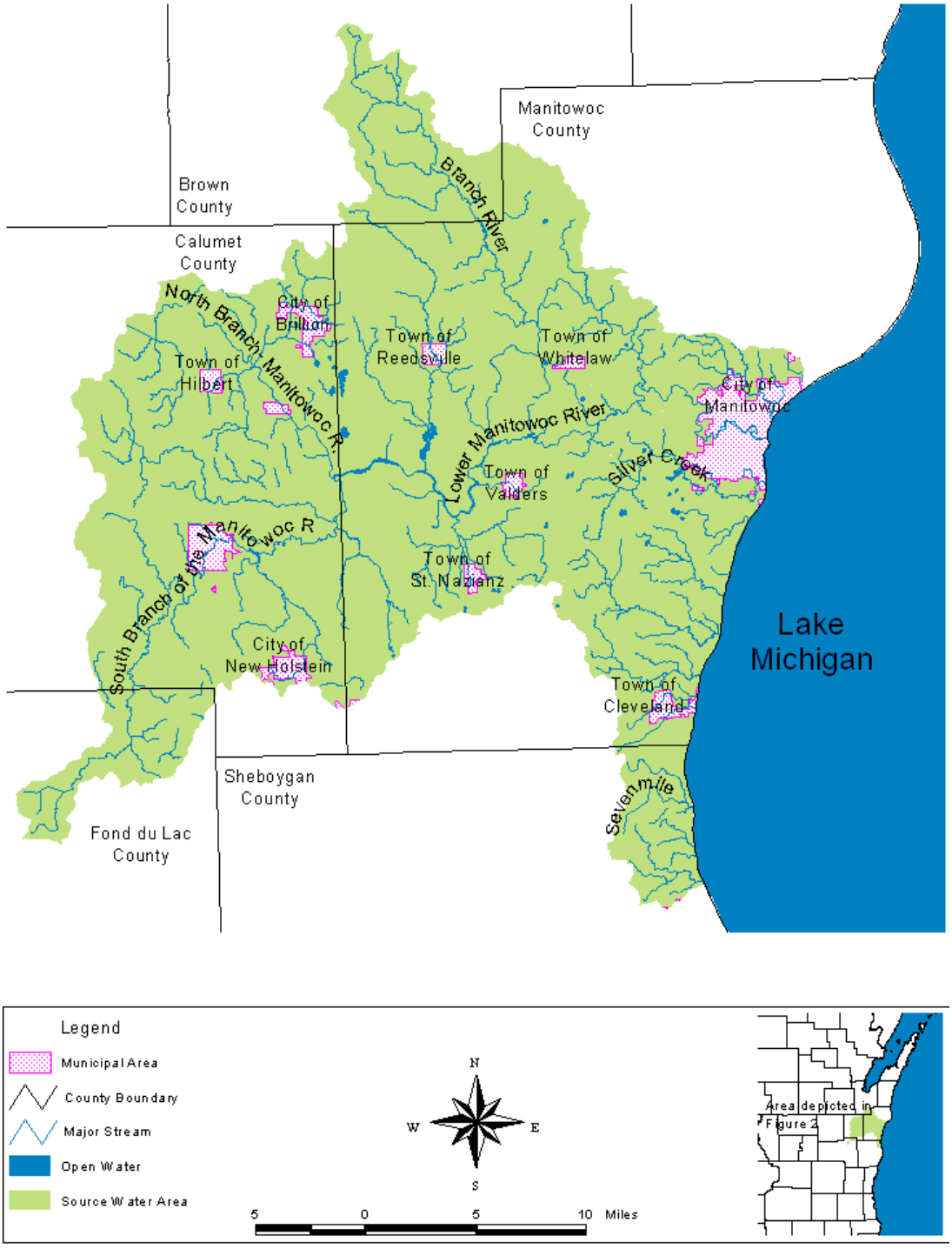
As shown in Figure 2, Manitowoc's source water area is located in East Central Wisconsin, south of the Door Peninsula. It includes portions of Manitowoc, Southeastern Brown, Eastern Calumet, Northeastern Fond du Lac and Northeastern Sheboygan counties. Urban areas in the source water area include the City of Manitowoc and the Towns of Cleveland, Whitelaw, Valders, St. Nazianz, New Holstein, Chilton, Hilbert, Potter, Brillion and Cato. The total source water area is 656 square miles.

Hydrology

As shown in Figure 2, five different watersheds drain the source water area. These are the Sevenmile-Silver Creek, Lower Manitowoc River, Branch River, North Branch of the Manitowoc River and South Branch of the Manitowoc River Watersheds. Four of these watersheds contribute water solely to the Manitowoc River. The Sevenmile-Silver Creek Watershed is composed of multiple small streams that drain directly into Lake Michigan, south of the Manitowoc River.

The soil types and land cover throughout most of the source water area inhibit infiltration of water into the ground and cause precipitation to flow overland. This overland flow is referred to as runoff. High amounts of runoff cause stream flows to increase dramatically during and following precipitation events and springtime thaws. Runoff quickly transports contaminants from spills and human activities into surface water with little to no filtration. Following these periods of high runoff little water remains in the source water area to maintain stream flows during dryer periods of the year. The average annual flow of the Manitowoc River from 1973 to 1999 is 318 cubic feet per second. The highest stream flows generally occur in April, which has a monthly average stream flow from 1973 to 2000 of 959 cubic feet per second.

