METROPOLITAN COUNCIL

Environmental Services

2014

River Water Quality Summary for the Twin Cities Metropolitan Area

This document is a summary of the 2014 water quality of major rivers in the Twin Cities metropolitan area (metro area), based on monitoring results from the Metropolitan Council Environmental Services (MCES) river monitoring program. Rivers are important natural resources for the metro area and provide many valuable services: they are popular destinations in summer months for boating, swimming, and camping; they are used frequently for year-round recreational fishing; and the upper Mississippi River is a significant source of drinking water. Scenic areas of the region's rivers such as St. Anthony Falls in Minneapolis and the federally protected St. Croix National Scenic Waterway are also popular tourist destinations. The MCES river monitoring program helps to ensure these beneficial services are efficiently maintained and protected.

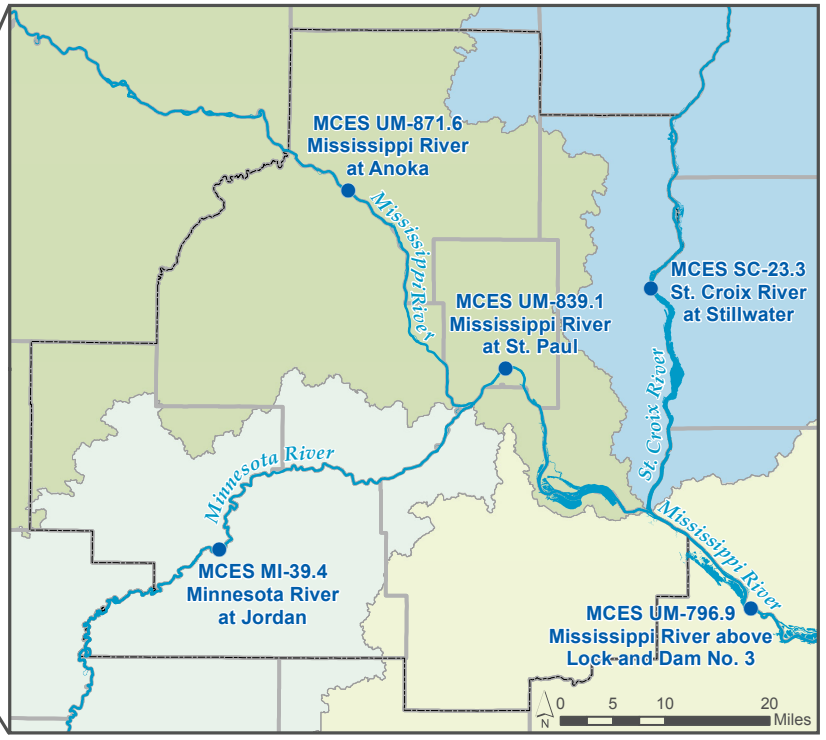


Figure 1: Key metro area monitoring locations and watersheds of the Mississippi, Minnesota, and St. Croix Rivers upstream of the metro area.

Information collected from the River Monitoring program is used by the Minnesota Pollution Control Agency (MPCA) and other agencies for a wide variety of purposes, such as determining compliance with Minnesota water quality standards and documenting long-term changes and trends in water quality. The information is also used to assess the performance and effectiveness of MCES treatment plants, which are some of the highest performing plants in the country. Additionally, the monitoring program supports the regional policies established in the Metropolitan Council's Thrive MSP 2040 and 2040 Water Resources Policy Plan including the policy of assessing the condition of the region's lakes, streams, rivers and aquifers to evaluate the impact on regional water resources and to measure success in achieving regional water goals.

In 2014, MCES river monitoring was conducted at six automated and 20 conventional sampling sites on five major rivers: Mississippi, Minnesota, St. Croix, Vermillion, and Rum. MCES collected conventional samples four to five times per month during the open-water season (March through October) when there is typically more recreational activity and the river environment changes quickly and up to two times per month during the remainder of the year. In 2014, the conventional sampling effort resulted in 813 field visits, 4,170 field parameter readings, and over 22,500 laboratory results.

