2021 Source Water Assessment

CITY OF MANKATO PUBLIC WATER SYSTEM

PWS ID # 1070009

2021 Source Water Assessment – Mankato
Public Water Supply ID: 1070009

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I hereby certify that this plan, document or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Geologist under the laws of the State of Minnesota.

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Glossary

Agronomist – An expert in the science of soil management and crop production.

Appropriations – The total amount of water approved for use from an aquifer, stream, lake, or reservoir by the Minnesota Department of Natural Resources.

Aquatic consumption – A standard that is applied to a body of water by the Minnesota Pollution Control Agency that differentiates whether fish caught in that waterbody should be consumed by people or not.

Aquatic life use – A standard that is applied to a body of water by the Minnesota Pollution Control Agency that describes whether the waterbody supports a healthy aquatic ecosystem or not.

Aquatic recreation use – A standard that is applied to a body of water by the Minnesota Pollution Control Agency that describes whether the waterbody supports or is impaired for recreational (i.e. swimming, boating, fishing, etc.) purposes.

Buffer – An area of equal width on either side of a stream.

Centerline – The center of a stream.

Concentrations – The abundance of an element or compound within a volume of water.

Contaminant – A chemical, either natural or man-made, that degrades water quality.

Cyanobacteria – A type of microorganism that obtains its energy through photosynthesis. Also known as Blue-Green Algae, they produce toxins that can be harmful if pets and humans come in contact with them.

Cyanotoxins – A toxin that is produced by cyanobacteria.

Delineated area – A watershed area that has been outlined as contributing to a downstream waterbody that serves as a public water supply source. The ERA, SMA, and DWSMA are all delineated areas.

Dilution – The action in which a chemical concentration is reduced in water by increasing the amount of water present.

Disinfectant – Any oxidant, including but not limited to chlorine dioxide, chloramines, and ozone added to water in any part of the treatment or distribution process, that is intended to kill or inactivate pathogenic microorganisms.

Disinfection byproduct (DBP) – A chemical that is formed from a reaction between a disinfectant and organic matter that is present in water.

Eutrophication – A process through which a waterbody is enriched with excess nutrients, commonly from surface water runoff, which results in dense plant growth and decreased oxygen at depth.

Fecal coliform – A type of bacteria that is found in animals, humans, and transmitted to the natural environment.

Geography – Physical features of a described land area.

Gradient – The degree of slope of a surface, either of the land or water table.

Infrastructure – The physical structures and facilities that are needed for a public water supply's operation.

Inorganic chemical – Metals, salts, or other compounds that typically do not contain carbon.

Intake – A pipe located in a waterbody from which a public water supplier pumps their raw water for treatment.

Lakeshed – An area surrounding a lake that contributes water via runoff, groundwater, or stream flow.

Lime Sludge – A semi-solid material that is a byproduct of using lime during a water treatment process.

Microorganism – An organism that can only be seen with the use of a microscope.

Mitigate – Decrease in severity.

Organic chemical – A compound that contains carbon.

Perennial stream – A reoccurring or year round stream flow.

Photosynthesis – The process by which a plant uses sunlight in combination with carbon dioxide and water to create food for itself.

Point-source potential contaminant source – As defined in MDH draft guidance (2021), a discharge or other regulated activity that occurs at a discrete location.

Radionuclides – An element that decays radioactively, emitting radiation as a result.

Ranney well – A well that has been constructed to extract water from an aquifer in direct connection to a surface water source like a river or lake.

Toxin – Poison from plant or animal origin.

Watershed – An area of land that drains all the streams and rainfall to a common outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel.

Abbreviations

DBPs – Disinfection By-Products

DNR – Department of Natural Resources

DWSMA-SW – Drinking Water Source Management Area – Surface Water

EPA – U.S. Environmental Protection Agency

ERA – Emergency Response Area

HAB – Harmful Algal Bloom

HUC – Hydrologic Unit Code

KML – Keyhole Markup Language

LiDAR – Light Detection and Ranging

MCL – Maximum Contaminant Level

MDA – Minnesota Department of Agriculture

MDH – Minnesota Department of Health

mg/L – milligrams per liter

MN – Minnesota

MGY – millions of gallons per year

MNDWIS – Minnesota Drinking Water Information System

MnGEO – Minnesota Geospatial Information Office

MPARS – Minnesota Permitting and Reporting System

MPCA – Minnesota Pollution Control Agency

MPN/100 mL – Most probable number of organisms per 100 milliliters of solution

NHD – National Hydrography Dataset

NRCS – Natural Resource Conservation Services

NTU – Nephelometric Turbidity Units

NWI – National Wetland Inventory

PCBs – Polychlorinated Biphenyls

PCSI – Potential Contaminant Source Inventory

ppb – parts per billion

ppm – parts per million

PWS – Public Water Supplier

SDWA – Safe Drinking Water Act

SMA – Spill Management Area

SWA – Source Water Assessment

SWCD – Soil and Water Conservation District

SWIPP – Source Water Intake Protection Plan

SWPP – Source Water Protection Plan

TMDL – Total Maximum Daily Load

TTHM – total trihalomethanes

ug/L – micrograms per liter

USGS – United State Geological Survey

Introduction to the Source Water Assessment

Background

The 1996 amendments to the federal Safe Drinking Water Act (SDWA) required the Minnesota Department of Health (MDH) to complete source water assessments (SWAs) for public water systems (PWS). The first source water assessment (SWA) for Mankato was completed in 2003.

Since the first SWAs were completed, much has changed in the processes used to develop source water protection plans, as well as with the data and tools to support these efforts. For example, we now have more data available and use more sophisticated methods to characterize water quality. Also, the water resource management framework in Minnesota has changed substantially, most notably with a shift towards watershed-based comprehensive local water planning.

MDH has dedicated resources to update the SWA and to work with the PWS to create a Surface Water Intake Protection Plan (SWIPP). These documents will be used to drive implementation of activities to protect the surface water-derived source water for the city of Mankato for the next 10 years. After those 10 years have elapsed, MDH will reassess the PWS source water assessment area. This updated SWA will then guide the amended SWIPP.

Contributors to the SWA

MDH, in partnership with the city of Mankato, assembled a team of staff from MDH and the city of Mankato to develop and review this SWA.

Purpose of the SWA

The information from this updated and enhanced assessment can be used in efforts to expand upon activities to prevent or mitigate contamination of Mankato's surface water-derived source of drinking water.

The SWA provides information regarding the drinking water sources for public water systems. A SWA includes information on the following: identification of the resource used as a drinking water source, its physical setting, public water system intake and treatment, contaminants of concern, and known threats.

Source Water Characteristics

The city of Mankato obtains approximately 70 percent of its public water supply from two shallow Ranney wells designed to collect water from the Minnesota and Blue Earth Rivers (Figure 1). The Blue Earth River Watershed (HUC8: 07020009) flows to Mankato from the south and drains 2,271,890 acres. The Minnesota River at Mankato flows east-southeast and drains several HUC8 watersheds

totaling 7,301,810 acres. Of the two watershed areas 86 percent is within the state of Minnesota, while 11 percent of the drained land is in South Dakota, 2.3 percent is in Iowa, and less than one percent is in North Dakota.