Figure 2: Hydrology of Source Water Area



Soils and topography

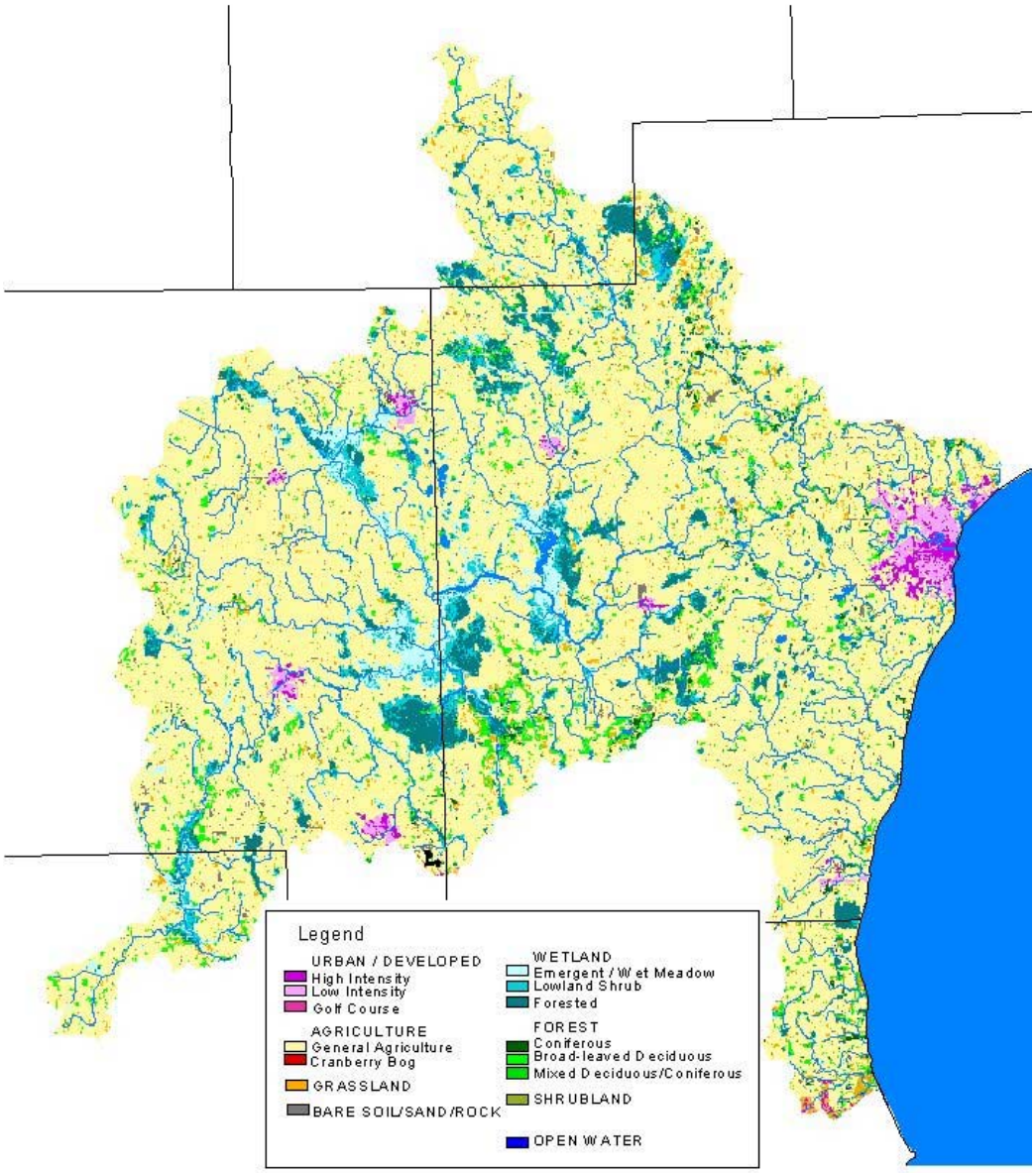
Most soils found in the source water area are clayey loams of low permeability. More permeable soils are found in the northern half of the Branch River Watershed and southwestern portions of the source water area. Topography ranges from hilly in the middle portions of the source water area to broad flat sloping plains in the eastern and western portions of the source water area.

Land Cover

Land cover can play a major role in source water quality. Spatial data in Figure 4 was generated from interpretations of aerial photographs taken from 1971 to 1982.

As shown in Figure 3, agriculture is the dominant land cover in the source water area. Dairy operations are the most common type of agricultural activity.

Figure 3: Land Cover



- *Agricultural*

  For this assessment agricultural land cover includes cropland, pasture, orchards and nurseries. Agricultural practices generally cause the land to be more susceptible to erosion and runoff than naturally vegetated land. Due to common practices and activities, agricultural land cover can be a major source of inorganic, treatment by-product precursors, microbial and synthetic organic contaminants for the source water.

  Agriculture is the predominant land use in the source water area. Runoff from agricultural land is believed to be negatively impacting source water throughout the source water area. Poorly managed manure spreading and storage practices have led to fish kills in Manitowoc County. The WDNR classified nonpoint source pollution from agricultural land, stream bank pasturing, barnyard runoff and cropland erosion as negatively impacting source water in multiple streams throughout the source water area.

- *Urban*

  Urban areas depicted in Figure 3 include residential, industrial and commercial activities. Contaminants associated with residential land cover include synthetic organic, volatile organic, inorganic, precursors of disinfection by-products and microbial contaminants. Due to high concentrations of impermeable surfaces, such as streets, driveways, parking lots, sidewalks and roofs, urban areas have increased potential to create large quantities of runoff during and following precipitation events. Runoff from residential areas transports contaminants associated with this land cover into source water. These contaminants can also enter source water from residential areas through point source discharges and atmospheric deposition.

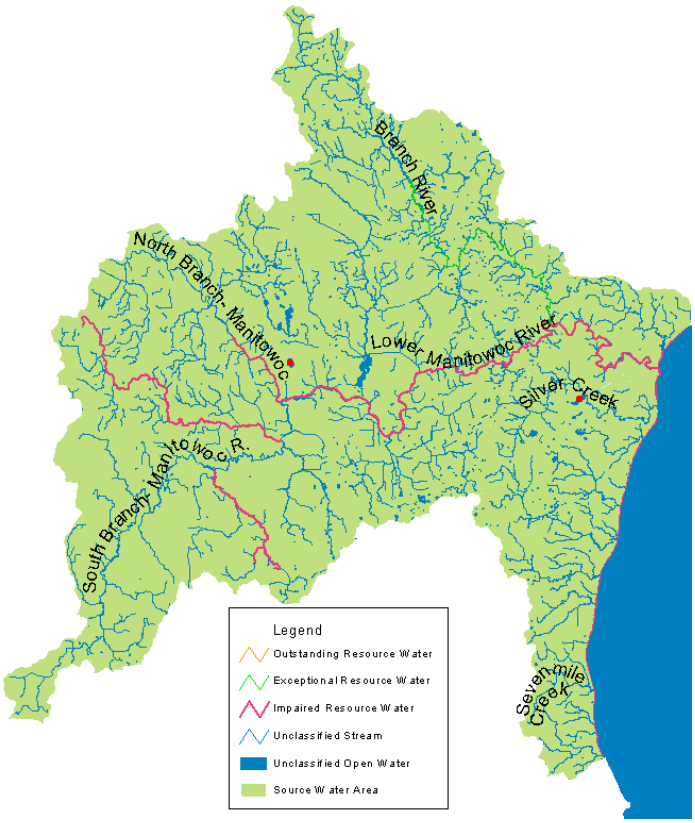
- *Natural vegetation*

  For this assessment, natural vegetation includes wetlands, woodlands and some unused lands. Generally, natural vegetation has positive impacts on source water. These impacts include increased infiltration of precipitation into the ground, decreased quantity of storm water runoff, removal of contaminants from source water, reduced potential for erosion and less drastic fluctuations of streamflow.

Water quality

As shown in Figure 4, water quality throughout the source water area varies widely. Contaminated sediments along with inorganic, microbial and synthetic organic contamination are degrading surface water quality in many regions of the source water area. The entire length of the Pine Creek in the South Branch of the Manitowoc River is considered to be an impaired waterway, as is the Manitowoc River downstream from its confluence with the North Branch of the Manitowoc River. From the town of Potter to the mouth of the Manitowoc River is also considered an impaired waterbody. Impaired waters are defined by the WDNR as waters, which are not meeting water quality standards for specific substances or their designated uses. South of Brown County the Branch River is listed as an exceptional resource

