A riverine forest in Racine's source water area
Photograph courtesy of E.J. Judziewicz.

Source Water Assessment
For Racine Water Utility

Racine, Wisconsin
April 3, 2003

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

WISCONSIN
DEPT. OF NATURAL RESOURCES

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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 Racine'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. Due to the vulnerable nature of surface water, most drinking water systems utilizing surface water are determined to have high levels of susceptibility to source water contamination.

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 your community's 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 Racine, Wisconsin is located in the southeastern portion of the state. Racine Water Utility relies solely on Lake Michigan to provide drinking water to its 99,100 consumers. The Racine Water Utility also provides drinking water to an additional 10,000 consumers serviced by the Caledonia Utility District, the North Park Sanitary District and the Sturtevant Waterworks.

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 variety of land covers, it is not feasible to assess the impact of the entire Lake Michigan drainage basin on Racine's source water. In an attempt to improve source water quality at a practical scale, the WDNR delineated local source water areas based on watersheds that may specifically impact source water entering the Racine surface water 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 Southeastern Wisconsin, Racine's delineated source water area is almost 200 square miles. The Root River Watershed drains the source water area into Lake Michigan approximately one-mile southwest of the Racine drinking water intakes. It includes portions of eastern Racine, southwestern Milwaukee, eastern Waukesha and northern Racine counties. Streams in the source water area are prone to high flows during and immediately following storm events and very low flows in periods of low precipitation. This is due to the types of soils and land practices in the source water area. Generally soils in the source water area are relatively impermeable red clays and clayey loams. Land uses include a mix of agriculture and urban areas with little natural vegetative cover.

Racine Water Utility has reliably provided its customers with clean, high quality drinking water. The water treatment facilities can potentially treat 40 million gallons of drinking water per day (mgd). The year round average daily demand is 25 mgd. Treatment includes application of Potassium Permanganate at the intakes to control zebra mussel growth, chemical flocculation and physical sedimentation to remove larger contaminants, filtration and chlorination.

As with most surface water systems, Racine's source water is highly susceptible to contamination. Racine's source water is significantly impacted by both manageable local factors in the source water area and larger less controllable features of southern Lake Michigan. Racine's source water is commonly impacted during and immediately following spring thaw, heavy precipitation and sustained winds.

Source water protection for Racine should begin with the formation of a source water protection team composed of delegates from local, regional, state and federal organizations. This group would plan and

implement best management practices in the source water area to prevent source water contamination. Initial source water protection projects should focus on managing runoff from urban and agricultural activities in the source water area.

A hard copy of the detailed assessment is available at the Racine 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 previously. 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 Racine'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

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. Nonpoint source pollution includes contaminated runoff and atmospheric deposition. Examples of nonpoint source pollution are runoff from agricultural and urban land covers and atmospheric deposition from burning of fossil fuels.

Source water contaminant categories include microbial, inorganic, synthetic organic, volatile organic, disinfection by-product precursors and radioactive contaminants. 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.

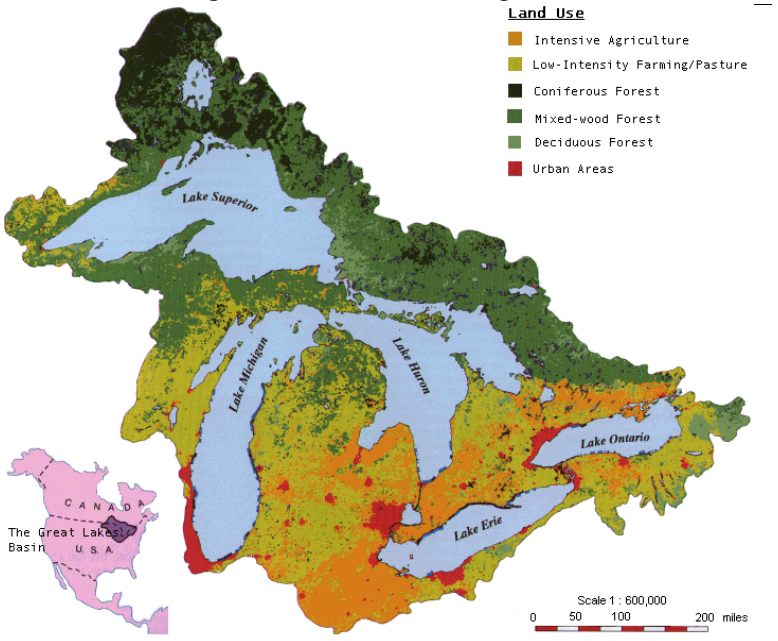
- *Microbial contaminants*, such as viruses and bacteria may come from: sewage treatment plants, septic systems, agricultural livestock operations, and wildlife. Microbial contaminants can lead to widespread acute illnesses in customers of a contaminated drinking water system. Examples of microbial contaminants include *Giardia*, *Cryptosporidium* and *E. coli*.
- *Inorganic contaminants*, such as salts and metals, which can occur naturally or result 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, which may come from a variety of sources including 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 the pesticides atrazine and lindane as well as industrial products such as polychlorinated bi-phenyls (PCBs).
- *Volatile organic contaminants*, such as petroleum products, solvents, cleaners and degreasers, which 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. Some examples of precursors of disinfection by-products include dissolved organic carbon and bromide. Likely sources of dissolved organic carbon come from agricultural and urban storm water runoff.
- *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.