Source Watershed Statistics for the City of Mankato

Total Watershed Area: 9,573,692 acres

Stream Length: 19,974 miles

Wetland Area: 20,621 acres[1]

- [1]Wetland information is based on Department of Natural Resources (DNR) National Wetland Inventory (NWI) data

Infrastructure Characteristics

The following list describes the key infrastructure components and permit capacity to provide safe and reliable water for residents and businesses in the city of Mankato. The city operates two Ranney wells, Well #13 (209830) and Well #15 (683899), that are adjacent to the Blue Earth and Minnesota Rivers, respectively. These two wells are officially designated as "groundwater under the direct influence" of surface water, meaning that the water coming from these two wells is considered to be surface water that has been filtered through riverbed sediments, but has a very short time-of-travel through those sediments. This means that the water coming from these two wells must be treated to the standards required of public drinking water systems that use surface water, to both remove and inactivate pathogens to meet the standards outlined on the MDH Safe Drinking Water Act Standards website (https://www.health.state.mn.us/communities/environment/water/factsheet/sdwa.html).

The city also maintains two full-time primary wells (Well #14 (458567) and Well #16 (686257)), one seasonal backup well (Well #11 (209395) and one emergency well (Well #12 (209391), all drilled into a deep, non-vulnerable aquifer, to fulfill all water needs for residents. Groundwater from these wells is mixed with water from the two Ranney wells throughout the year. This groundwater comes from the Mt. Simon Aquifer, which is subject to much less recharge from the surface, making it an unsustainable long-term drinking water source for the city. Planning activities for the Mt. Simon wells are outlined in the city's current Wellhead Protection Plan (SEH, 2014).

Public Water System Characteristics	
Intake Location and Method:	Two Ranney wells (Wells #13 and #15, Minnesota Well Unique Numbers 209830 and 683899) extend below the Minnesota and Blue Earth Rivers.
Treatment Facility:	One treatment facility near the Blue Earth-Minnesota River confluence.
Treatment Methods:	Blending, softening, iron/manganese sequestration, corrosion control, ultrafiltration and particulate removal, fluoridation, disinfection.
Production:	Max daily production of (up to) 8.15 million gallons, average daily 4.914 million gallons (Minnesota Drinking Water Information System (MNDWIS)).
Storage Capacity:	10.565 million gallons tank and tower storage.
Backup Water Sources:	Can blend surface water with an increased proportion of groundwater from primary, seasonal, and emergency wells when needed.
DNR Appropriations Permit:	Combined from all sources (Minnesota Permitting and Reporting System (MPARS) No. 1970-1412): 2,800 millions of gallons per year (MGY) permitted, actual use listed in Table 1

Table 1 shows the water volumes pumped from all of the city's wells.

Table 1 – Annual Volume of Water Discharged from Water Supply Wells

Well Name (Unique Number)	2015	2016	2017	2018	2019
Well #13 (209830)	750.9	258.4	886.5	609.4	**917.0**
Well #15 (683899)	377.7	**815.4**	131.8	523.4	276.8
Ranney Wells Total	1,128.6	1,073.8	1,018.3	1,132.8	**1,193.8**
Other Wells Total	**724.4**	682.6	624.0	583.1	552.1
System Total	**1,853.0**	1,756.4	1,642.2	1,715.9	1,745.9

- All volumes are expressed as millions of gallons. Bolding indicates the greatest annual pumping volume reported in the five-year span for that well or wells.

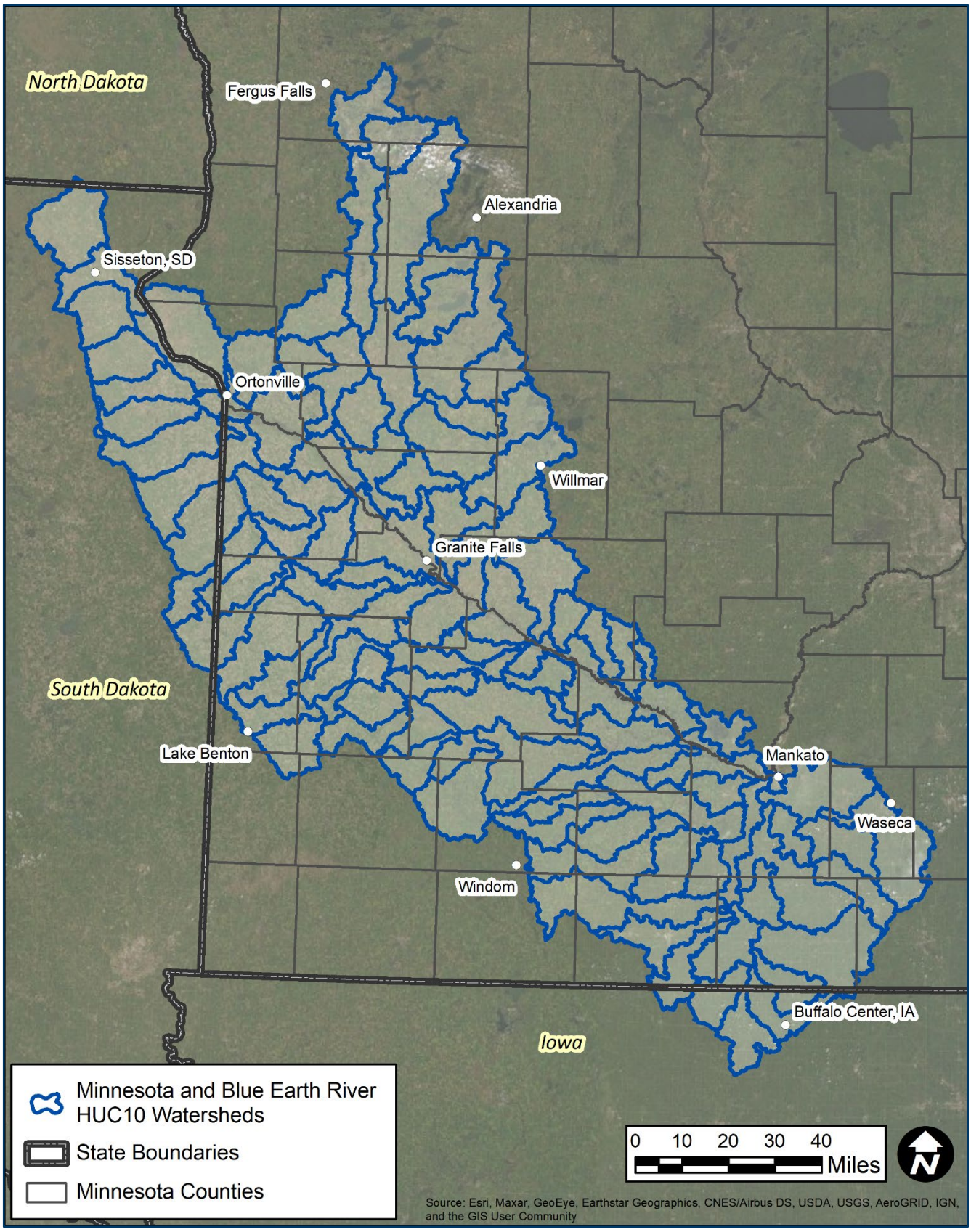

Figure 1 – Minnesota and Blue Earth River Watersheds Upstream from Mankato.