To summarize the water quality of rivers in the metro area in 2014, MCES compared concentrations of key water quality parameters from five sites (Figure 1). The Mississippi River at Anoka, Minnesota River at Jordan, and St. Croix River at Stillwater sites monitor flows into the metro area. The Mississippi River at St. Paul site is located downstream of where the Minnesota flows into the Mississippi River, and the Mississippi River above Lock and Dam 3 site near Red Wing monitors flows out of the metro area. Overall, the metro area covers a relatively small percentage of the total watershed area of the Mississippi, Minnesota, and St. Croix Rivers, as shown in Figure 1.

The water quality of each river is influenced by a number of factors including watershed size, adjacent land use, and geology. These factors need to be carefully considered when making conclusions about the parameter concentration results. For example, the St. Croix River watershed consists mostly of forested areas which are more resistant to erosion than other types

of land in Minnesota, while the Minnesota River watershed is dominated by agricultural fields which tend to have more erosion. This difference in land use is one factor that may explain why the St. Croix River generally has lower concentrations of the monitored water quality parameters discussed in this report while the Minnesota River generally has higher concentrations. Each river faces different management challenges based on the unique environmental factors in the area.

MCES compared the 2014 average for each of the key water quality parameters at the five sampling sites to 10-year averages from 2005-2014. Since concentrations are highly affected by flow which can be very different between years, the comparison between 2014 and the previous decade should not be taken as an indication of increasing or decreasing water quality, but rather as a snapshot comparison to conditions of recent years.

MCES also compared the 2014 averages to state water quality standards where applicable, as presented in Table 1. Total suspended solids and eutrophication standards, which include total phosphorus, were recently added in 2014. Standards allow the MPCA to objectively evaluate the quality of Minnesota's water resources and ensure the region's waters are protected. When the water quality of a river exceeds a standard, the MPCA may declare it impaired, which starts the process for the development of a plan outlining how to meet the water quality standards.

Table 1: Water quality standards at the five sampling sites

Parameter	Mississippi River at Anoka	Minnesota River at Jordan	Mississippi River at St. Paul	St. Croix River at Stillwater	Mississippi River above Lock and Dam 3
Chloride (Cl) – mg/L	Cl concentrations must not exceed a 4-day average of 230 mg/L or a one hour average of 860 mg/L				
Dissolved Oxygen (DO) – mg/L	DO concentrations should not fall below a daily minimum of 5 mg/L				
***E. coli* bacteria** – organisms/100mL	Between April 1 and October 31, the geometric mean of at least five samples taken in any calendar month should not exceed 126 E. coli organisms/100mL, and no more than 10% of samples taken in a calendar month should exceed 1,260 E. coli organisms/100mL				
Total Suspended Solids (TSS) – mg/L TSS concentrations should not exceed:	30[a]	65[a]	32[b]	15[a]	32[b]
Total Phosphorus (TP) – mg/L Between June 1 and September 30, the average TP concentration of samples should not exceed:	0.10	0.15	0.125	0.05	0.10
Nitrate – Nitrogen (NO3) – mg/L NO_3 concentrations from waters designed as drinking water sources should not exceed:	10	NA	NA	10	NA

Standards are part of the Minnesota Administrative Rules as set by the Minnesota Pollution Control Agency's Chapter 7050: Waters of the State

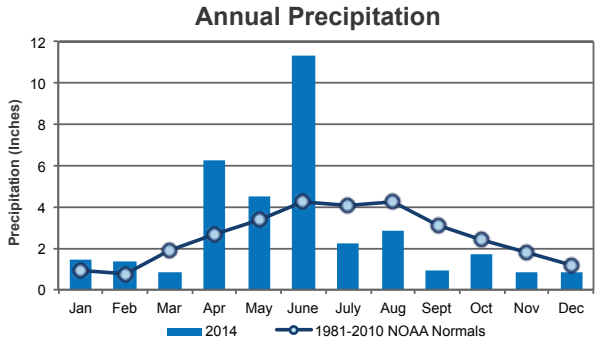
[a] The standard can only be exceeded 10% of the time and only applies between April 1 and September 30

[b] The standard can only be exceeded 50% of the time and only applies between June 1 and September 30

Precipitation and River Flow

Description: Regional precipitation is measured at the Minneapolis-St. Paul International Airport, which is a good indicator of significant rainfall events in the metro area because of its central location. River flow, or the rate of water flowing in a river, affects aquatic life and is influenced by precipitation amounts. During wet periods, nonpoint source pollutants are carried through storm sewer systems to lakes and smaller streams and ultimately most often to the major rivers. The higher flows can cause stream bank erosion, habitat destruction, and flooding. During dry periods, low flows can result in more concentrated river pollution, increased sediment deposition, and lower habitat quality.