Hydrologic Setting

Description of the Source Water Area

As shown in Figure 1, the Great Lakes drains over 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 Racine'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

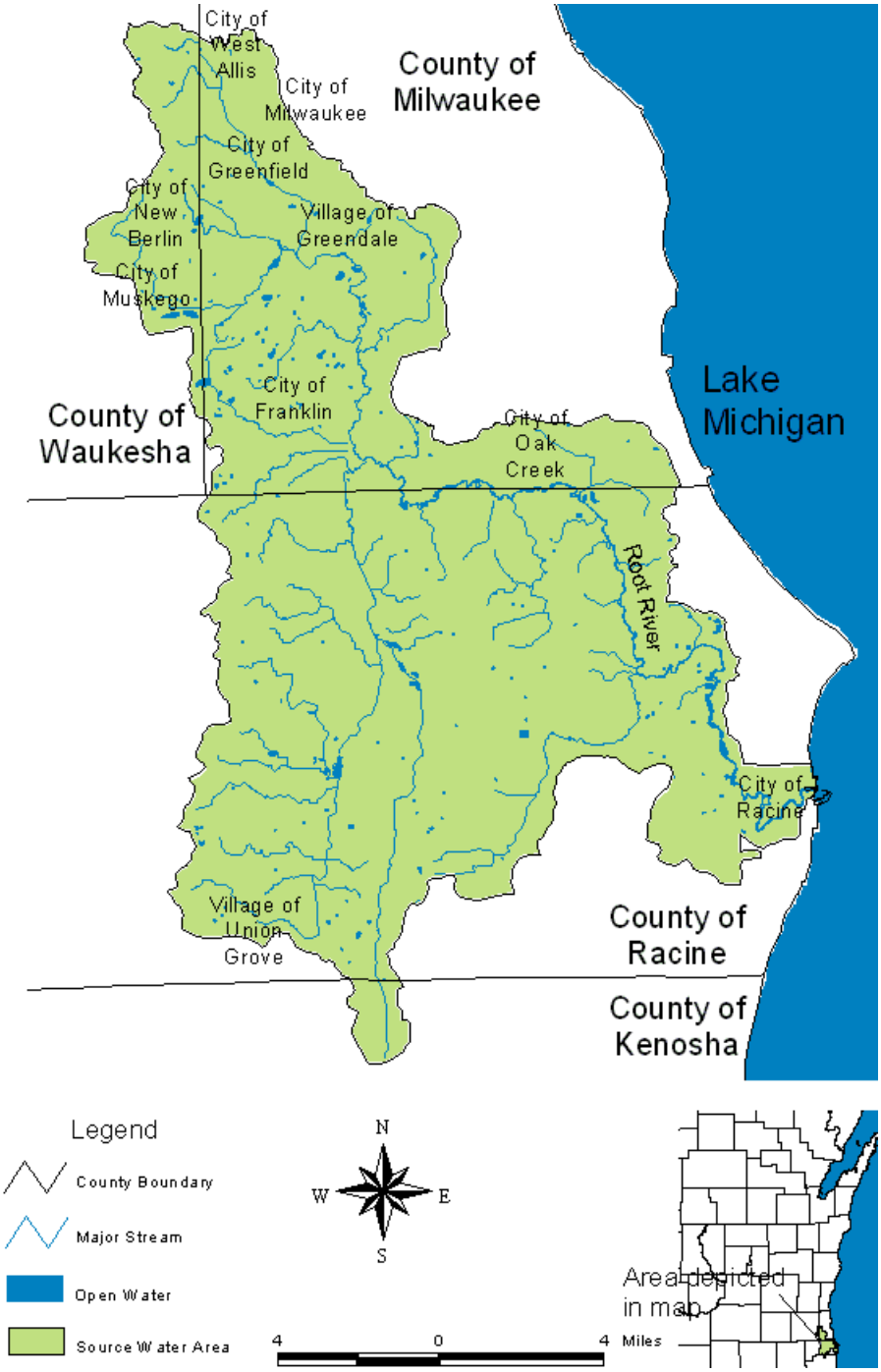
Figure 1: Great Lakes Drainage Basin



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.

As shown in Figure 2, Racine's source water area is located in Southeastern Wisconsin. It includes portions of Eastern Racine, Southeastern Milwaukee, Eastern Waukesha and Northern Kenosha counties. Portions of the Cities of Racine, Franklin, Oak Creek, Greendale, New Berlin, Muskego and Milwaukee along with the Town of Union Grove are located in the source water area. The total area of Racine's source water area is almost 200 square miles.

Figure 2: Source water area



Hydrology

As shown in Figure 3, the source water area is drained by the Root River Watershed. The Root River begins in the northern portion of the source water area near the cities of New Berlin and West Allis. It flows south gaining flow from the Whitnall Park Creek and the East Branch. The East Branch Root River Canal and the West Branch Root River Canal drain the southwestern portion of the source water area. These streams join and become the Root River Canal, which flows into the Root River. The Root River discharges into Lake Michigan at the City of Racine.