Watershed Areas Delineated for the Source Water Assessment

Three nested areas are included in the SWA. These areas are shown in Figure 2.

Emergency Response Area

The Emergency Response Area (ERA) is designed to help the city address potential contaminant point sources and contaminant releases that present an immediate health concern to water users. The ERA geographic area is defined by the amount of notification time the city needs to close the surface intake, plus some additional time to accommodate unanticipated delays in notification and shut down. The defined time of travel for the ERA is eight hours. Where gage data is not available to estimate travel time, a 10 river mile distance is used. The width of the ERA is a quarter mile (1,320 feet) on either side of the stream reach.

The Mankato ERA includes reaches of the Minnesota, Blue Earth, and Le Sueur Rivers and Minneopa Creek (Figure 2). The time of travel distances were calculated using the geometric means of channel velocity data from USGS gages along those rivers. The ERA distance for these gaged streams represents an eight hour time of travel to the Ranney wells. For the Le Sueur River ERA delineation, the time of travel along the Blue Earth River from the Blue Earth-Le Sueur confluence to the Ranney well was subtracted from eight hours, and the remaining time of travel was converted into the river mile distance upstream along the Le Sueur.

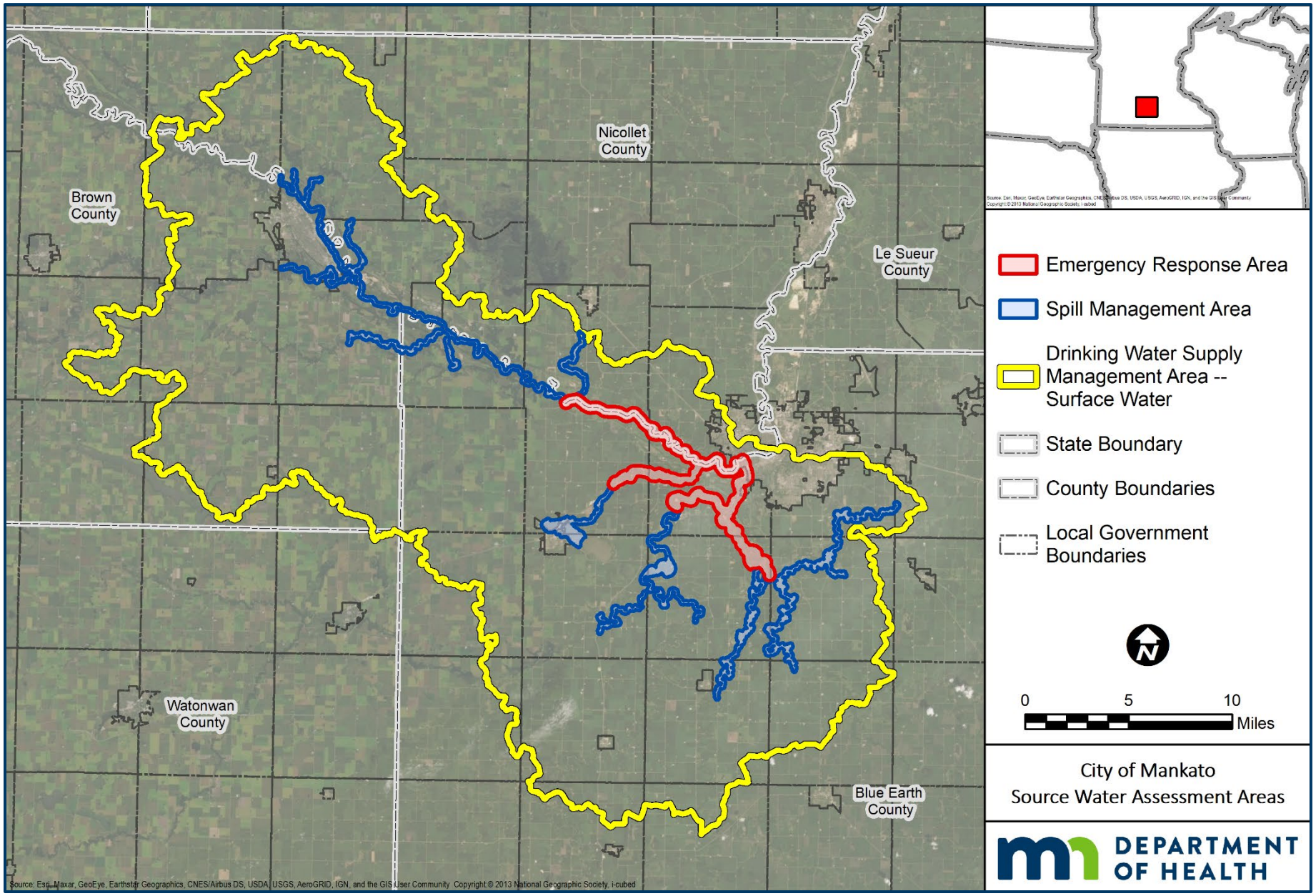

Figure 2 – Mankato's Drinking Water Supply Management Area, Spill Management Area, and Emergency Response Area.

The ERA also includes Minneopa Creek, which has no gage data available. In instances like this, a 10-river mile distance from the intake can be used to delineate the ERA (MDH, 2021). To delineate the Minneopa Creek portion of the ERA, the distance along the Minnesota River from the Ranney well to the Minneopa-Minnesota confluence was subtracted from 10 miles, and the remaining river mile distance was then applied to Minneopa Creek upstream from the convergence.

Historical aerial photos from the U.S. Geological Survey (USGS) and the Minnesota Geospatial Information Office (MnGEO) dating back several decades show that the Minnesota, Blue Earth and Le Sueur Rivers have changed substantially since the NHD dataset was last amended, as river meandering of those streams has altered channel geometries. To correct for this, aerial photographs from as recently as 2017 were used to move GIS line segments to as close to current channel courses as possible. This was done to ensure that river time of travel distances were as accurate as possible.

The land use in the ERA is mostly agricultural, forested, and wetlands.

Spill Management Area

The Spill Management Area (SMA) is designed to focus source water protection activities on potential contaminant sources within 500 feet of either 1) the centerline of a public stream, or 2) the shoreline of a lake contributing flow to the city's source waterbody (MDH, 2021). Like the ERA, the SMA is designed to highlight point source contamination issues of immediate concern that could impact the water supply.