Figure 4: Water Quality



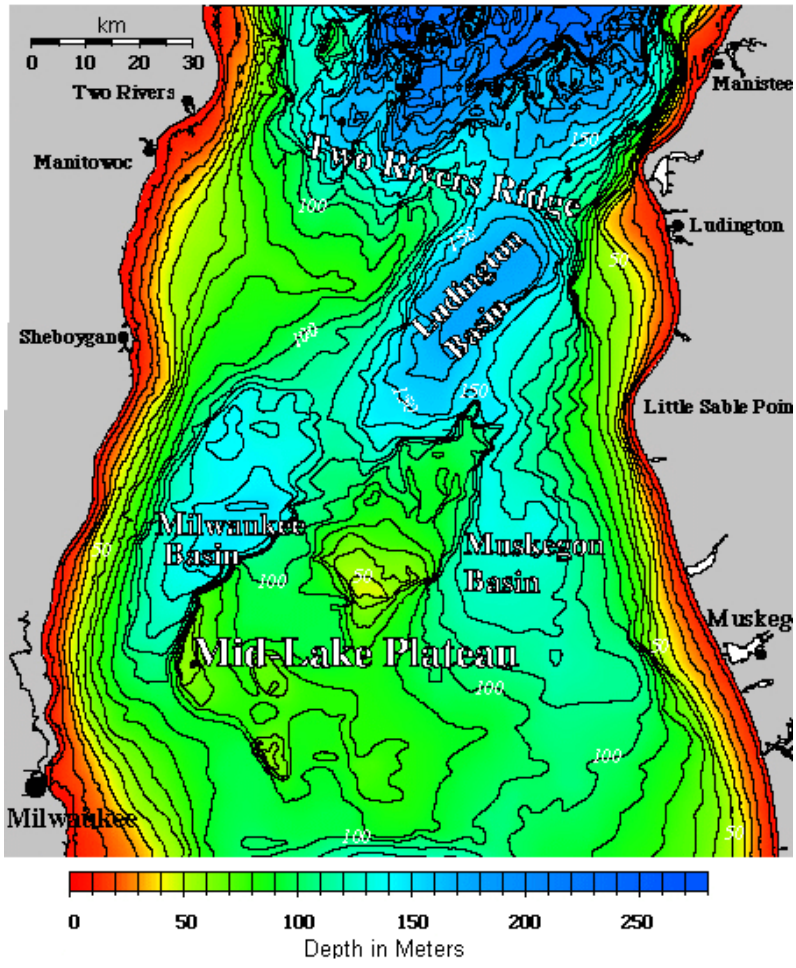
water. Outstanding resource waters are defined as a lake or stream having excellent water quality, high recreational and aesthetic value, high quality fishing and is free from point and nonpoint source pollution. Exceptional resource waters are defined as a stream exhibiting the same high quality resource values as outstanding waters but may be impacted by point source or have the potential for future discharge from a small sewer community.

Description of Lake Michigan near the Source Water Area

Bathymetry

As shown in Figure 5, the Manitowoc drinking water intake is located near the edge of a relatively shallow bay. A glacial feature named the Two Rivers Ridge juts out southeasterly from Manitowoc creating an extended shallow area. This feature may have a negative impact on source water quality at the intake, because of the extended shallow area it creates south of the deepest basin in the lake. This shallow area may allow for more frequent suspension of lake-bottom sediments, less dilution of contaminants and more variable currents.

Figure 5: Mid-Lake Bathymetry



Winds

Wind plays a major role in Lake Michigan circulation patterns and water quality in near-shore areas. The prevailing westerly wind becomes more variable during spring and summer months when southerly windstorms occur. Poorer water quality at the intakes frequently coincides with southeasterly windstorms, which can cause lake currents to reverse or stagnate.

Figure 6: Lake Michigan Circulation Patterns

Currents

Currents in Lake Michigan, particularly along the western shore near Manitowoc are highly variable. As shown in Figure 6, the Manitowoc intakes are located in an area of mixing between the northern Lake Michigan counter-clockwise rotation and the southern Lake Michigan counter-clockwise rotation. The bathymetric features discussed previously coupled with stream discharge and wind combine to create localized currents that have not been well studied.

Water quality

Water quality in Lake Michigan improves with distance from shore. Near shore water quality is generally lower and more prone to fluctuations, which frequently occur during and following periods of thawing and precipitation when contaminants from land are transported into Lake Michigan. Fluctuations also occur during easterly windstorms, which can churn up lake bottom sediments. Atmospheric deposition of contaminants often occurs near more concentrated urban areas. The majority of contaminants enter the lake via non-point source pollution and atmospheric deposition. With distance from shore most contaminants evaporate, settle into the lake bottom sediments or dilute to levels below EPA Maximum Contaminant Levels, a standard for potable drinking water.

It is important to note that water quality discussions of source water at the intakes are based almost entirely on monitoring that occurs at the drinking water intakes. Few contaminants have been comprehensively monitored in source water at the intakes. Generally water quality at the primary drinking water intake is near drinking level quality. Volatile organic and microbial contaminants have been detected at the primary drinking water intake. The pathogen *Cryptosporidium* has been detected in the source water at the intake. Volatile organic contaminants that have been detected in the source water at the drinking water intake include pollutants typically associated with industrial, incineration and waste disposal activities. During periods of higher energy demand, source water from the Manitowoc power plant intakes can mix with source water from the primary intake. Source water from the power plant intakes is generally of lower quality and more turbid than water from the primary water intake.

Susceptibility Assessment for Surface Water System

For the purposes of Wisconsin's source water assessments, susceptibility is defined as the likelihood that a contaminant of concern will enter a public water supply at a level that may result in adversely impacting human health. A susceptibility determination is based on a stepwise synthesis of information regarding the surface water intake's vulnerability and the source water's sensitivity to a potential source of a contaminant of concern.

Methodology

Detailed guidelines for completing this source water assessment can be found in Wisconsin's Source Water Assessment Program Plan.

An initial survey was performed on the Manitowoc surface water intake's source water area to assess local impacts to the source water. The initial survey included interviewing Manitowoc Public Utility employees, conducting a sensitivity analysis, delineating critical assessment zones and reviewing existing data. The source water area was determined to not significantly impact source water quality entering the treatment facility.

Sensitivity Analysis

Sensitivity is defined as the likelihood that source water will be impacted by contaminants due to the intrinsic physical attributes of the source water area. Sensitivity is determined from the natural setting of the source water and indicates the natural protection afforded the source water. Factors in sensitivity include hydrologic characteristics of the source water area, proximity, direction and quantity of discharge relative to the intake and degree of dilution afforded by distance from shore and depth of intake. Based on the Great Lakes Protocol for conducting a sensitivity analysis, calculated sensitivity is the product of the intake's distance from shore and the depth of water at the intake. It is important to keep in mind that this does not take into account numerous site-specific variables. Relative levels of calculated sensitivity include moderate, high and very high.

Manitowoc Public Utilities draws source water from Lake Michigan to the treatment facility through 2 surface water intakes. The primary intake is used year round and has a low calculated sensitivity rating. Under rare circumstances, small amounts of source water can enter the treatment facility through the Manitowoc Power Plant intake. The power plant intake has a moderate calculated sensitivity rating.