Figure 3: Drainage pattern of the source water area

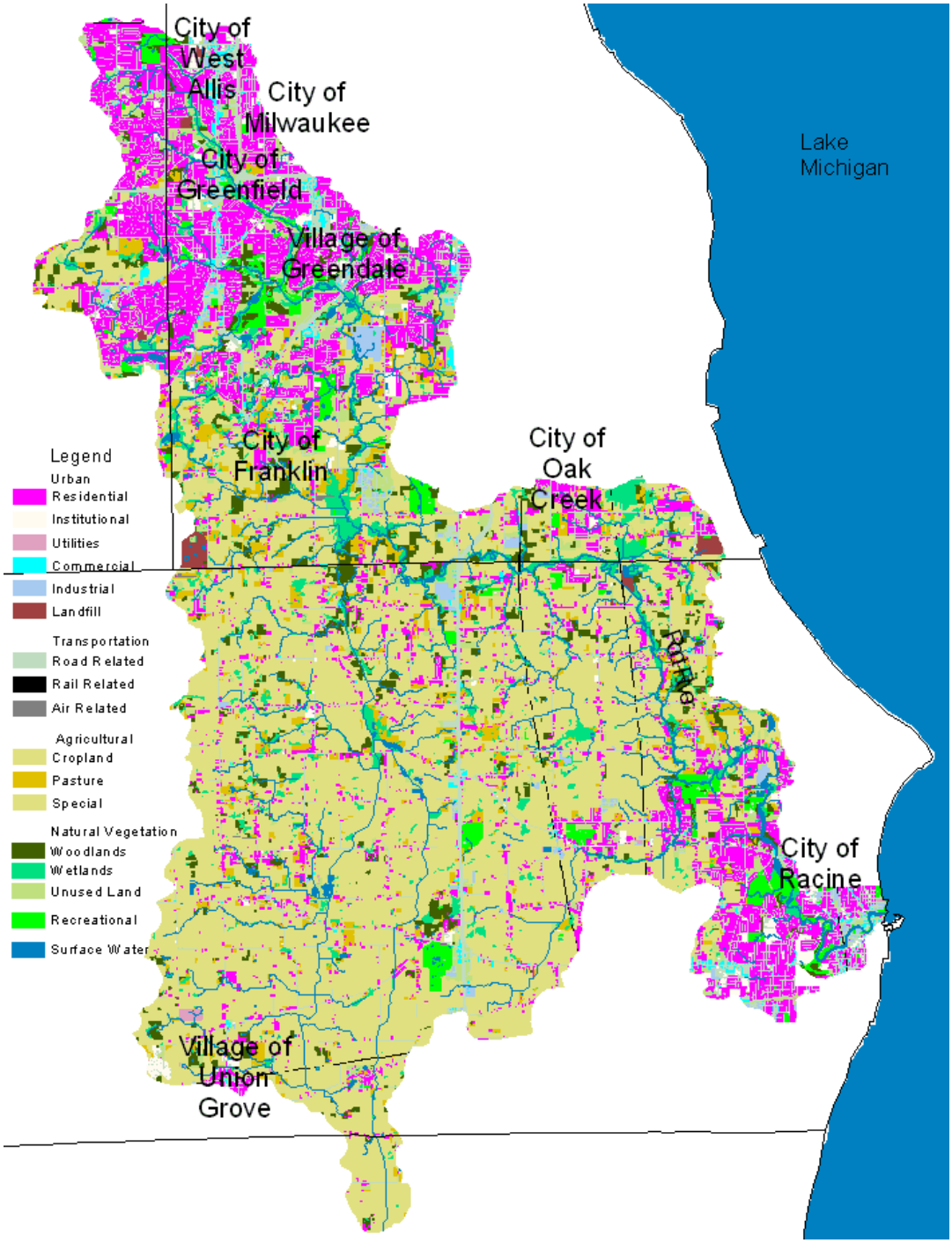
Soil types and land cover throughout most of the source water area inhibit infiltration of water into the ground and causes precipitation to flow overland. This overland flow is referred to as runoff. High amounts of surface runoff cause stream flows to increase dramatically during and following precipitation 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 Root River from 1963 to 2000 was 152 cubic feet per second. The highest stream flows generally occur in April. The highest stream flow on record occurred in April of 1993 was 1071 cubic feet per second. The Root River discharges into Lake Michigan approximately one-mile southwest of the drinking water intakes.

Soils and land cover

Land cover can play a major role in source water quality. Spatial data in Figure 4 was generated from 1995 locational data.

As shown in Figure 4, land cover in the source water area is a mix of agricultural and urbanized areas with small pockets of natural vegetation. Soil types found throughout the source water area include red clays and clayey loams.

Figure 4: Land use in the source water area



- *Residential related land cover*

  Residential areas depicted in Figure 4 include single- and two-family homes, low and high rises and mobile homes, at varying levels of density. Due to high concentrations of impermeable surfaces, such as driveways, sidewalks and roofs, residential land cover has 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. Contaminants associated with residential land cover include synthetic organic, volatile organic, inorganic, precursors of disinfection by-products and microbial contaminants. These contaminants can also enter source water from residential areas through spills and atmospheric deposition.

  Population and urban areas have been growing rapidly throughout the source water area. Racine County's population increased almost 8 % from 1990 to 2000. Cities in the source water area include most of Racine, Franklin and Greendale. Small portions of Milwaukee, Oak Creek, Muskego and New Berlin are also located in the source water area. Urban areas in the upper and lower portions of the source water area have been identified by the WDNR as a negative impact to source water.