The Mankato SMA has been delineated for all perennial public stream tributaries and lakes within either a 24 hour time of travel or 25 river miles upstream of the Ranney wells (Figure 2). All lakes within the watershed were delineated with 500 foot buffers from the shoreline. The final SMA includes the lakes and stream reaches listed below:

- Blue Earth River
- Cobb River
- Cottonwood River
- Crystal Lake
- Fritsche Creek
- Heyman's Creek
- Huelskamp Creek
- Le Sueur River
- Lily Lake
- Little Cottonwood River
- Maple River
- Minneopa Creek
- Minnesota River
- Morgan Creek
- Swan Lake Outlet
- Unnamed Stream (Le Sueur trib.)
- Unnamed Stream (Watonwan trib.)
- Watonwan River

Within the Minneopa Creek watershed, the SMA is truncated at Crystal Lake. Modeling conducted for the Crystal Lake TMDL report (MPCA, 2019) suggests that the residence time for water and nutrients in the lake is on the order of six months. As such it was decided that including streams, lakes, and ditches upstream from Crystal Lake was unnecessary.

The land use in the SMA is mostly agricultural, wetlands, open water, and forested.

Drinking Water Supply Management Area – Surface Water

The Drinking Water Supply Management Area – Surface Water (DWSMA-SW) is designed to protect water users from long-term health effects related to low levels of contamination that originate from diffuse, widespread sources that are relatively close to the drinking water intake. These contaminant sources, known as non-point contaminants, can pose a higher-level threat when the combined concentration of the contaminant from across the watershed is substantially high. The DWSMA-SW also delineates areas where future land use development may have a greater influence on source water quality. These future development issues are discussed below and will be addressed more fully in the city's Surface Water Intake Protection Plan.

The DWSMA-SW was delineated using HUC 12 watershed boundary data from the U.S. Natural Resources Conservation Service (NRCS), and refinements were conducted by using the Minnesota Department of Natural Resources (DNR) surface water auto-catchment dataset to remove river catchments that were downstream from the confluence. The full and partial HUC 12 watersheds delineated as the DWSMA-SW, which are listed below in Table 2, fully contain the ERA and SMA delineations. The HUC 12 level was chosen for delineation because most watershed project planning in Minnesota occurs at that scale. For the city of Mankato, the DWSMA-SW encompasses 19 HUC 12 watersheds upstream from or within the city. One additional HUC 12 watershed (City of Mankato-Minnesota River) at the confluence of the Minnesota and Blue Earth Rivers was also included, but DNR-delineated catchments that were downstream from the ERA were removed (Figure 2).

The resulting DWSMA-SW includes the watersheds listed in Table 2. The streams within the DWSMA-SW drain from land represented by agricultural, forested, wetland, and developed uses. Historical aerial photos from the USGS and MnGEO dating back several decades show that the current dataset of streams that are considered perennial is accurate.

Source Water Assessment Area

The Source Water Assessment Area (SWAA) includes the entire Blue Earth and Minnesota River watersheds upstream from the city of Mankato's Ranney wells to the state boundaries with Iowa, and South Dakota. The final SWAA is shown in Figure 3.

SWA Area Statistics for the City of Mankato

Emergency Response Area: 9,422 acres

Spill Management Area: 14,701 acres

Drinking Water Supply Management Area – Surface Water: 291,666 acres

Source Water Assessment Area: 8,272,354 acres

Table 2 – Watersheds included in the Mankato DWSMA-SW

HUC 12 Watershed Name	HUC 12 Code	Watershed (acres)
Blue Earth River	070200091103	12,884
City of Courtland-Minnesota River	070200071002	31,021
City of Mankato-Minnesota River[1]	070200071102	7,966
City of New Ulm-Minnesota River	070200070604	15,571
City of Vernon Center-Blue Earth River	070200091102	29,131
Cobb River	070200110305	21,957
Cottonwood River	070200080803	29,935
County Ditch No 3-Minnesota River	070200071003	23,521
County Ditch No 78	070200100605	12,047
Huelskamp Creek-Minnesota River	070200070602	30,715
Judicial Ditch No 48	070200070901	30,335
Lake Crystal	070200070902	13,921
Le Sueur River	070200110607	27,604
Little Cottonwood River	070200070704	35,270
Maple River	070200110509	23,630
Minneopa Creek	070200070903	10,278
Morgan Creek	070200071001	37,765
Swan Lake Outlet	070200070803	6,171
Watonwan River	070200100606	16,872

▪1. DNR subwatershed only. Not a full HUC 12 watershed.

Contaminants of Concern

The federal Safe Drinking Water Act (SDWA) regulates primary contaminants, which are listed on the National Primary Drinking Water Regulations website (https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations). They are divided into categories of microorganisms, organic chemicals, inorganic chemicals, radionuclides, disinfectants, and disinfection byproducts.

Water quality indicators are used to determine watershed health. Maintaining source water quality over time ensures that treatment processes remain effective and efficient for consumers. While there may not be drinking water standards or limits for some indicators like total organic carbon or total suspended solids, they can lead to creation of disinfection byproducts (DBPs) within drinking water treatment and distribution systems. DBPs are not usually found in source water, and can be avoided by requiring PWSs that use conventional treatment to remove a significant percentage of total organic carbon prior to chlorination.