Critical Assessment Zone

In keeping with the Great Lakes protocol, a critical assessment zone was delineated based upon the intakes calculated sensitivity. Any land, particularly shoreline, which is within the delineated critical assessment

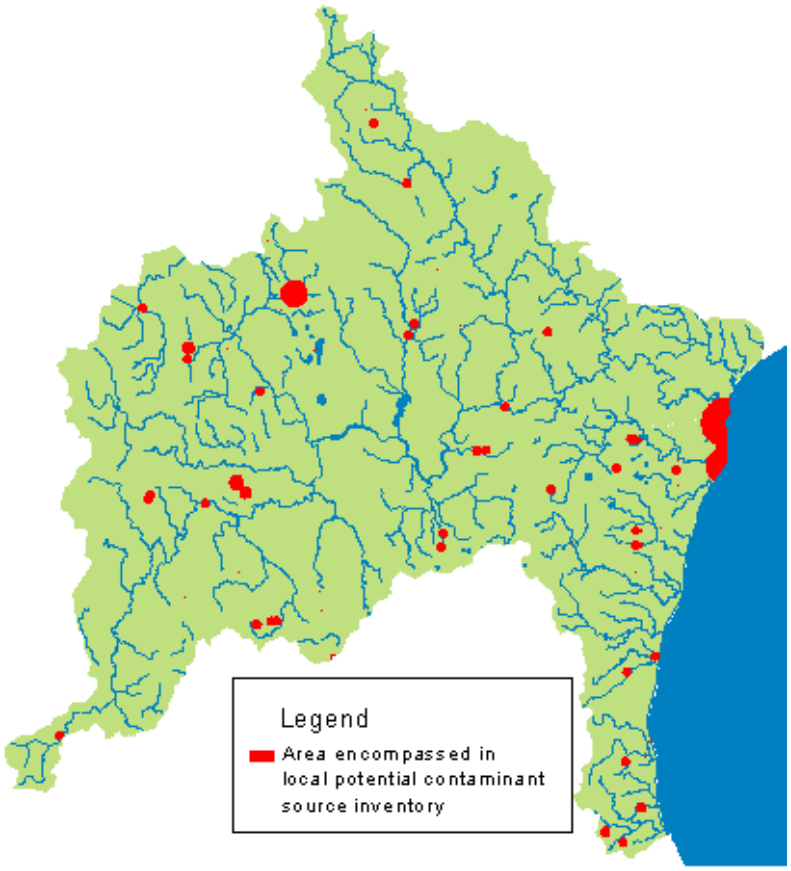
zone, must be part of an in-depth assessment. The zone is a circle centered on the intake. The size of the circle depends on the calculated sensitivity rating. Neither of these critical assessment zones encompasses any land.

Potential Contaminant Source Inventory

A major component of the susceptibility determination is based on the distribution of potential contaminant sources in the source water area. A high density of potential contaminant sources in the source water area would indicate a higher probability of contaminating source water. Source water from a source water area with a low density of potential contaminant sources would be less likely to become contaminated.

It is important to understand that a potential contaminant source is not necessarily a source of contaminants. It has the potential to become a source of contaminants but if managed properly won't impact the source water.

Figure 7: Areas of Localized Potential Contaminant Source Inventory



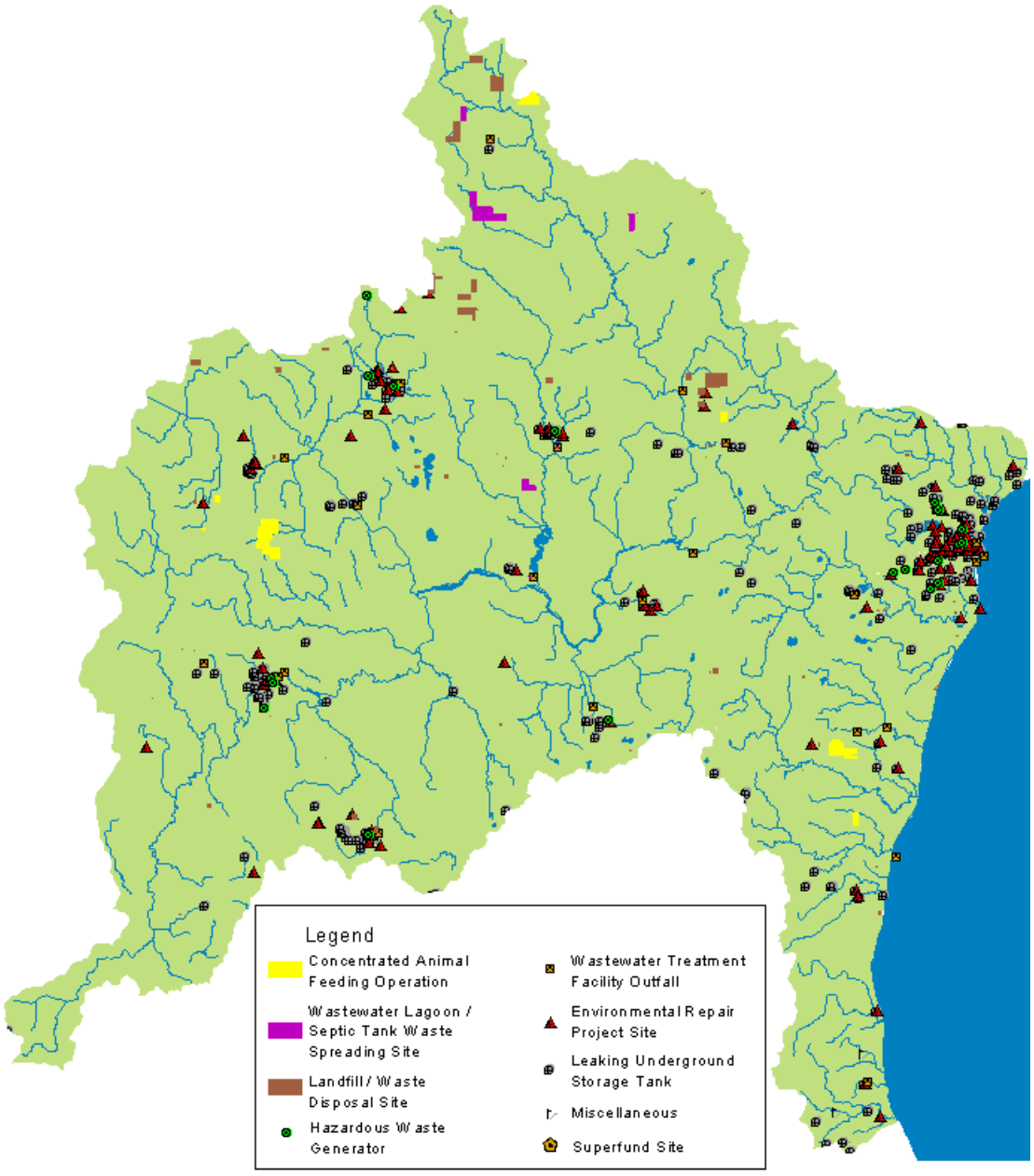
Data used in the significant potential contaminant source inventory includes area-wide and localized information sources. Area-wide locational data are displayed in Figure 8. Information for the remainder of the potential contaminant sources was inventoried only within source water areas for ground water systems. These areas of localized potential contaminant source inventories are shown on Figure 7. Information concerning the distribution of localized significant potential contaminant sources is not available for land outside of the red areas in Figure 7. Potential contaminant sources inventoried within these areas are shown on Figures 9.

Animal feeding operations

Animal feeding operations are agricultural operations where animals are kept and raised in confined situations. Animal feeding operations generally congregate animals, feed, manure, dead animals, and production operations on a relatively small area of land. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures. Animal waste and wastewater can enter water bodies from spills or breaks of waste storage structures (due to accidents or excessive rain), and manure spreading practices. Animal feeding operations have the potential to contribute pollutants such as inorganic, synthetic organic, microbial contaminants as well as hormones and antibiotics to the source water.

Animal feeding operations shown on Figure 8 include only concentrated animal feeding operations (over 1,000 animal units), which are regulated for wastewater discharge. This does not provide an accurate distribution of the more common smaller animal feeding operations. A limited distribution of smaller animal feeding operations in the source water area is depicted in Figure 9. Manitowoc County has a history of water quality problems from activities related to livestock operations such as manure spreading on frozen fields and animal waste spills.