2014 Results: Precipitation in the metro area during 2014 was almost 5 inches above the normal precipitation, as defined by NOAA 1981-2010 Climate Normals (a data set updated every 10 years). The first half of the year (January through June) was fairly wet, experiencing 12.0 inches of precipitation above normal. The month of June was especially wet, reaching more than 7 inches above normal and going on record as the wettest June since 1874! In contrast, the second half of the year (July through December) was fairly dry, having a precipitation deficit of 7.2 inches compared to normal.

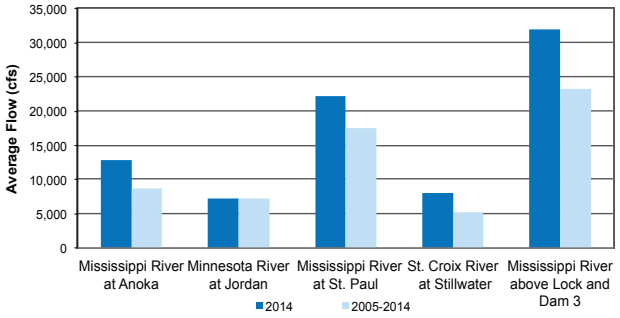


Overall, 2014 had above normal precipitation, leading to annual river flows that were above the 10-year averages. Compared to the 10-year average at each site, the 2014 average river flow was:

Site	2014 vs. 10-year
Mississippi River at Anoka	Higher
Minnesota River at Jordan	Same
Mississippi River at St. Paul	Higher
St. Croix River at Stillwater	Higher
Mississippi River above Lock and Dam 3	Higher

Comparisons between 2014 and 2005 – 2014 averages throughout this summary are reported using the following method: "Same" means the average 2014 concentration was within the 95% confidence interval (a statistical tool used to represent how spread out the data is) of the 10-year average, while "Lower" and "Higher" mean the 2014 average was below or above the 95% confidence interval of the 10-year average, respectively.

Annual River Flow



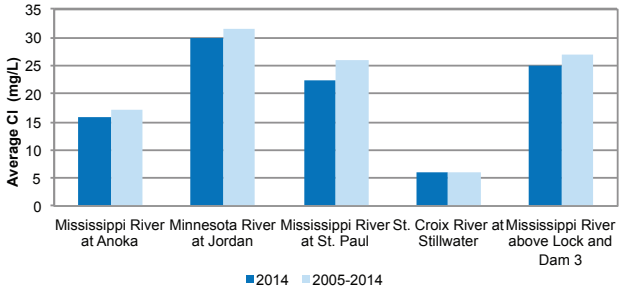
Chloride (Cl)

Description: Chloride, one component of salt, is typically used for winter maintenance of roads, sidewalks, and parking lots, and for home water softening. Excess levels of Cl in the environment can be toxic to aquatic and terrestrial organisms.

2014 Results: Compared to the 10-year average at each site, the 2014 average Cl concentration was:

Site	2014 vs. 10-year
Mississippi River at Anoka	Lower
Minnesota River at Jordan	Lower
Mississippi River at St. Paul	Lower
St. Croix River at Stillwater	Same
Mississippi River above Lock and Dam 3	Lower

Chloride (Cl) Concentration



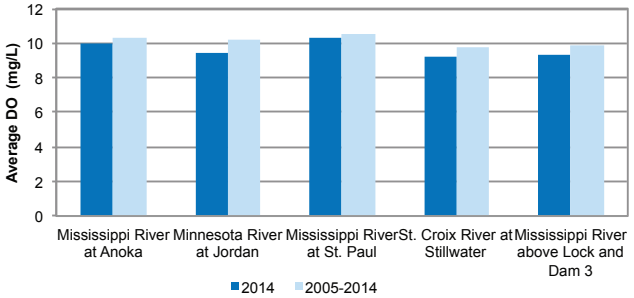
Dissolved Oxygen (DO)