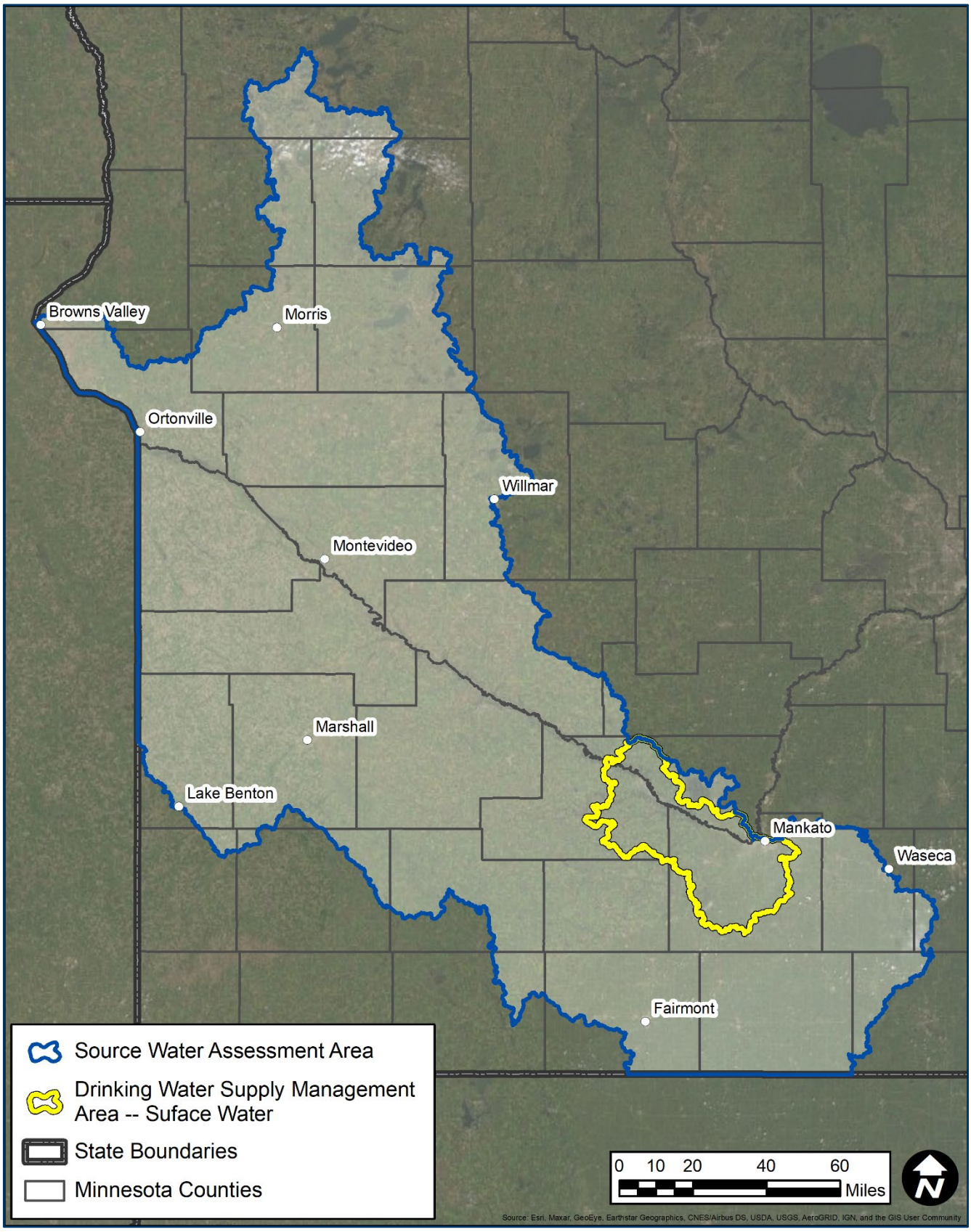

Figure 3—Mankato's Source Water Assessment Area.

In addition to the contaminants regulated by the SDWA, some emerging contaminants are also of concern. Emerging contaminants are chemicals about which we are gaining new understanding and awareness regarding their public health or environmental impacts. These emerging contaminants do not yet have SDWA regulated maximum contaminant levels (MCLs), but may have health-based guidance values developed by the U.S. Environmental Protection Agency (EPA) or MDH. A summary of these guidance values is available on the MDH Health-Based Water Guidance Table website (https://www.health.state.mn.us/communities/environment/risk/guidance/gw/table.html).

Table 3 summarizes important water quality detection data for the city of Mankato. The detections are either concentrations of constituents found in the raw source water sampled from the Ranney wells (i.e. turbidity, total organic carbon, E. coli) or from post-treatment entry or distribution point samples (i.e. organic compounds, nitrate, disinfection by-products and harmful algal bloom toxins). Contaminants that originate from source water related are also highlighted.

Table 3 – Drinking Water Quality Results for City of Mankato

Water Quality Parameters and Measurement Units	Violations	Detections and water quality concerns	Data Source	Potential Source(s) and comments
Regulated Volatile Organic Compounds, Synthetic Organic Compounds[2]	None	Recent metolachlor (0.2 ug/L) and atrazine (0.1 ug/L) detections on 8/12/2019; some past (prior to 2009) detections of herbicides and gasoline compounds	MDH	Entry-point data likely related to source water concentrations
Nitrate (as Nitrogen) mg/L or ppm[2]	None	Treated water maximum of 6.3 mg/L listed in MNDWIS; source data have exceeded 10 mg/L for both Ranney wells, historically	MDH, City	High concentrations likely to recur each spring and fall due to tile drainage and agricultural runoff through upstream watersheds
Turbidity (NTU)[1]	None	Source results below 3 NTU during LT2 Source Monitoring Survey 2016 - 2018	MDH	Source water turbidity usually due to erosion in watershed
Total Organic Carbon (mg/L)[1, 2]	N/A	Source water from Blue Earth well usually < 4 mg/L; Treated water usually < 3 mg/l	MDH	Can lead to increased production of disinfection by-products
Disinfection By-Products - Haloacetic Acids (ug/L)[2]	None	Average total concentration 16 ug/L (2010 to present)	MDH	By-products of disinfection
Disinfection By-Products - Total trihalomethanes (TTHM, ug/L)[2]	None	Average total concentration 49 ug/L (2010 to present)	MDH	By-products of disinfection
E. coli (MPN/100 mL)[1, 2]	None	No entry point detects. Periodic detects in Ranney well raw water.	MDH	Sewers, septic systems, sewage lagoons, animal manure
Harmful Algal Bloom Toxins[3]	N/A	No detects reported	MDH, City	Indicates presence of potentially harmful algae in water column

- [1]Raw Water
- [2]Treated Water
- [3]For more information visit the EPA Drinking Water Health Advisories for Cyanotoxins website (https://www.epa.gov/cyanohabs/epa-drinking-water-health-advisories-cyanotoxins).

The Minnesota Pollution Control Agency (MPCA) has established that a number of streams and lakes in the DWSMA are impaired for aquatic recreation, consumption and life uses. Table 4 describes the reaches that are impaired and what those impairments are. Many of the reach impairments have total maximum daily load (TMDL) agreements for those reaches. Aquatic recreation use, aquatic life use, and aquatic consumption definitions can be found at Guidance Manual for Assessing the Quality of Minnesota Surface Waters for Determination of Impairment: 305(b) Report and 303(d) List (https://www.pca.state.mn.us/sites/default/files/wq-iw1-04i.pdf).

While these impairments do not directly pertain to drinking water, they do further underscore the water quality issues observed in the Minnesota and Blue Earth River watersheds. It should be noted that while the city's drinking water treatment system protects against fecal coliform and E. coli bacteria, there are some contaminants, like nitrate, that are not as easily treated. Mitigating the aquatic consumption, recreation, and life impairments within the two watersheds would benefit drinking water for the city of Mankato.

The water quality in the Minnesota and Blue Earth Rivers at Mankato has been impacted by human activities (MPCA, 2020). The observed water quality issues in the Minnesota and Blue Earth Rivers that can or have impacted drinking water quality include:

- Nitrate concentrations that require blending with deeper groundwater, with the highest concentrations occurring in early spring and late fall; and
- Pesticides have been detected in the watershed and entry point samples. While not nutrients, they can be derived from similar sources.

Nitrate

The Blue Earth and Minnesota Rivers have been studied for nitrate trends for some time. The MPCA released a report on nitrate nitrogen in watersheds throughout Minnesota in 2013 (MPCA, 2013). In it, the Blue Earth, Le Sueur, and Watonwan watersheds were noted to be significant contributors of nitrate to the Minnesota and Mississippi Rivers, with the combined load contributed by those three watersheds observed to be roughly 50 percent more than the nitrate load contributed by all watersheds upstream from New Ulm. When compared with all other Minnesota HUC 8-level tributaries to the Mississippi River, the Minnesota River – Mankato, Blue Earth and Le Sueur River watersheds contribute 6.7, 6.4, and 5.7 percent, respectively, to the total nitrogen load as measured in Keokuk, Iowa, making them the second, third, and fourth highest contributors of nitrogen in Minnesota, respectively (MPCA, 2013).

Nitrate data throughout the Minnesota and Blue Earth River watersheds show fairly consistent trends overall, highlighting seasonality throughout the Mankato DWSMA-SW. MPCA's intensive assessment monitoring took place in the Cottonwood, Minnesota River at Mankato, Blue Earth, and Le Sueur watersheds in 2017 and 2018. During that two-year period, nitrate was sampled, on average, every seven days throughout the two watersheds except during frozen conditions.