Figure 8: Area wide Potential Contaminant Source Inventory



Landfills and waste disposal sites

In the past landfills were unregulated and were common sources of contaminants. Some of these are now classified as Bureau of Remediation and Repair Tracking System sites, which are discussed below. Licensed landfills are now strictly regulated and monitored. Closed and active landfills can be sources of inorganic, synthetic organic and volatile organic contaminants in source water.

It is unknown how many inactive landfills exist in the source water area. As shown in Figure 8, there are ten licensed landfills and 81 waste disposal sites in the source water area. Some of these landfills are located within 1000-feet of streams.

Wastewater treatment facilities

Wastewater treatment facilities (WWTFs) include municipal and industrial operations. Municipal facilities can be sources of inorganic, microbial, synthetic organic and volatile organic contaminants as well as hormones, pharmaceuticals and other organic contaminants that have been linked to developmental and reproductive defects in animals. Following treatment, effluent is frequently discharged through an outfall directly into surface water. Typical treated and disinfected sewage contains low concentrations of contaminants. During or following a storm event, the municipal WWTF may be inundated with more raw sewage than it can process. In the event of this a bypass or sanitary sewer overflow occurs. This allows untreated sewage to enter directly into surface water. A typical bypass will contain a high concentration of contaminants associated with urban runoff and WWTFs. For more information on sanitary sewer overflows and bypasses please visit http://cfpub1.epa.gov/npdes/home.cfm?program_id=4 on the World Wide Web. Contaminants associated with industrial WWTFs are dependent upon the specific industry but may include microbial, volatile organic, inorganic and synthetic organic contaminants.

Wastewater treatment facilities are shown on Figure 8. The WDNR determined municipal WWTFs were identified as being sources of environmental degradation on various streams throughout the source water area. Industrial wastewater treatment facilities were determined to be negatively impacting streams in the South and Lower Branches of the Manitowoc River, as well as the Branch River and Sevenmile and Silver Creek Watersheds. Industrial WWTFs were identified as negative impacts to source water in tributaries draining into the Manitowoc River.

Bureau of Remediation and Redevelopment Tracking System

The WDNR Remediation and Redevelopment Program keeps track of sites where chemical contamination of soil, surface water and/or groundwater has occurred. The Bureau of Remediation and Redevelopment Tracking System (BRRTS) is the Department's database for tracking the status of investigation and cleanup activities at these sites. There are several types of sites that are tracked by BRRTS, including leaking underground storage tank sites, Environmental Repair Program sites, spill sites and Superfund sites. For information on specific contamination sites in Wisconsin please visit BRRTS at, http://www.dnr.state.wi.us/org/aw/rr/brrts/index.htm on the World Wide Web.

- Leaking Underground Storage Tank sites

  A Leaking Underground Storage Tank (LUST) site is defined as a leaking underground storage tank that has contaminated soil and/or groundwater with petroleum.

  As shown in Figure 8, the highest concentration of LUST sites in the source water area occurs in and around the city of Manitowoc. As of 3/13/02, 130 LUST sites are located within the municipal boundaries of Manitowoc. Other high concentrations of LUST sites occur in urban areas throughout the source water area.

- Environmental Repair Program sites

  Environmental Repair Program (ERP) sites are sites other than LUSTs that have contaminated soil and/or groundwater. Often, these are old historic contaminant releases to the environment.

  As shown in Figure 8, the highest concentration of ERP sites in the source water area occurs in and around the city of Manitowoc. As of 3/13/02, 53 ERP sites are located within the municipal boundaries of Manitowoc. Other high concentrations of ERP sites occur in urban areas throughout the source water area.

- Spill sites

  Spills are defined as a discharge of hazardous substances that may adversely impact, or threaten to adversely impact public health, welfare or the environment. It is important to note that the number of unreported spills is unknown, but is probably well beyond those spills that are reported. From July of 1980 to October of 2002, there had been 183 spills reported in the Manitowoc municipality. Gasoline and oil are the most commonly spilled contaminants.

- Superfund sites

  Superfund sites are highly contaminated areas that have been set aside for cleanup by the USEPA. For more information on the Superfund program and individual sites please see, http://www.epa.gov/superfund/ on the World Wide Web.

  As shown in Figure 8, there are two Superfund sites within the source water area. They are both located near the town of Whitelaw. The Lemberger Landfill Inc., site has leached organic and inorganic contaminants in the groundwater. It is located .5 miles west of the Branch River and is bordered by a wetland to the southwest. The other Superfund site, Lemberger Transport & Recycling Inc. has contaminated groundwater with organic and inorganic contaminants.

Hazardous Waste Generators

Hazardous waste generators are defined as facilities, which handle materials classified as hazardous waste. Hazardous waste is defined as any substance that is toxic to humans. Contaminants associated with hazardous waste generators are site specific. Hazardous waste generators include a wide array of facilities ranging from hospitals and schools to manufacturing and industrial operations.

As shown in Figure 8, large quantity hazardous waste generators are concentrated in the City of Manitowoc. There are 19 located in the source water area. This does not account for the more numerous smaller quantity hazardous waste generators located throughout the source water area.

Boating Related Activities

Boating related activities are potential sources of organic, inorganic and microbial contaminants to the source water. Contaminants can enter directly into the source water through spills or indirectly through runoff from marinas and shipyards where many cleaning agents, paints, petroleum products and other chemicals are commonly stored and used. For more information on the effects of and preventive measures for boating related activities please visit http://www.epa.gov/owow/nps/mmsp/index.html

Recreational boating and fishing are both popular on Lake Michigan near the city of Manitowoc. As shown in Figure 8, there are six public boat launches and/or docks located in the source water area near Lake Michigan. The Manitowoc Deep Harbor is still in service and receives some shipping traffic. Generally, these ships carry non-toxic cargo, such as grain, cement and coal. There is also a trans-lake car ferry, which passes relatively near the intake. Offshore shipping lanes are far removed from the water intake.

