



GREAT LAKES SUSTAINABILITY INDICATORS | DRINKING WATER

DRINKING WATER QUALITY



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The **drinking water quality indicator** analyzes violations of contaminants present in water (typically measured as water leaves its treatment plant) and other regulations, illuminating the quality of drinking water available to consumers. To truly safeguard public health, effective regulations, policies, programs, and outreach must ensure that all consumers receive safe, potable water at tap.

In general, water systems in the U.S. and Canada provide reliable and high-quality drinking water. However, financial and infrastructure pressures can negatively impact water quality, especially in areas where public investment is insufficient.

Complicating the issue, drinking water regulations—with a few notable exceptions—generally do not require community water supplies to measure water quality beyond the residential property line. Largely unaccounted for are the chemical changes that can occur to water in a building when it "stands" unused for extended periods or is exposed to contaminants leaching from plumbing fixtures.

WHY IS THIS INDICATOR IMPORTANT?

Community water systems in the U.S. and Canada face many pressures, including aging infrastructure, limited community finance, and emerging source-water contaminants. Yet water quality is essential to human well-being.

While rare, severe failures of high water quality—such as in the Flint, Michigan, water crisis or in the Walkerton, Ontario, *E. coli* outbreak—have a detrimental impact on communities and their trust in their water supplies. Outside of these national-headline grabbing events, the EPA attributes roughly 16.4 million cases of acute gastroenteritis each year to drinking water provided by U.S. community water systems (Messner et. al, 2006).

Growing evidence indicates that lower income and minority communities receive water of poorer quality. Here are some examples:

- Sixty percent of First Nations water systems in Ontario are designated as high risk for environmental or public health violations (Neegan Burnside Ltd., 2011);
- Hispanic communities in the U.S. are experiencing higher nitrate levels in their public water supplies (Schaidler et al., 2019);
- Rural low-income communities in the U.S. suffer from health-based water quality incidents (Allaire et al., 2019).

Therefore, drinking water quality can both provide important evidence of system status and identify potential racial and ethnic justice issues.

This research is part of the Great Lakes Indicators project funded by the Erb Family Foundation. The project is rooted in the understanding that the environmental health of the Great Lakes directly affects the region's economic health, individual and societal health and well-being, as well as values and perceptions of the Great Lakes.

*The Great Lakes offer valuable ecosystem services, including providing **drinking water** to many of the region's inhabitants. The **drinking water indicators** are intended to help regional leaders and advocates understand their water quality, reliability, affordability, and constituents' trust in their drinking water, better positioning them to influence management and policy decisions.*

HOW IS IT MEASURED?

Currently, Ontario provincial and U.S. federal regulations set guidelines to monitor over 90 contaminants and bacteria in public drinking water systems. Historically, compliance with these guidelines has constituted safe drinking water.

In the U.S., a subset of violations of the Safe Drinking Water Act constitute a “health-based” violation. The list of violations include all maximum contaminant level violations (MCLs), as well as a group of monitoring and compliance violations that might impact health. The health-based violation count is currently used by the EPA as the preferred indicator of safe drinking water.

Water quality incidents in Ontario are reported by the Ministry of Environment, Conservation and Parks (MECP). The main data source for this analysis is the database of Adverse Water Quality Incidents (AWQI). AWQI occur when drinking water quality standards are breached, such as by insufficient disinfection, high turbidity, or equipment malfunction. Not all AWQI have direct health implications to consumers of water.

DATA AVAILABILITY AND LIMITATIONS

The most comprehensive drinking water quality data is derived from reporting related to the federal Safe Drinking Water Act (SDWA) in the U.S. and the provincial Safe Drinking Water Act in Ontario. While standards are not identical, the general set of reported contaminants are the same.

Both Acts require water systems to report violations (U.S.) or incidents (ON) to constituents in the form of Consumer Confidence Reports (CCR). Databases of these reports are available to the public. Reporting standards for the U.S. and Ontario both allow for inter-municipal comparisons. One limitation is that neither set of regulations tracks unregulated or emerging contaminants whose impact on health are yet to be determined, such as microplastics, pharmaceuticals, and personal care products.

The EPA reports violations to the SDWA with its Safe Drinking Water Information System (SDWIS) Federal Reporting Service. Violations range from failure to notify constituents publicly to monitoring and reporting violations to contaminant and bacterial exceedance violations. The EPA codes some violations, including all maximum contaminant violations, as “health-based,” signifying a potential to impact human health. Reports include all drinking water systems in the U.S. and have been reported quarterly since the 1980s. The SDWA database does account for discrepancies in state-to-state regulatory standards, such as Michigan’s more stringent Lead and Copper Rule.

The AWQI database in Ontario includes annual reports that are available from 2014 to 2020. Violations range from monitoring and reporting issues to contaminant violations and boil water advisories. The AWQI database records when a contaminant violation has occurred. In addition, the Ministry of Environment, Conservation and Parks reports testing results when a violation has not occurred, as well as inspection scores for water systems.