Table 4 – Stream and Lake Chemistry Impairments within the city of Mankato's DWSMA-SW

Lake or Stream Name	Reach Description	AUID	Use Classes	Impaired Parameters	Parameters with TMDLs	In ERA or SMA
Blue Earth River	Le Sueur River to Minnesota River	07020009-501	2Bg, 3C	Fecal coliform[1], Mercury-Water[2], Turbidity[3], Mercury-Fish[2], Fish Bioassessments[3]	Fecal coliform[1], Mercury-Water[2], Mercury-Fish[2]	ERA
Blue Earth River	Willow Creek to Watonwan River	07020009-507	2Bg, 3C	Turbidity[3], Mercury-Fish[2], Fish Bioassessments[3]	Mercury-Fish[2]	SMA
Blue Earth River	Rapidan Dam to Le Sueur River	07020009-509	2Bg, 3C	Fecal coliform[1], Mercury-Water[2], Nutrients[3], Turbidity[3], Mercury-Fish[2], Fish Bioassessments[3]	Fecal coliform[1], Mercury-Water[2], Mercury-Fish[2]	ERA, SMA
Blue Earth River	Watonwan River to Rapidan Dam	07020009-510	2Bg, 3C	Mercury-Fish[2]	Mercury-Fish[2]	SMA
Cobb River	T107 R26W S30, west line to Le Sueur River	07020011-556	2Bg, 3C	E. coli[1], Nutrients[3], Turbidity[3], Fish Bioassessments[3]	E. coli[1]	SMA
Cottonwood River	JD 30 to Minnesota River	07020008-501	2Bg, 3C	Fecal coliform[1], Turbidity[3], Mercury-Fish[2]	Fecal coliform[1], Mercury-Fish[2]	SMA
County Ditch 11	Unnamed ditch to Unnamed creek	07020007-657	2Bm, 3C	Benthic Macroinvertebrates Bioassessments[3]	--	--
County Ditch 27	Headwaters to Lily Lake	07020007-535	2Bm, 3C	Fish Bioassessments[3]	--	--
County Ditch 3	-94.1041 44.1989 to Minnesota River	07020007-660	2Bg, 3C	Benthic Macroinvertebrates Bioassessments[3]	--	--
County Ditch 56 (Lake Crystal Inlet)	Headwaters to Lake Crystal	07020007-557	2Bm, 3C	E. coli[1], Fish Bioassessments[3]	--	--
County Ditch 67	CD58 to Little Cottonwood River	07020007-658	2Bg, 3C	Fish Bioassessments[3], Benthic Macroinvertebrates Bioassessments[3]	--	--
County Ditch 78	164th St to Watonwan River	07020010-559	2Bg, 3C	Fish Bioassessments[3], Benthic Macroinvertebrates Bioassessments[3]	--	SMA
Fritsche Creek (County Ditch 77)	-94.4172, 44.3557 to Minnesota River	07020007-709	2Bg, 3C	E. coli[1], Benthic Macroinvertebrates Bioassessments[3]	--	SMA
Heyman's Creek	Unnamed creek to Minnesota River	07020007-640	2Bg, 3C	E. coli[1]	--	SMA

Lake or Stream Name	Reach Description	AUID	Use Classes	Impaired Parameters	Parameters with TMDLs	In ERA or SMA
Heyman's Creek	T110 R30W S22, north line to Unnamed creek	07020007-675	2Bg, 3C	Benthic Macroinvertebrates Bioassessments[3]	--	SMA
Huelskamp Creek	Unnamed creek to Minnesota River	07020007-641	2Bg, 3C	E. coli[1]	--	SMA
Judicial Ditch 10	Unnamed creek to T108 R30W S2, east line	07020007-701	2Bm, 3C	Benthic Macroinvertebrates Bioassessments[3]	--	--
Judicial Ditch 48	Unnamed ditch to Minneopa Creek	07020007-593	2Bm, 3C	Fish Bioassessments[3]	--	--
Le Sueur River	Maple River to Blue Earth River	07020011-501	2Bg, 3C	Fecal coliform[1], Mercury-Water[2], Nutrients[3], Turbidity[3], PCB-Water[2], PCB-Fish[2]	Fecal coliform[1]	ERA
Le Sueur River	Cobb River to Maple River	07020011-506	2Bg, 3C	Turbidity[3], **PCB-Fish[2]**	--	ERA, SMA
Le Sueur River	CD 6 to Cobb River	07020011-507	2Bg, 3C	E. coli[1], Turbidity[3], PCB-Fish[2], Fish Bioassessments[3]	E. coli[1]	SMA
Little Cottonwood River	Headwaters to T109 R31W S22, north line	07020007-676	2Bg, 3C	Fecal coliform[1], Turbidity[3], Fish Bioassessments[3], Benthic Macroinvertebrates Bioassessments[3]	--	--
Little Cottonwood River	T109 R31W S15, south line to Minnesota River	07020007-677	2Bg, 3C	Fecal coliform[1], Turbidity[3], Benthic Macroinvertebrates Bioassessments[3]	--	SMA
Maple River	Rice Creek to Le Sueur River	07020011-534	2Bg, 3C	Fecal coliform[1], Turbidity[3], Benthic Macroinvertebrates Bioassessments[3]	Fecal coliform[1]	SMA
Minneopa Creek	Headwaters to Lily Lake	07020007-531	2Bm, 3C	Fish Bioassessments[3]	--	--
Minneopa Creek	T108 R28W S23, south line to Minnesota River	07020007-534	2Bg, 3C	E. coli[1], Turbidity[3], Fish Bioassessments[3], Benthic Macroinvertebrates Bioassessments[3]	--	ERA, SMA
Minnesota River	Little Rock Creek to Cottonwood River	07020007-721	2Bg, 3C	Nutrients[3], TSS[3], Mercury-Fish[2], PCB-Fish[2]	Mercury-Fish[2]	SMA
Minnesota River	Cottonwood River to Blue Earth River	07020007-722	2Bg, 3C	Mercury-Water[2], Nutrients[3],Turbidity[3], PCB-Water[2], PCB-Fish[2], Mercury-Fish[2]	Mercury-Water[2], Mercury-Fish[2]	ERA, SMA
Morgan Creek	T109 R29W S30, south line to Minnesota River	07020007-691	2Bg, 3C	E. coli[1], Fish Bioassessments[3], Benthic Macroinvertebrates Bioassessments[3]	--	SMA