- *Industrial related land cover*

  For this assessment industrial land cover includes activities related to manufacturing, wholesale and storage and extractive processes. Similarly to residential land cover, industrial areas have high concentrations of impermeable surfaces, which prevent large amounts of precipitation from infiltrating the ground. This runoff transports contaminants associated with industrial activities into source water. These include volatile organic, synthetic organic and inorganic contaminants. Industrial activities can also lead to contamination of source water through point source discharges, spills and atmospheric deposition.

- *Transportation related land cover*

  For this assessment transportation related land cover includes all forms of motor vehicle corridors and parking lots along with rail-related and air-related forms of transportation. Most all transportation related land cover is impermeable to precipitation. Contaminants associated with runoff from transportation related land cover includes volatile organic, synthetic organic and inorganic contaminants. Contaminants from transportation related land cover could also enter source water through atmospheric deposition and spills.

- *Agricultural land cover*

  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. 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.

  Agricultural practices in the western portions of the source water area south of the Racine/Milwaukee county boundary have been identified as a negative impact to source water quality in the Root River Canal, the Root River Canal West Branch and the Root River.

- *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.

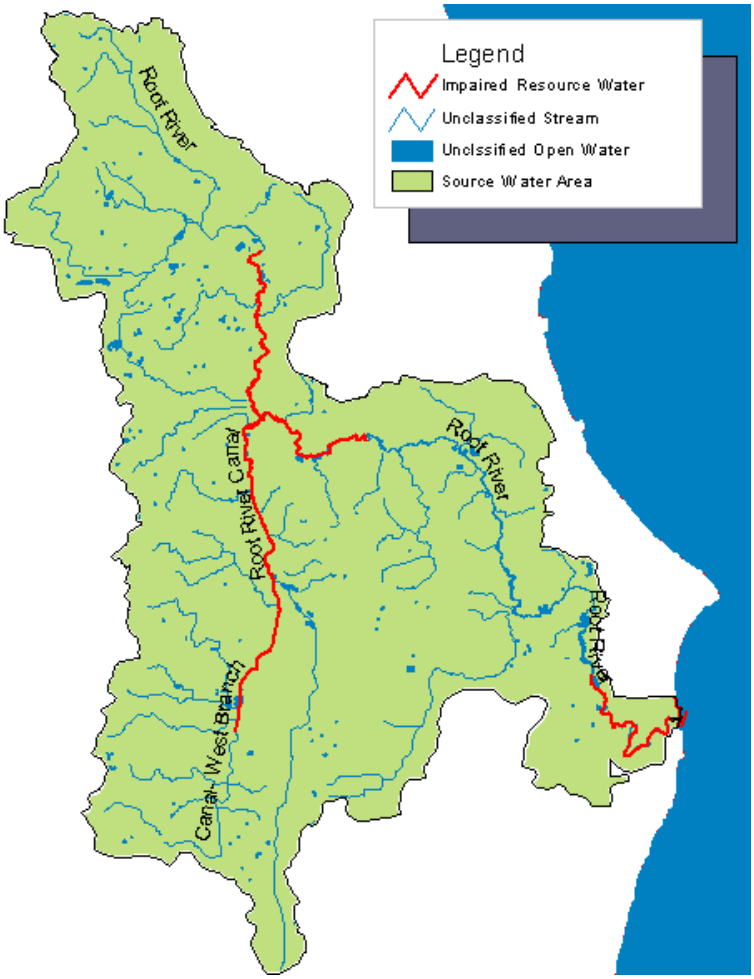
- *Recreational land cover*

  For this assessment, recreational land cover includes public as well as private, land and water related recreational areas. Examples of these include parks, fields, golf courses and beaches. Recreational land cover can affect source water similarly to natural vegetation. However it is also associated with microbial, synthetic organic and inorganic contaminants.

Water quality

Water quality in the source water area varies from severely degraded to good. As shown in Figure 5, areas of impaired water quality caused by urban runoff include the Root River downstream from the Horlick Dam and upstream of the Racine/Milwaukee county border. Impaired waters are defined by the WDNR as waters, which are not meeting water quality standards for specific substances or their designated uses. Areas of impaired water quality caused by agricultural runoff include the Root River Canal and the West Branch of the Root River Canal.

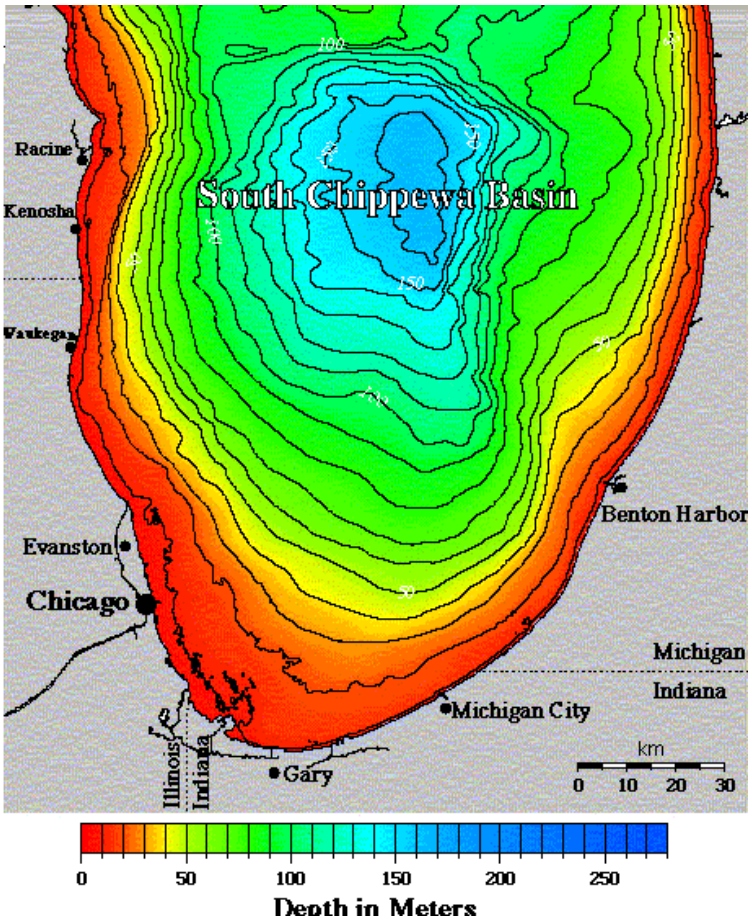
Figure 5: Water quality in the source water area