DESCRIPTIVE SUMMARY OF DATA

In 2018, there were 12,386 total SDWA violations in Great Lakes states. Health-based violations comprised 1,147 and maximum contaminant level violations comprised 710. To put this in perspective, 79% of community water systems did not have any violations in 2018, 96% did not have any health-based violations, and 98% did not have any maximum contaminant violations. Generally, water quality in Great Lakes states is compliant with EPA standards.

However, there are isolated water quality incidents. Table 1 shows, by state, violations per 100,000 people served (2018). Note significant state variation in violation rates by category. Pennsylvania has the highest total violations, while Wisconsin has the highest health-based and maximum contaminant violations. In general, Illinois, Michigan, Minnesota, and Ohio have lower violations per 100,000 people than the other Great Lake states.

Table 1. SDWA Violations Reported in 2018

STATE	ALL VIOLATIONS PER 100,000 PEOPLE	HEALTH-BASED VIOLATIONS PER 100,000 PEOPLE	MCL VIOLATIONS PER 100,000 PEOPLE
Illinois	5.62	1.28	0.97
Indiana	21.00	1.06	0.78
Michigan	9.51	0.90	0.45
Minnesota	7.04	1.61	1.06
New York	16.18	1.35	1.21
Ohio	5.09	1.52	1.14
Pennsylvania	42.05	2.17	0.54
Wisconsin	34.45	3.80	1.85

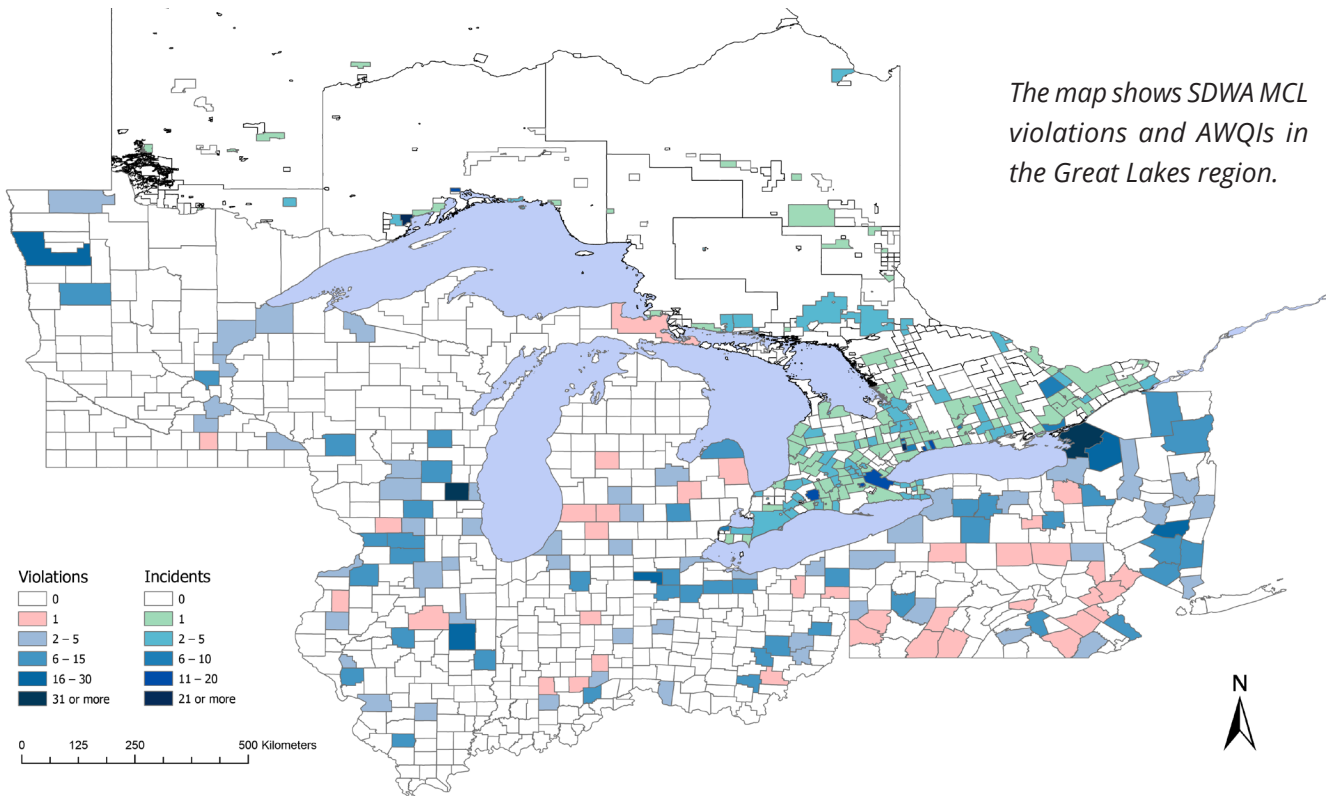
The SWDA violations identify each contaminant and its regulated threshold in finished water. The most common maximum contaminant violations are total trihalomethanes, total haloacetic acids, arsenic, and combined radium.