Lake or Stream Name	Reach Description	AUID	Use Classes	Impaired Parameters	Parameters with TMDLs	In ERA or SMA
Swan Lake Outlet (Nicollet Creek)	CD 39 to Minnesota River	07020007-683	2Bg, 3C	E. coli[1], Benthic Macroinvertebrates Bioassessments[3]	--	SMA
Unnamed Creek	T108 R28W S6, south line to T108 R28W S6, north line	07020007-577	1B, 2Ag, 3B	Nitrate[4], Fish Bioassessments[3], Benthic Macroinvertebrates Bioassessments[3]	--	--
Unnamed Creek (Little Beauford Ditch)	Headwaters to Victory Drive (MN22)	07020011-642	2Bg, 3C	Chlorpyrifos[3], Fecal coliform[1], Mercury-Water[2], PCB-Water[2], Turbidity[3]	Fecal coliform[1]	--
Unnamed Creek (Little Beauford Ditch)	Victory Dr (MN22) to Cobb River	07020011-643	2Bg, 3C	Chlorpyrifos[3], Turbidity[3], Fecal coliform[1]	Fecal coliform[1]	--
Watonwan River	Perch Creek to Blue Earth River	07020010-501	2Bg, 3C	Fecal coliform[1], Turbidity[3], Mercury-Water[2], Mercury-Fish[2]	Fecal coliform[1], Mercury-Water[2], Mercury-Fish[2]	SMA
Crystal Lake	--	07-0098-00	2B, 3C	Nutrients[1], Fish Bioassessments[3]	--	SMA
Loon Lake	--	07-0096-00	2B, 3C	Nutrients[1], Mercury-Fish[2]	Mercury-Fish[2]	--
Mills Lake	--	07-0097-00	2B, 3C	Nutrients[1]	--	--

- 1 Aquatic Recreation Use
- 2 Aquatic Consumption Use
- 3 Aquatic Life Use
- 4 Drinking Water Use

Figure 4 shows trends at eight different stations within the Minnesota and Blue Earth River watersheds within Mankato's DWSMA-SW. Elevated nitrate concentrations were consistently observed during the spring and early summer months of 2017 at all stations, followed by sharp declines. These seasonal trends were likely due to snowmelt and spring rains draining through field tile, followed by some photosynthetic consumption of nutrients by organisms in the water column throughout the summer. Concentrations then rose again through the fall, presumably due to relatively increased precipitation and mild winter temperatures and subsequent increases in field drainage tile flow during the late fall and through the winter. Nitrate increased again through the spring before resuming high concentrations during the early summer of 2018. Comparing the magnitude of concentration changes between the two years show that variation in the 2018 data are less than 2017, and that maximum concentrations for 2018 were also less. The reason for this decrease may be that the spring of 2018 was very wet

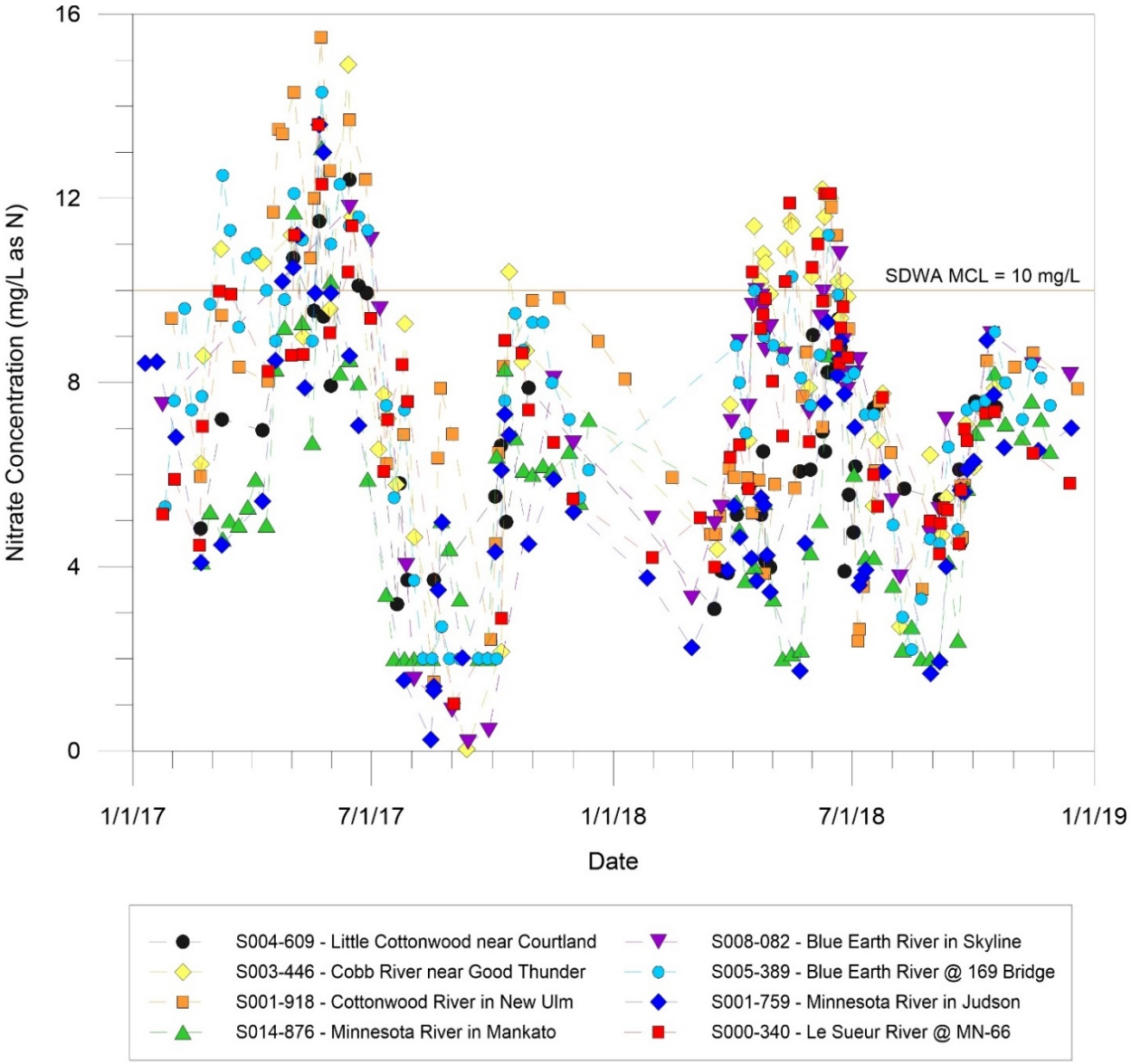

Figure 4—Nitrate concentration trends at intensive monitoring sites located within the city's DWSMA-SW.

in southern Minnesota, and this increased precipitation may have diluted the typical spring nitrate peak. Regardless, spring and early summer concentrations did exceed the SDWA MCL of 10 milligrams per liter (mg/L as nitrogen) both years in multiple watersheds upstream from Mankato.

The decreasing trend in maximum concentration over time is also visible in longer-term data collected by the city of Mankato. The city has measured nitrate in the Blue Earth and Minnesota Rivers and the city's two Ranney wells since 2010. Figure 5 shows nitrate trends observed in both rivers from 2010 through 2019. The data clearly shows the same seasonal nitrate trends in both rivers, with the highest nitrate concentrations tending to occur in late winter and early spring, as thawing snowpack and near-surface soils release nitrate-laden water to area streams via tile drainage. It should be noted that while the trends in both streams are similar, concentrations in the Blue Earth River are higher overall than in the Minnesota River. Annual maximum nitrate concentrations in the Blue Earth River ranged from 11.4 mg/L in 2011 to 21.7 mg/L in 2013, before falling slightly to 18.2 mg/L in Spring 2015. Concentrations in the Minnesota River were lower, ranging from 7.7 mg/L (2011) to 17.5 mg/L (2015 and 2016) during that same period.