Description of Lake Michigan near the Intakes

Bathymetry

Figure 6: Bathymetry of southern Lake Michigan



As shown in Figure 6, a shallow area extends parallel to shore, before dropping off into the relatively shallow South Chippewa Basin six to seven miles east of the drinking water intakes. This relatively shallow area may have a negative impact on source water quality by preventing dilution of contaminants, allowing for more easily resuspended lake bottom sediments and creating more variable currents near the intake.

Wind

Wind plays a major role in Lake Michigan currents and water quality in near-shore areas. The prevailing westerly winds gives way to variable easterly and southerly winds during the spring and summer months. Variable winds alter current direction and speed along with causing fluctuations in water quality. Windstorms from any direction can stir up lake bottom sediments, which result in poor source water quality. These events occur most commonly during the winter and spring months.

Currents

Direction and speed of currents in Lake Michigan are highly variable and largely dependent upon wind direction. As shown in Figure 7, unaffected currents near the Racine intake travel south as part of a larger southern Lake Michigan counterclockwise rotation. Easterly and southeasterly winds can quickly reverse lake water circulatory patterns and cause water to stagnate along the shoreline near the intake. Periods of easterly winds often coincide with poorer source water quality.

Figure 7: Lake Michigan Currents

Water quality

Water quality in Lake Michigan improves with distance from shore. Nearshore water quality is generally lower and more prone to fluctuations. Nearshore water quality fluctuations frequently occur in spring when precipitation and snow melt transport contaminants from land into Lake Michigan. Fluctuations also occur during windstorms, which can churn up lake bottom sediments. Atmospheric deposition of contaminants occurs near concentrated urban areas.

With distance from shore most contaminants evaporate, settle into

the lake bottom sediments or dilute to undetectable levels allowing water quality to reach near drinking water purity. Farther from shore, Lake Michigan contains very low concentrations of drinking water contaminants. Organic chemicals and heavy metals are below Wisconsin safe drinking water standards. The majority of these contaminants enter the lake via nonpoint source pollution and atmospheric deposition. Coliform and microbial contaminants are higher nearshore, but have been detected farther from shore. Similar to nearshore areas, easterly windstorms can resuspend sediments far from shore, which can cause water quality fluctuations.

Based on water clarity monitoring source water quality at the Racine intakes fluctuates throughout the year. Fluctuations frequently coincide with windstorms, heavy precipitation and spring thaw. Warmer source water temperatures from June to September can also result in taste and odor problems in treated drinking water. It is important to note that most contaminants in source water at the intakes have not been comprehensively studied. Total coliform, an indicator of microbial contamination is detected in the source water at the drinking water intake frequently throughout the year. Other microbial contaminants, such as *Giardia* and *Cryptosporidium* have occasionally been detected at the intake. Inorganic contaminants, such as heavy metals are detected in the source water at the drinking water intake occur throughout the year. Synthetic organic contaminants typically associated with pesticides have been detected at very low levels at the drinking water intake.

Susceptibility Assessment

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 an adverse human health impact. This definition applies to groundwater and surface water-based public water supplies. 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.

Methodology

For a detailed explanation of the protocol for Great Lake source water assessments please Appendix R of Wisconsin's Source Water Assessment Program Plan Appendices.

An initial survey was performed on the Racine source water area to assess local impacts to the source water. The initial survey included interviewing Racine Water Utility employees, conducting a sensitivity analysis, delineation of a critical assessment zone and reviewing existing data. The initial survey revealed that source water is impacted by local factors.

A more in-depth study of the source water area was carried out to determine what activities and areas within the source water area affect the source water's susceptibility to particular types of contaminants. This more in-depth study reviewed the distribution of potential contaminant sources in the source water area, historical data, localized water quality of tributaries and background water quality levels and characteristics of Lake Michigan.

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.

The calculated sensitivity rating of the drinking water intakes are moderate. This calculated sensitivity does not account for the effects of the Root River, which may cause the intakes sensitivity to be higher.