Description: DO is the amount of oxygen dissolved in water. It can enter an aquatic system from the atmosphere and it is also produced by aquatic plants through photosynthesis. DO concentrations can be reduced by high temperatures, low water flow, high pollution, and decomposition of organic material in the water. Since almost all organisms require oxygen to live, high levels of DO are essential for a healthy river system, and low levels can lead to a loss of fish and other organisms from the area.

2014 Results: Compared to the 10-year average at each site, the 2014 average DO concentration was:

Site	2014 vs. 10-year
Mississippi River at Anoka	Lower
Minnesota River at Jordan	Lower
Mississippi River at St. Paul	Same
St. Croix River at Stillwater	Lower
Mississippi River above Lock and Dam 3	Lower

Dissolved Oxygen (DO) Concentration

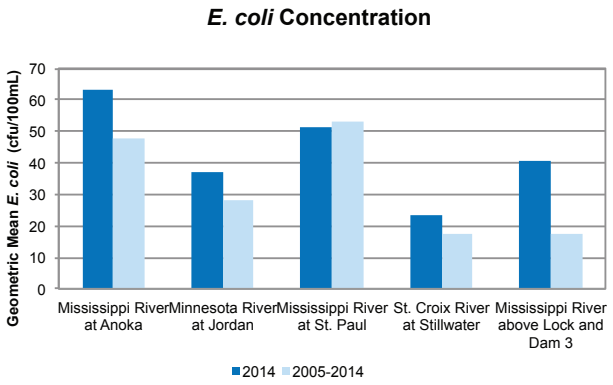


E. coli Bacteria

Description: *Escherichia coli (E. coli)* are bacteria which typically originate from failing septic tanks, untreated wastewater, and waste from livestock, pets, and wildlife. High *E. coli* levels can indicate the presence of potentially dangerous pathogens in water bodies such as typhoid fever, hepatitis and dysentery. Therefore the concentration of *E. coli* is one of several parameters used to determine a river's suitability for recreational purposes.

2014 Results: Compared to the 10-year average at each site, the 2014 average *E. coli* concentration was:

Site	2014 vs. 10-year
Mississippi River at Anoka	Higher
Minnesota River at Jordan	Higher
Mississippi River at St. Paul	Lower
St. Croix River at Stillwater	Higher
Mississippi River above Lock and Dam 3	Higher

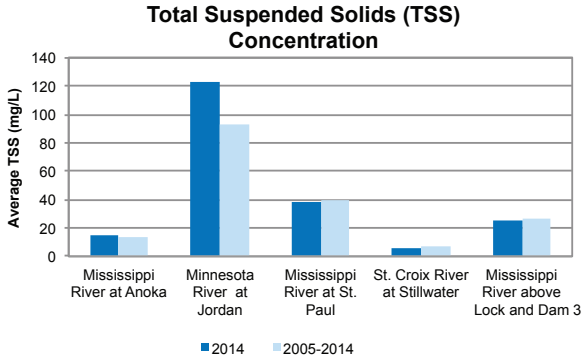


Total Suspended Solids (TSS)

Description: TSS is any material suspended in water which can be removed with a filter. TSS has a variety of sources including eroded sediment from stream banks, lawns, construction sites, and agricultural fields as well as organic particulate such as decaying matter and algae. High levels of TSS in rivers may harm aquatic life by decreasing the light available for plant growth, increasing water temperature, clogging gills of aquatic inhabitants, and covering habitat. High TSS levels can also affect recreational use by decreasing water clarity and creating unfavorable swimming conditions.