The Ontario data spans a full year, from Quarter 2 of 2018 to Quarter 2 of 2019. In that period, there were 2,294 AWQIs in Ontario, of which 1,213 were contaminant-related. The average number of contaminant-related AWQIs per system is 1.5. Half of systems have no contaminant-related AWQIs, and 95% have less than five contaminant-related AWQIs. A few systems have 20 or more AWQIs, with a maximum of 137. The table below reports AWQIs by system size. Contaminant-related AWQIs tend to be consistent across size, but smaller systems seem to have more incidents overall.

Table 2: Average Number of AWQIs by Type and System Size

SIZE	ALL	CONTAMINANT-RELATED	FREQUENCY
Large municipal drinking water system	2.58	1.75	528
Small municipal drinking water system	4.39	1.16	56
Non-municipal year-round residential drinking water system	2.29	1.23	182

Maximum Contaminant Level Violations (USA) & Adverse Water Quality Incidents (ON), 2018



OPTIONS FOR FURTHER ANALYSIS

The examples in this section illustrate additional ways to explore violations and adverse water quality incidents.

Time-Series Analysis

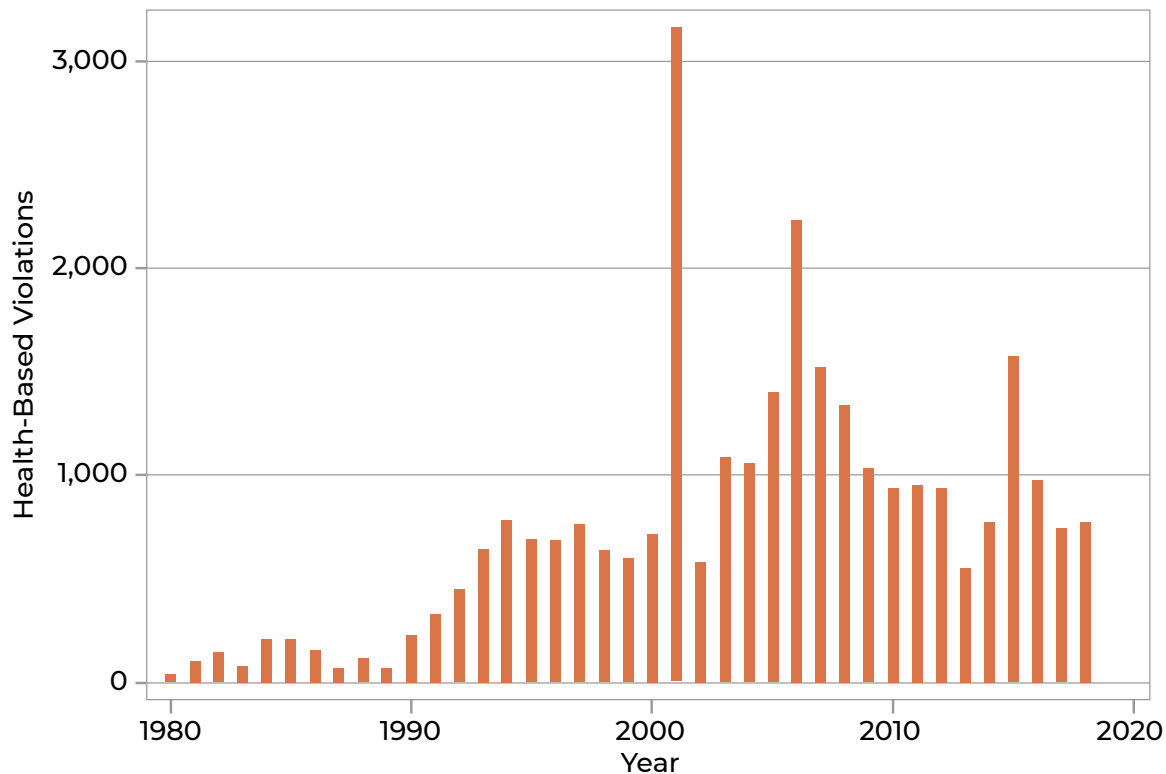
The EPA SDWIS and AQWI record the specific date of infractions. The SWDIS data date back to 1980, while AQWI data date back to 2014. This temporal information can be used to analyze water quality over time. Note that for the SDWIS dataset, certain violations have changed over time, resulting in spikes in violations as systems adjust treatment processes. While the example below aggregates reporting across all eight Great Lakes states, results could be broken out at the state, county, and city level.

Demographic and Utility Analysis

The EPA SWDIS data is reported by system. Geographic variables include city and county served, which can be paired with American Community Survey demographic data. Not all community water systems serve cities. The Ohio water systems do not report the city-served variable. However, by using system names, it is possible to match water systems to townships, cities, and villages.

Local jurisdictions provide accurate demographic data to conduct analysis using racial and economic variables. Furthermore, the SWDIS includes utility-level data on water source type, number of people served, and number of total violations. Together, these data can be used to estimate the impact of race, income, and utility type on health violations.

Example: Time-Series Graph of Health-Based Violations in Great Lakes States



The rise in health-based violation often corresponds to changes in EPA regulations. The large spike in 2001 occurred because the Stage 1 Disinfectants and Disinfection Byproducts Rule became enforceable.

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