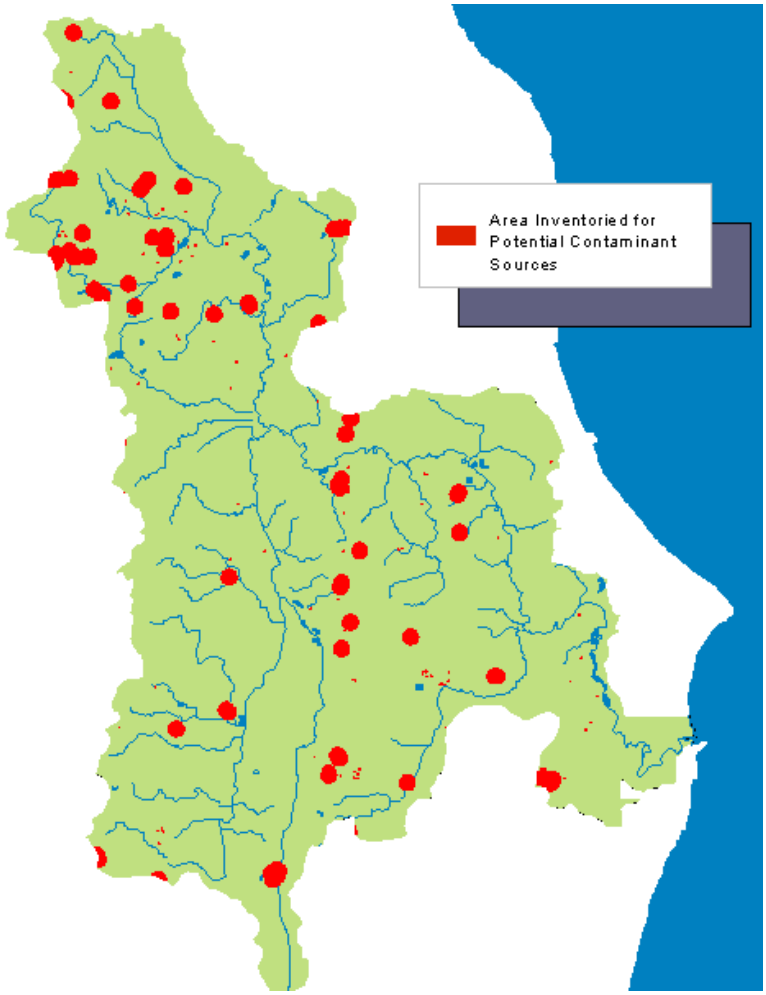
Critical Assessment Zone

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. The critical assessment zones for the Racine drinking water intakes do not encompass any land area.

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.

Figure 8: Areas inventoried for localized potential contaminant sources



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.

Data used in the potential contaminant source inventory includes area-wide and localized information sources. Source water area-wide potential contaminant source data is shown in Figure 9. Locational information for localized potential contaminant sources shown on Figure 10 were inventoried only within areas encompassed by the source water areas for ground water systems. Figure 8 depicts the limited amount and distribution of land in the source water area inventoried for localized significant potential contaminant sources. Information concerning the distribution of localized significant potential contaminant sources is not available for land outside of the red areas in Figure 8.

Landfills

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 are frequently sources for inorganic, synthetic organic and volatile organic contaminants in source water.

As shown in Figure 9, there are ten regulated landfills and in the source water area. All the regulated landfills are located within a mile of a stream that drains into the Root River. Seven of these landfills are

classified by the WDNR's Bureau of Remediation and Redevelopment Tracking System as leaking underground storage sites, which are discussed below.

Wastewater treatment facilities

Wastewater treatment facilities (WWTFs) can be sources of inorganic, microbial, synthetic organic and volatile organic contaminants along with 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 WWTF may be inundated with more raw sewage than it can process. In the event of this a bypass or sanitary sewer overflow will happen. 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.

WWTF locations are shown in Figure 9. From 1995 to 2000, 12 sanitary sewer bypasses were reported in the source water area.

WDNR's 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 9, LUST sites are concentrated in urban areas throughout the source water area. As of 2/26/02, there are 286 LUST sites within the municipality of Racine.

- 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.