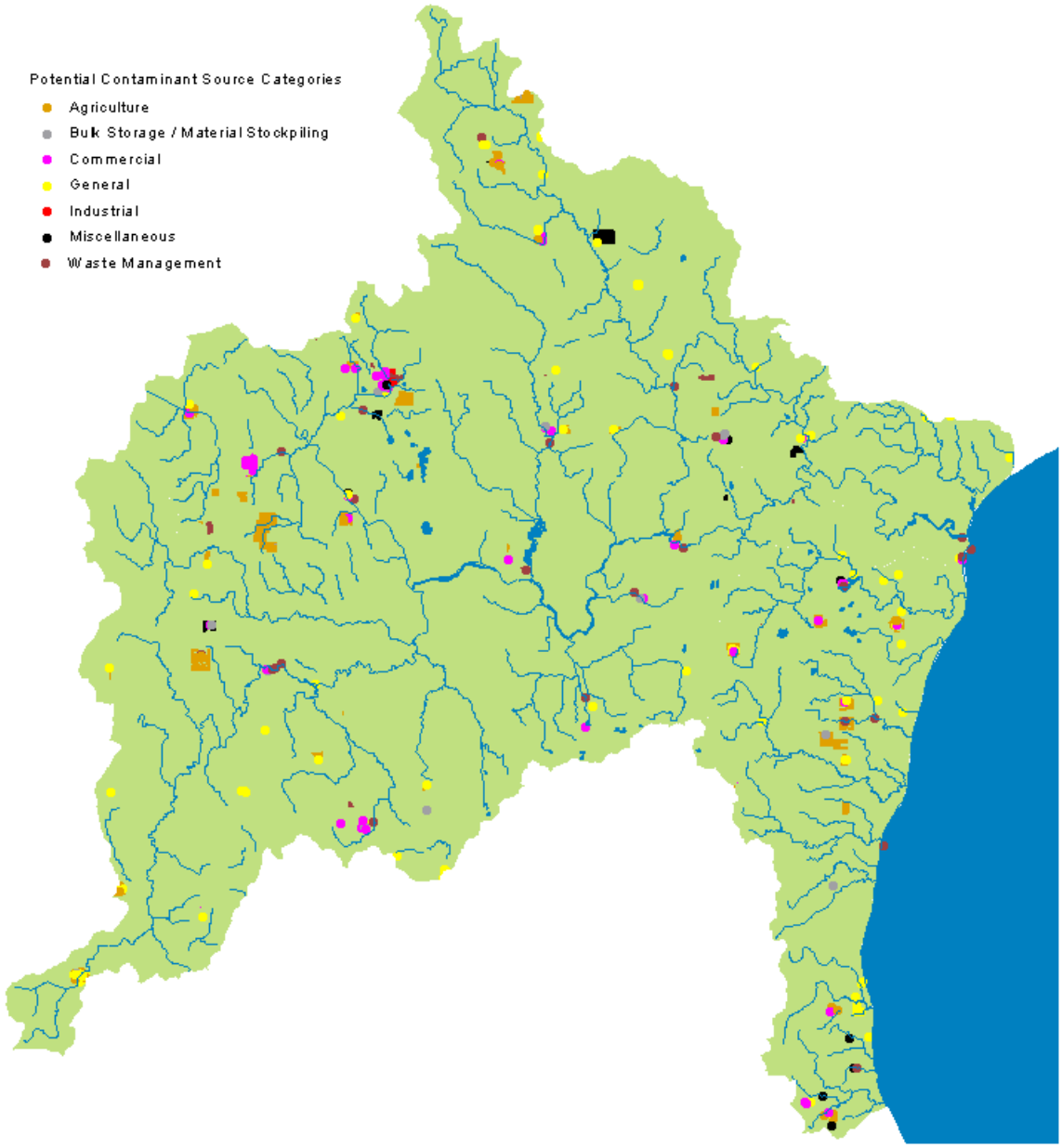
Pipeline

Contaminants associated with pipelines are site specific. There is a 10-inch diameter gasoline and distillate pipeline, which passes through the western portions of the source water area. This pipeline does cross multiple streams in the source water area in eastern Calumet County. This pipeline has the potential to be a source of volatile organic contaminants.

Localized Agricultural and Bulk Storage Potential Contaminant Sources

Localized agricultural and bulk storage activity locations for this assessment are shown in Figure 9. Agricultural activities include active farming operations, animal feedlots, agricultural irrigation and lined and unlined manure storage facilities. These activities are potential sources of synthetic organic, inorganic and microbial contaminants. Bulk storage activities include feed mills, agricultural co-ops, 500 gallon and larger petroleum and chemical storage sites and road salt storage sites. Contaminants associated with storage facilities are largely site-specific, but generally they are potential sources of inorganic, synthetic organic and volatile organic contaminants.

Figure 9: Localized Potential Contaminant Sources



Localized Commercial Potential Contaminant Sources

Localized commercial activities locations for this assessment are shown in Figure 9. Commercial activities include airports, auto body shops, boat yards, car washes and Laundromats in unsewered areas, cemeteries, dry cleaners, gas service stations, machine/metal working shops, motor vehicle repair shops, paint shops, photo processing facilities, jewelry and metal plating facilities, printing facilities, rail yards, rail road tracks, scrap/junk yards and seed production plants. These activities are frequently associated with inorganic and volatile organic contaminants.

Localized General and Industrial Potential Contaminant Sources

Localized general and industrial activities for this assessment are shown in Figure 9. General activities include above-ground and below-ground storage tanks, municipal and non-municipal sewer lines, sewage holding tanks, septic tanks, sumps, drainfields, mounds and dry wells. These activities are potential sources for synthetic organic, volatile organic, inorganic and microbial contaminants. Industrial activities include asphalt plants, industrial chemical production facilities, electronic product manufacturers, electroplating / metal finishing facilities, furniture or wood manufacturing / refinishing / stripping facilities, foundries / smelting plants, mining operations / mine waste sites, paper mills, petroleum and chemical pipelines, plastics manufacturer / molding facilities, wood preserving facilities. These activities are potential sources of volatile organic, synthetic organic and inorganic contaminants.

Localized Waste Management and Miscellaneous Potential Contaminant Sources

Localized waste management and miscellaneous activities and contaminant conduits are shown in Figure 9. Waste management activities include municipal incinerators, injection wells, sludge spreading sites, solid waste transfer stations and wastewater lagoons. These activities are potential sources of inorganic, synthetic organic, microbial and volatile organic contaminants. Miscellaneous sources include fire training facilities, golf courses, gasification plants, laboratories and military installations. These sources are associated with microbial, synthetic organic and volatile organic contaminants.

Description of the Manitowoc Surface Water Drinking Water Treatment Facilities

Manitowoc Public Utilities has reliably provided high quality drinking water to its customers. Manitowoc Public Utilities provides an average of 9 million gallons per day (mgd). It is rated for a maximum capacity of 11 mgd.

After entering the treatment facilities through either the primary intake or the Manitowoc Power Plant intake source water undergoes treatment prior to distribution. Treatment of surface water includes passage through a 500-micron screen to remove larger particles and contaminants. Following initial filtration source water is passed through a .2 micron filter to remove remaining contaminants. Lastly, filtered source water is chlorinated to destroy microbial contaminants.

Susceptibility Determination for the Surface Water System

Source water for the Manitowoc Public Utility surface water intake is moderately susceptible to contamination. It is generally a function of Lake Michigan water quality and not frequently impacted by the source water area. The primary intake's long distance from shore minimizes the risk of contamination from manageable activities in the source water area. As discussed previously unaffected Lake Michigan water quality is near drinking level purity.

Source water entering the Manitowoc power plant intakes is far more susceptible to contamination due to the intakes' proximity to shore and nearby concentration of potential contaminant sources. However the minimal usage of this intake makes it of little concern.

Recommendations for Surface Water Source Water Protection

While not particularly impacting source water at the primary intake, Manitowoc's source water area does contribute to the over all water quality in Lake Michigan and may affect water quality entering the power plant intakes. With this in mind, source water protection should first focus on preventing runoff from agricultural areas where this is affecting water quality. Urban runoff from the city of Manitowoc is also concern. This is widespread throughout the source water area. Please refer to the Best Management Practices section below for ideas and resources for practical methods of source water protection.

Particular land practices and areas of concern in the source water area include:

- Barnyard runoff, streambank erosion, stream bank pasturing in the northern portions of the Branch River Watershed
- Livestock operations and manure spreading on frozen fields in areas near streams which drain to the Lower Manitowoc River above Clark Mills
- Agricultural practices in the South Branch Manitowoc River Watershed
- Urban runoff entering the lower five miles of the Manitowoc River

As mentioned previously a comprehensive source water protection plan is beyond the scope of this assessment. The source water protection team may consider using resources provided by the USEPA at http://www.epa.gov/safewater/protect/sources.html on the World Wide Web for overall source water protection planning. This website offers general source water information, financial assistance contacts, source water protection case studies, contaminant source inventories and contingency planning among other subjects. For specific information concerning best management practices and dealing with potential contaminant sources please visit http://www.epa.gov/ogwdw/protect/swpbull.html on the World Wide Web.