2014 Results: Overall, the Minnesota River is the primary TSS contributor within the metro area. Compared to the 10-year average at each site, the 2014 average TSS concentration was:

Site	2014 vs. 10-year
Mississippi River at Anoka	Higher
Minnesota River at Jordan	Higher
Mississippi River at St. Paul	Same
St. Croix River at Stillwater	Lower
Mississippi River above Lock and Dam 3	Same

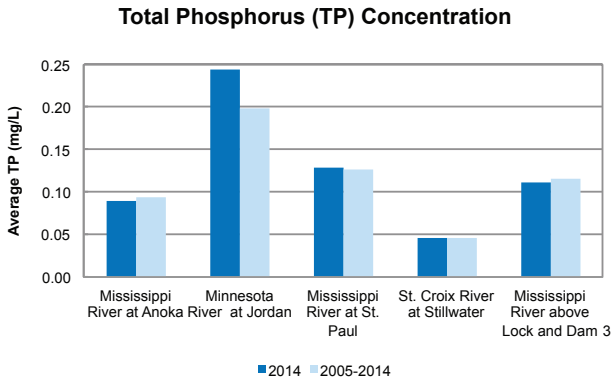


Nutrients: Total Phosphorus (TP)

Description: Phosphorus is an essential nutrient necessary for the growth of aquatic organisms. Nutrients cycle naturally in the environment, but elevated levels of TP in rivers can be caused by the erosion of fertilized soils. High levels of TP can stimulate excess growth of aquatic plants, causing algae blooms which reduce the oxygen levels in the water. This creates unlivable conditions for most aquatic life and makes the water unusable for most recreational activities.

2014 Results: Compared to the 10-year average at each site, the 2014 average TP concentration was:

Site	2014 vs. 10-year
Mississippi River at Anoka	Same
Minnesota River at Jordan	Higher
Mississippi River at St. Paul	Same
St. Croix River at Stillwater	Same
Mississippi River above Lock and Dam 3	Same



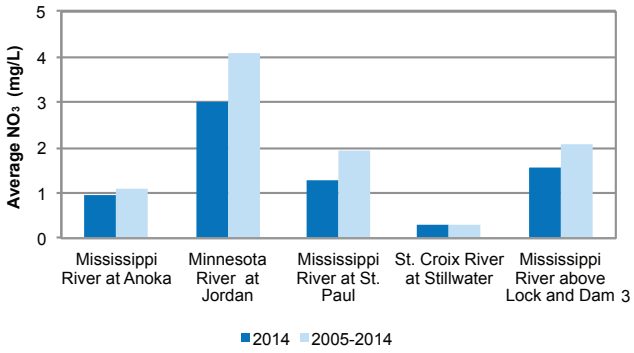
Nutrients: Nitrate—Nitrogen (NO_3)

Description: Nitrogen is an essential nutrient necessary for the growth of aquatic organisms. Aside from natural processes, common sources of NO_3 include fertilizers, plant debris, and septic and municipal wastewater treatment systems. High NO_3 levels can cause the same problems associated with high phosphorous concentrations and additionally can lead to methemoglobinemia, a blood condition typically affecting infants which impairs the ability of red blood cells to efficiently transport oxygen throughout the body.

2014 Results: Compared to the 10-year average at each site, the 2014 average NO_3 concentration was:

Site	2014 vs. 10-year
Mississippi River at Anoka	Lower
Minnesota River at Jordan	Lower
Mississippi River at St. Paul	Lower
St. Croix River at Stillwater	Same
Mississippi River above Lock and Dam 3	Lower

Nitrate - Nitrogen (NO_3) Concentration



Comparison to Standards

The MPCA is the federally authorized organization with the responsibility of determining when water quality exceeds standards and is officially impaired. However, for this summary, MCES used standards as a tool to provide insight into the water quality of the five river sites. In 2014, the chloride, dissolved oxygen, *E.coli*, and nitrate concentrations were all relatively good in comparison to the standards. Chloride 4-day or daily averages could not be calculated due to the collection methods, yet all measured samples at all five sites had concentrations below the standard of 230 mg/L. A direct comparison to the *E.coli* standards was also not possible, yet there were only two samples taken between April 1 and October 31 in 2014 which exceeded 1,260 organisms/100mL: one in the Minnesota River at Jordan and one in the Mississippi River at Anoka. All dissolved oxygen concentrations were above the 5 mg/L minimum standard, including in the Minnesota River, where historically concentrations dipped below the standard. High oxygen levels above the standard are good because most aquatic life cannot survive at low oxygen levels. The nitrate-nitrogen samples all met the drinking water standard except for two from the Minnesota River at Jordan (where that standard does not apply because that site is not a source for drinking water).