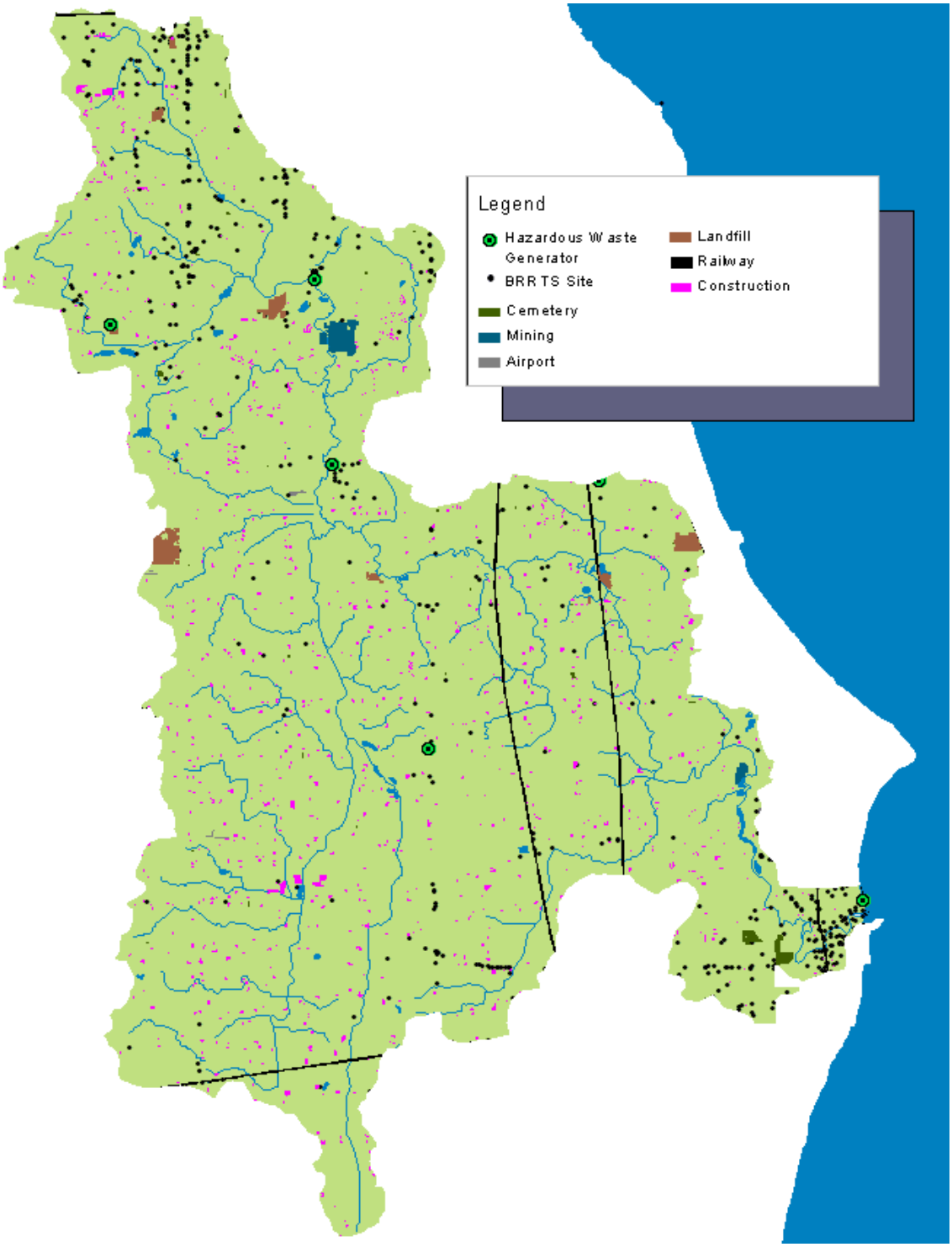
  As shown in Figure 9, Similarly to LUST sites, ERP sites are concentrated in urban areas throughout the source water area. As of 2/26/02 there were 71 ERP sites located within the municipality of Racine.

- Spills

  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.

  Most spills are concentrated in urban areas throughout the source water area. There have been 361 spills in the city of Racine reported to the WDNR from February of 1978 to October of 2000. 95 of these spills entered directly into surface water and 25 entered conduits to surface water, such as storm sewers.

Figure 9: Area-wide potential contaminant source inventory



- Superfund sites

  Superfund sites are highly contaminated areas that have been set aside for cleanup by the USEPA. Superfund sites are frequently associated with sources of inorganic, synthetic organic and volatile organic contaminants

  As shown in Figure 9, there are two Superfund sites located in the source water area. The Fadrowski Drum Site, located near the town of Franklin has contaminated the East Branch of the Root River with volatile organic compounds and inorganic contaminants. The Huntsville Disposal site is located adjacent to the Root River near the Milwaukee / Racine County border. Groundwater and soil near this site are contaminated with inorganic and synthetic organic 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 9, there are 6 large quantity hazardous waste generators located in the source water area. This does not account for the more numerous smaller quantity hazardous waste generators, which are concentrated in the City of Racine and the northern portions of the source water area.

Construction sites

Due to uncovered material, handling of toxic chemicals and exposed ground, construction sites can heavily impact the source water. They are potential sources of inorganic, volatile organic and synthetic organic contaminants. Locational information for construction sites in Figures 8 is based on 1995 data.

From 1990 to 2000 Kenosha County grew by 7.9 %. Much of the land developed to accommodate this large increase in population is urban sprawl in the source water area. As shown in Figure 9, residential areas have spread out in the form of suburbs and lakefront developments near the drinking water intakes.

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 is very popular along the southwestern shore of Lake Michigan. There are seven marinas located in the city of Racine.

Cemeteries

Cemeteries are potential sources of microbial, inorganic and synthetic organic contaminants. Contaminants from cemeteries can enter source water via leachate into groundwater or runoff into surface water. There are multiple cemeteries located throughout the source water area. As shown in Figure 9, there are several cemeteries located in the source water area.

Airports

Airports are potential sources of inorganic and volatile organic contaminants. As shown in Figure 9, there are three small airports in the source water area.