Source Water Assessment for the Manitowoc Groundwater System

Groundwater source water assessments consist of several components:

1) an identification of the source water area, the land area that contributes water to the drinking water system;

2) an inventory of significant potential sources of contamination within that area; and

3) a susceptibility determination for each system. For groundwater systems this determination is based on geology, well construction, monitoring results, and potential contaminant sources located within the source water area (see Appendix A for a diagram of how susceptibility is determined for Wisconsin's Source Water Assessments).

The Wisconsin Department of Natural Resources (DNR) used an automated system to produce assessments for the approximately 11,500 groundwater public water systems in the state.

This document is for informative purposes only. Source water assessments do not affect monitoring requirements. It is recommended you retain this assessment to help guide your future source water protection work.

About Your System:

The system consists of 3 well(s).

Well #1 (Wisconsin Unique Well #BG251)

- Well site geology (from land surface to bottom of well): Sandy clay and top soil, hyellow sandy clay, pea gravel and sand, gray sand and pea gravel, and gray sand.
- Sensitive area: No
- Collector well construction:
  Depth: 60 feet Number of laterals: 21 Total length of laterals: 541 feet
- Formations that well draws water from: Sand and gravel
- Age of well: 59 years Well construction code compliance: Yes
- Localized, relatively thin lenses of clay deposits provide a limited amount of protection from the downward movement of contaminants toward the groundwater. No continuous confining clay layer or geologic unit exists that would prevent contaminants from reaching the groundwater.

Well #2 (Wisconsin Unique Well #BG252)

- Well site geology (from land surface to bottom of well): Unknown.
- Sensitive area: No
- Collector well construction:
  Depth: 86 feet Number of Laterals: 21 Total length of Laterals: 448 feet
- Formations that well draws water from: Sand and gravel
- Age of well: 59 years Well construction code compliance: Yes
- Localized, relatively thin lenses of clay deposits provide a limited amount of protection from the downward movement of contaminants toward the groundwater. No continuous confining clay layer or geologic unit exists that would prevent contaminants from reaching the groundwater.

Well #3 (Wisconsin Unique Well #BG253)

- Well site geology (from land surface to bottom of well): Sand and gravel.
- Sensitive area: No
- Collector well construction:
- Depth: 86 feet Number of Laterals: 7 Total length of Laterals: 1036' feet
- Casing ends in: UNKNOWN formation
- Formations that well draws water from: UNKNOWN
- Age of well: 44 years Well construction code compliance: Yes
- Localized, relatively thin lenses of clay deposits provide a limited amount of protection from the downward movement of contaminants toward the groundwater. No continuous confining clay layer or geologic unit exists that would prevent contaminants from reaching the groundwater.

Groundwater Source Water Assessment Area:

The source water area was determined using the delineation from the system's wellhead protection plan. Any of a variety of methods could have been used to delineate the source water assessment area. Well and source water area locations are considered to be sensitive information and so are not included in this assessment.

Water Quality:

Owners and operators of public drinking water systems test their well water regularly in accordance with Safe Drinking Water Act requirements. For the purpose of this source water assessment a detection of a contaminant is generally regarded as an indication that the well is susceptible to that type of contaminant. For contaminants that may be naturally occurring a trigger level has been set to indicate susceptibility.

If water is treated then testing is done on treated water. If water is not treated then test results reflect source water quality. The Manitowoc Waterworks system does treat its water, so the test results do not reflect source water quality.

Modern analytical techniques in laboratories are capable of detecting extremely small quantities of contaminants in water. Detecting a substance does not necessarily indicate a health risk. Any monitoring detections of contaminants are noted in the following section.

Well Susceptibility to Contamination:

The Manitowoc Waterworks system is susceptible to contamination by volatile organic compounds (VOCs), ethylene dibromide (EDB), nitrate, arsenic, and nickel. The system has moderate susceptibility to contamination by synthetic organic compounds (SOCs) and microbes. See Appendix A for an explanation of the susceptibility determination process. Details for individual wells follow.

Well #1 (Wisconsin Unique Well Number BG251) is:

- is moderately susceptible to contamination by microbes for the following reasons:
  - Well is in a sand & gravel area.
  - No hydrogeological barrier is present to prevent or retard the downward movement of contaminants from the land surface to the groundwater.
- is susceptible to contamination by nitrate for the following reasons:
  - Potential nitrate source(s) were found in the source water area.
  - Nitrate monitoring detection, or nitrite > 0.55 mg/l
- is susceptible to contamination by arsenic for the following reasons:
  - Arsenic monitoring detections exceeding the preventive action limit.
- is susceptible to contamination by nickel for the following reasons:
  - Nickel monitoring detections exceeding the preventive action limit.
- is susceptible to contamination by volatile organic compounds (VOCs) for the following reasons:
  - VOC monitoring detections.
- is susceptible to contamination by ethylene dibromide (EDB) for the following reasons:
  - Monitoring detection of benzene or other EDB indicator.
- is moderately susceptible to contamination by SOCs/pesticides for the following reasons:
  - Well terminates in unconsolidated formation and there is < 60 feet of clay (confining layer).
  - Well has < 60 feet of grouted casing.

Well #2 (Wisconsin Unique Well Number BG252) is:

- is susceptible to contamination by nitrate for the following reasons:
  - Nitrate monitoring detection, or nitrite > 0.55 mg/l
- is susceptible to contamination by volatile organic compounds (VOCs) for the following reasons:
  - VOC monitoring detections.
- is susceptible to contamination by ethylene dibromide (EDB) for the following reasons:
  - Monitoring detection of benzene or other EDB indicator.
- is moderately susceptible to contamination by SOCs/pesticides for the following reasons:
  - Well has < 60 feet of grouted casing.
  - Potential SOC source(s) were found in the source water area but no SOC monitoring detections.

- has low susceptibility to inorganic compounds (IOCs) and microbes.

Well #3 (Wisconsin Unique Well Number BG253) is:

- is moderately susceptible to contamination by microbes for the following reasons:
  - Well is in a sand & gravel area.
  - No hydrogeological barrier is present to prevent or retard the downward movement of contaminants from the land surface to the groundwater.
- is susceptible to contamination by nitrate for the following reasons:
  - Nitrate monitoring detection, or nitrite > 0.55 mg/l
- is susceptible to contamination by volatile organic compounds (VOCs) for the following reasons:
  - VOC monitoring detections.
- is moderately susceptible to contamination by SOCs/pesticides for the following reasons:
  - Well terminates in unconsolidated formation and there is < 60 feet of clay (confining layer).
  - Well has < 60 feet of grouted casing.
  - Potential SOC source(s) were found in the source water area but no SOC monitoring detections.
- has low susceptibility to ethylene dibromide (EDB) and inorganic compounds (IOCs).

General Comments:

Well #2 (Wisconsin Unique Well Number BG252)
Increased susceptibility due to unknown geology at well #2

Recommendations for Groundwater Source Water Protection:

There is a wellhead protection plan or an ordinance to protect their wells or both for well(s) well 1 (BG251), well 2 (BG252), and well 3 (BG253). Protection activities should focus on whether there is a need to update the plan or the ordinance to further protect the recharge area around these wells. This may include obtaining additional information on any new potential sources of contamination to evaluate their risk to the water supply and identifying and managing improperly abandoned wells or other features that may provide direct pathways for contamination of the aquifer.