If the rivers were officially evaluated against the recently implemented TSS and TP standards, according to our results it would appear that the TSS and TP standards are not met at all five sites (Table 3). The St. Croix River at Stillwater had values just barely above the standards, while the Minnesota River at Jordan had the highest values. As a result, the new standards indicate the need for emphasis on the management of TSS and TP in the metro area.

Table 2: Comparison of 2014 TSS and TP results with water quality standards

Site	TSS (%) [a]		TP (mg/L) [b]	
	2014 value	Standard	2014 value	Standard
Mississippi River at Anoka	19 [c]	10	0.13	0.03
Minnesota River at Jordan	96 [c]	10	0.30	0.15
Mississippi River at St. Paul	50 [d]	50	0.15	0.025
St. Croix River at Stillwater	11 [c]	10	0.06	0.01
Mississippi River above Lock and Dam 3	61 [d]	50	0.15	0.05

[a] Comparison to the TSS standard was evaluated by calculating the percentage of 2014 MCES samples which fell above the standard. "2014 value" is percent of 2014 TSS samples above the standard and "Standard" is the percentage of times the standard can be exceeded
[b] TP "2014 value" was calculated from samples taken when the standard applies (June 1 – September 30)
[c] Calculated from samples taken between April 1 to September 30, as defined in the standard
[d] Calculated from samples taken between June 1 to September 30, as defined in the standard

Concluding Remarks

Data gathered from the MCES's river monitoring program can be used to track general patterns as the three main rivers (Minnesota, Mississippi, and St. Croix) converge and flow through the metro area. Out of the three rivers entering the metro area, the Minnesota River had the highest concentrations of nutrients, chloride, and total suspended solids in 2014. Just upstream of the Mississippi River at St. Paul, the Minnesota River concentrations were diluted as the water entered into the Mississippi and mixed together, producing the intermediate concentrations observed at St. Paul. Further downstream at the Mississippi at Lock and Dam 3 where water leaves the metro area, lower concentrations occurred likely due to dilution from the St. Croix River when it enters the Mississippi. There are exceptions to this general dilution pattern though. For example, chloride and nitrate concentrations increased between St. Paul and Lock and Dam 3, indicating pollutants such as road salts may have entered the rivers within the metro area with concentrations that were higher than what was already in the river. Table 3 summarizes the 2014 results of the water quality parameters in comparison to the 10-year averages. Overall, the river flow and *E. coli* counts were higher in 2014 compared to the past decade at most of the sites. On the other hand, chloride, dissolved oxygen, and nitrate concentrations were below the 10-year average at most sites. Compared to the past decade, total suspended solids concentrations were variable in 2014, while total phosphorus concentrations were generally the same as in the past 10 years.

Table 3: Summary of 2014 average water quality parameters compared to 10-year averages (2005-2014)

Parameter	Mississippi River at Anoka	Minnesota River at Jordan	Mississippi River at St. Paul	St. Croix River at Stillwater	Mississippi River above Lock and Dam 3
River Flow	Higher	Same	Higher	Higher	Higher
Chloride (Cl)	Lower	Lower	Lower	Same	Lower
Dissolved Oxygen (DO)	Lower	Lower	Same	Lower	Lower
E. coli bacteria	Higher	Higher	Lower	Higher	Higher
Total Suspended Solids (TSS)	Higher	Higher	Same	Lower	Same
Total Phosphorus (TP)	Same	Higher	Same	Same	Same
Nitrate – Nitrogen (NO^3)	Lower	Lower	Lower	Same	Lower

"Same" means the average 2014 concentration was within the 95% confidence interval (a statistical tool used to represent how spread out the data is) of the 10-year average, while "Lower" and "Higher" mean the 2014 average was below or above the 95% confidence interval of the 10-year average, respectively.

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