Railroads and Switchyards

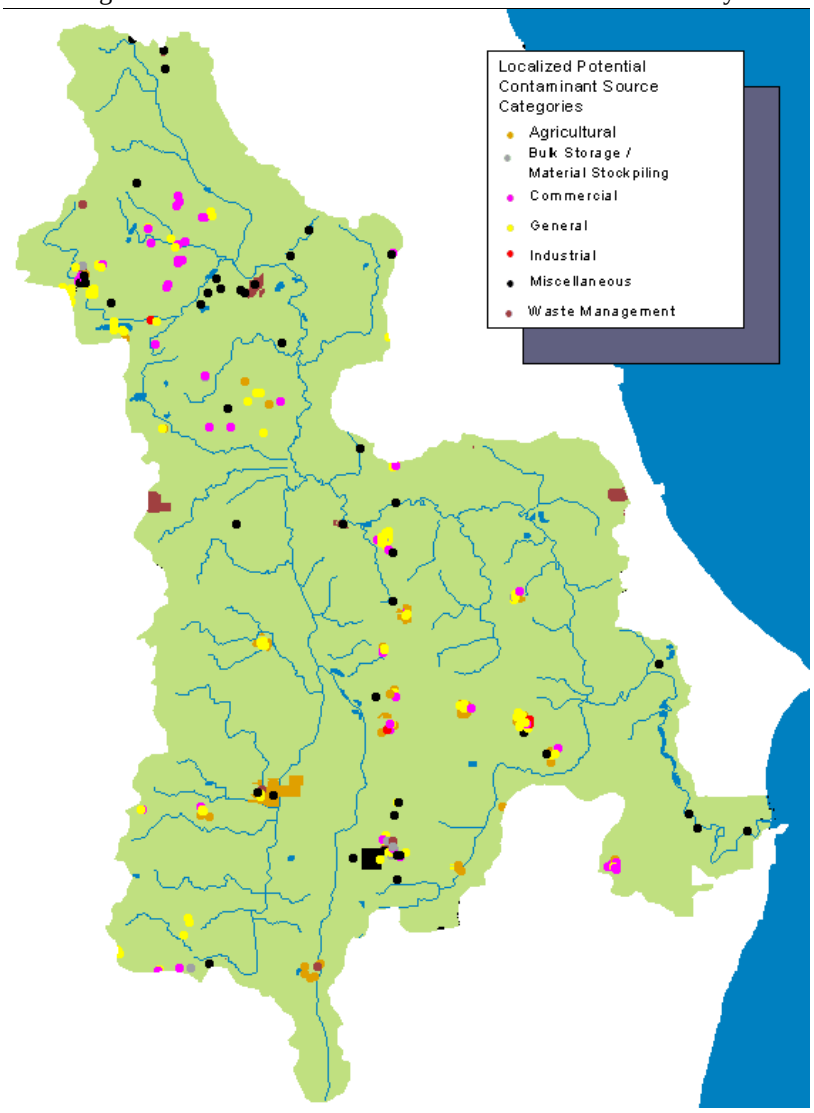
Railroads and switchyards can be sources of contaminants via spills, which are transported as cargo on trains or by contaminants used in the day to day operation of trains. Contaminants associated with spills of cargo vary depending on individual trains and regions, but in 2000 there was an estimated 4.4 million tons of hazardous material transported by rail statewide. Contaminants associated with the day to day operation

and maintenance of railroads and switchyards include synthetic organic, volatile organic and inorganic contaminants. The City of Milwaukee, located to the north of the source water area is a hub for railroads in Wisconsin, as is to a smaller extent the City of Racine. As shown in Figure 9, there are multiple railways that cross the source water area.

Localized Agricultural and Bulk Storage Potential Contaminant Sources

Localized agricultural and bulk storage activity locations for this assessment are shown in Figure 10. 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 10: Localized Potential Contaminant Source Inventory



As mentioned preciously, agricultural practices have been determined to be negative impacts to multiple streams in the source water area.

Localized Commercial Potential Contaminant Sources

Localized commercial activities locations for this assessment are shown in Figure 10. 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 10. 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 10. Waste management activities include municipal incinerators, injection wells, sludge spreading sites, solid waste transfer stations, storm water retention ponds 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.

Wildlife

Natural levels of wildlife generally do not have a negative impact on water quality. However, concentrated animal populations can have a major impact on water quality. They are known to contaminate water with microbial contaminants. These unnatural concentrations of wildlife are frequently related to human activities, such as recreational areas where feeding occurs.

High concentrations of wildlife and domesticated animals on the North Beach may be sources of contaminants to the source water.

Description of Racine's Drinking Water Treatment Facilities

Racine Water Utility reliably provides high, quality drinking water to its consumers. The year-round daily average water demand is approximately 25 million gallons of drinking water per day. The maximum and minimum water demand ranges from 15 to 40 million gallons per day. The treatment facility can reliably treat up to 40 million gallons per day.

Water enters the treatment plant through three surface water intakes located in southwestern Lake Michigan. Potassium permanganate is applied at the intakes to manage zebra mussel growth. Upon entering the treatment facility source water is chlorinated to deactivate microbial contaminants, flocculation, sedimentation and filtration to physically remove contaminants.

Susceptibility Determination

As with most surface water systems, Racine's source water quality is highly susceptible to contamination and significantly impacted by local factors. Source water entering Racine's intakes which are located thousands of feet from shore is significantly impacted by both manageable local factors in the source water area and larger less controllable features of southern Lake Michigan. Based on source water quality monitoring contaminants from local sources frequently reach the Racine intakes. Local impacts in the source water area include agricultural and urban activities. Larger, less manageable southern Lake Michigan features, which affect source water quality include wind induced suspension of lake bottom sediments, variable currents and annual sediment transport. Racine's source water quality normally degrades during spring thaw, periods of heavy precipitation and windstorms.

Recommendations

Source water protection should begin with the formation of a team composed of local, regional and state members to more completely assess impacts to source water and implement best management practices to prevent source water contamination. Initial source water protection efforts of this team should focus on the following,

- Runoff from urban areas in the northern and southeastern portions of the source water area
- Runoff from agricultural activities in the western portion of the source water area

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.

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