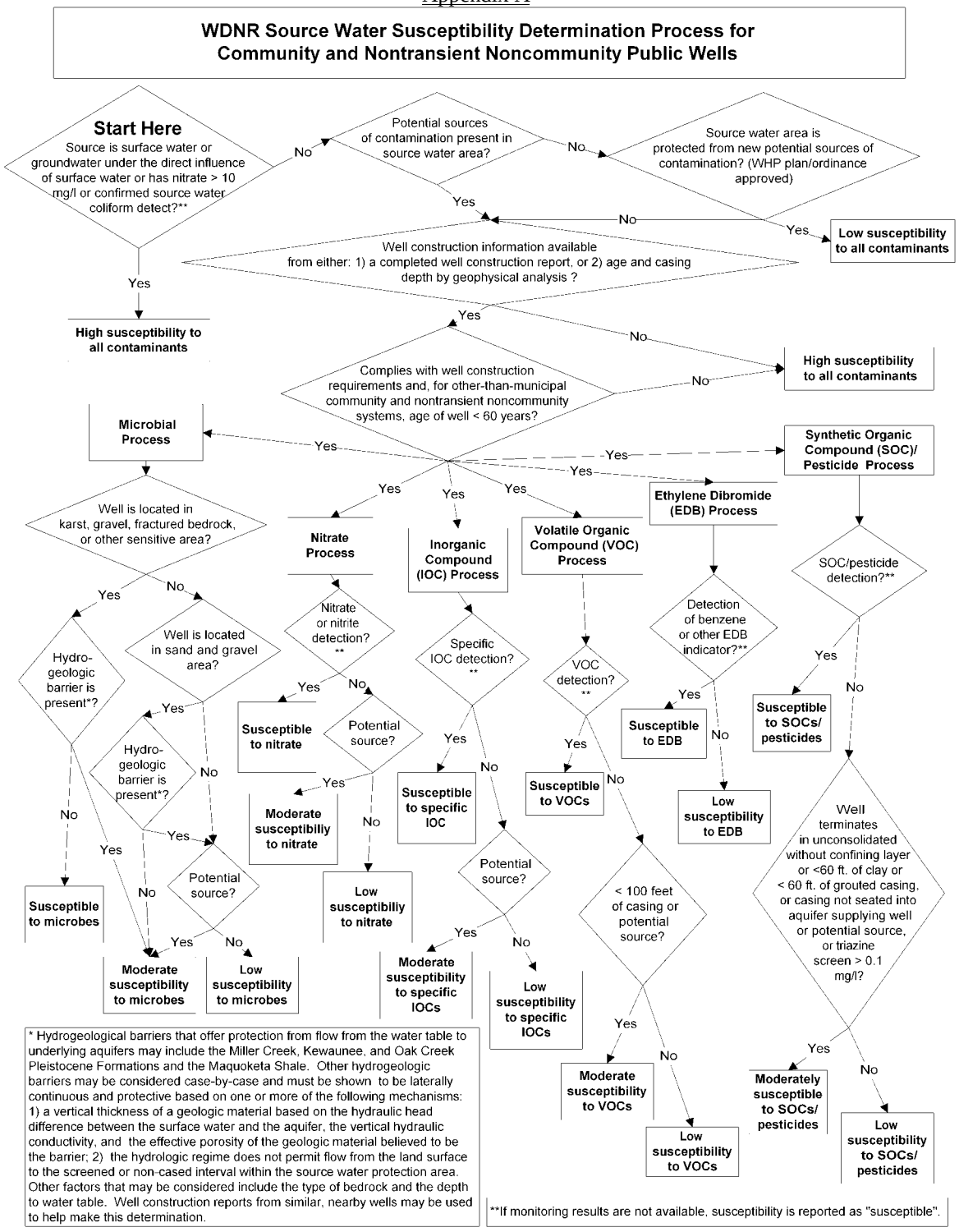
More information on source water protection is available at

http://www.epa.gov/safewater/protect.html

More information on Wisconsin's wellhead protection program is available at

http://www.dnr.state.wi.us/org/water/dwg/gw/wellhead.htm

Appendix A


WDNR Source Water Susceptibility Determination Process for Community and Nontransient Noncommunity Public Wells
Start Here
Source is surface water or groundwater under the direct influence of surface water or has nitrate > 10 mg/l or confirmed source water coliform detect?**
No
Potential sources of contamination present in source water area?
No
Source water area is protected from new potential sources of contamination? (WHP plan/ordinance approved)
Yes
No
Yes
Low susceptibility to all contaminants
Yes
Well construction information available from either: 1) a completed well construction report, or 2) age and casing depth by geophysical analysis ?
Yes
No
High susceptibility to all contaminants
Yes
Complies with well construction requirements and, for other-than-municipal community and nontransient noncommunity systems, age of well < 60 years?
No
High susceptibility to all contaminants
Microbial Process
Yes
Synthetic Organic Compound (SOC)/ Pesticide Process
Yes
Yes
Yes
Yes
Yes
Ethylene Dibromide (EDB) Process
Well is located in karst, gravel, fractured bedrock, or other sensitive area?
Nitrate Process
Inorganic Compound (IOC) Process
Volatile Organic Compound (VOC) Process
SOC/pesticide detection?**
Yes
No
Nitrate or nitrite detection? **
Specific IOC detection? **
VOC detection? **
Detection of benzene or other EDB indicator?**
Yes
Hydro-geologic barrier is present*?
Well is located in sand and gravel area?
Yes
No
Susceptible to nitrate
Potential source?
Susceptible to specific IOC
Susceptible to VOCs
Susceptible to EDB
Susceptible to SOCs/ pesticides
Yes
No
Hydro-geologic barrier is present*?
Yes
No
Moderate susceptibiliy to nitrate
Low susceptibiliy to nitrate
Potential source?
Low susceptibility to EDB
Well terminates in unconsolidated without confining layer or <60 ft. of clay or < 60 ft. of grouted casing, or casing not seated into aquifer supplying well or potential source, or triazine screen > 0.1 mg/l?
Susceptible to microbes
Potential source?
Potential source?
< 100 feet of casing or potential source?
Yes
No
Moderate susceptibility to microbes
Low susceptibility to microbes
Moderate susceptibility to specific IOCs
Low susceptibility to specific IOCs
Moderate susceptibility to VOCs
Low susceptibility to VOCs
Moderately susceptible to SOCs/ pesticides
Low susceptibility to SOCs/ pesticides
* Hydrogeological barriers that offer protection from flow from the water table to underlying aquifers may include the Miller Creek, Kewaunee, and Oak Creek Pleistocene Formations and the Maquoketa Shale. Other hydrogeologic barriers may be considered case-by-case and must be shown to be laterally continuous and protective based on one or more of the following mechanisms: 1) a vertical thickness of a geologic material based on the hydraulic head difference between the surface water and the aquifer, the vertical hydraulic conductivity, and the effective porosity of the geologic material believed to be the barrier; 2) the hydrologic regime does not permit flow from the land surface to the screened or non-cased interval within the source water protection area. Other factors that may be considered include the type of bedrock and the depth to water table. Well construction reports from similar, nearby wells may be used to help make this determination.
**If monitoring results are not available, susceptibility is reported as "susceptible".

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