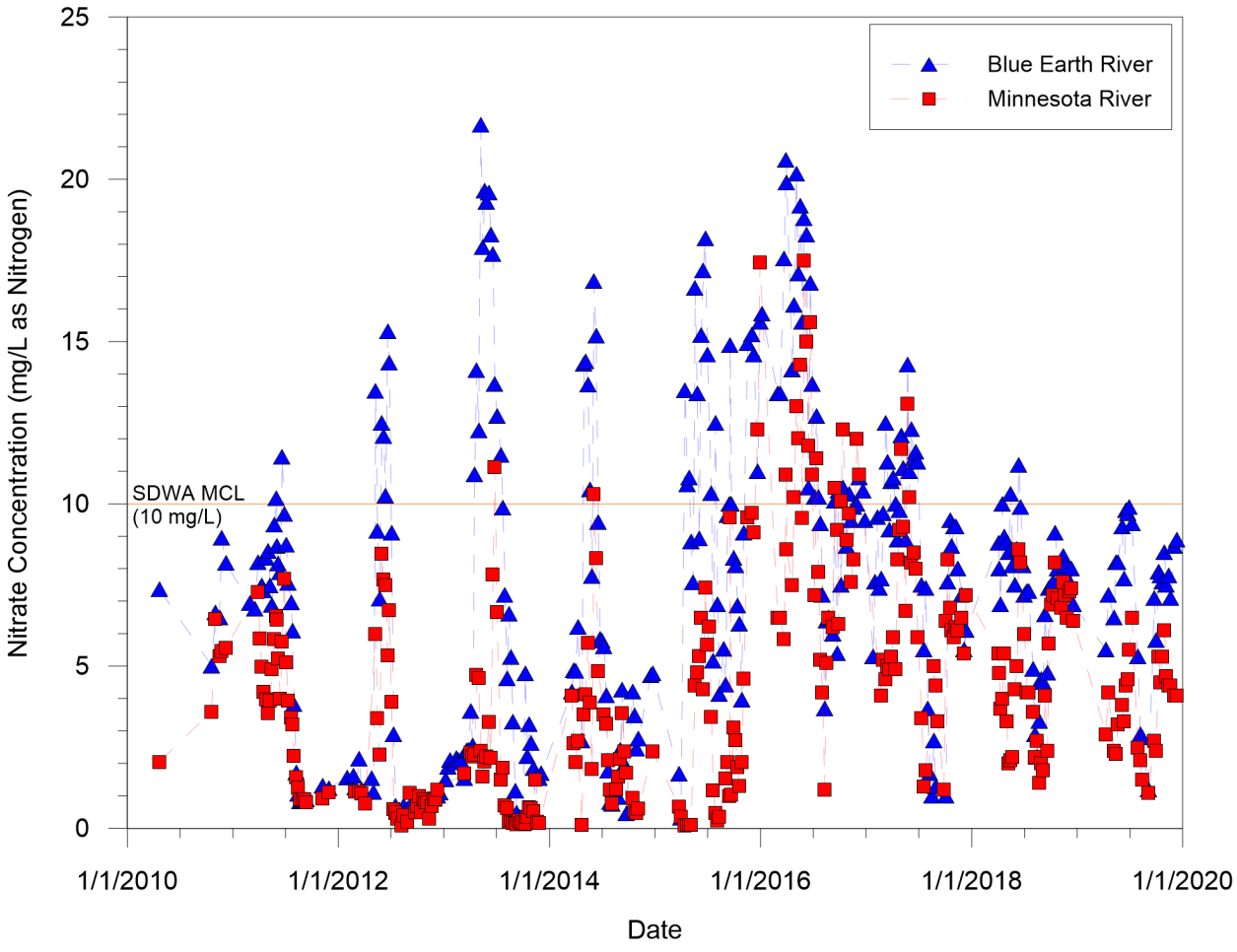

Figure 5—Nitrate concentrations measured by the city of Mankato in the Blue Earth and Minnesota Rivers from 2010 through 2019.

However, beginning in summer and fall of 2015, nitrate cycling in both rivers appeared to change abruptly. This was most likely due to a mix of climatic conditions, as Fall 2015 signaled the end of a multi-year period of drier weather in southern Minnesota, and temperatures were somewhat higher than average that fall and early winter. Rainfall during fall of 2015 and winter of 2016 was around 10 inches within most watersheds upstream from Mankato. Many fields in the Blue Earth watershed did not fully freeze during the early winter, which would have allowed rain and snowfall to flush through tile drainage and into streams. As a result, nitrate concentrations in the Blue Earth River were greater than 10 mg/L (the Safe Drinking Water Act maximum contaminant level) during most of the fall and winter of 2015, and into the spring of 2016, not dropping until tile drains dried up and photosynthesis by organisms in streams and rivers was able to take up some of the excess nitrate in the water column. Nitrate in the Minnesota River was also quite high but concentrations from that river were not consistently greater than 10 mg/L until early spring.

Nitrate trends since 2016 look somewhat different. Annual maximum nitrate concentrations still occur in the spring, with concentrations dropping during the summer, likely due to primary production in the water column. However, during the fall concentrations rebound to near spring high concentrations and remain elevated through the winter. Also evident in the data is an overall decrease in concentration since 2016, with annual maximum concentrations becoming progressively lower, year-to-year. This trend is likely due to 2016, 2018 and 2019 being three of the wettest years on record for most of the Minnesota River Valley.

Annual rainfall in the Blue Earth, Watonwan, Minnesota at Mankato, Cottonwood, and Le Sueur watersheds has increased by a rate of between 3.4 and 4 inches per decade since 2000, and rainfall in all five of these watersheds has been around 10 inches above normal (as defined by the 30-year average from 1980 to 2010) for both 2018 and 2019. These last few wet years have increased flow discharges. Analysis of USGS field-measured streamflow from those same watersheds also suggest that discharge has been higher year-round from 2017 onward than in previous years, on average. This likely means that nitrate is being diluted in the city's grab sample data since 2016.

Nitrate concentration trends in data from samples collected from the Mankato Ranney wells are muted in comparison to river levels, although well concentrations have exceeded the SDWA MCL in the recent past. SDWA compliance data, as well as periodic source samples from both Ranney wells, are shown in Figures 6 and 7. Well #13, which is the Ranney well that is closest to the Blue Earth River, had nitrate concentrations at or above the MCL of 10 mg/L during two periods (Figure 6). The first occurred during June of 2013, when raw water concentrations exceeded 12 mg/L, while nitrate in the Blue Earth River was between 10.9 and 21.7 mg/L. The second period coincided with the 2015-2016 high nitrate period. Well water nitrate was measured at 10 mg/L on December 2, 2015, before dropping below the MCL for most of the rest of the winter. Samples collected from April through July 2016 were found to be at or above the MCL, with the June 10 sample measuring 14 mg/L.

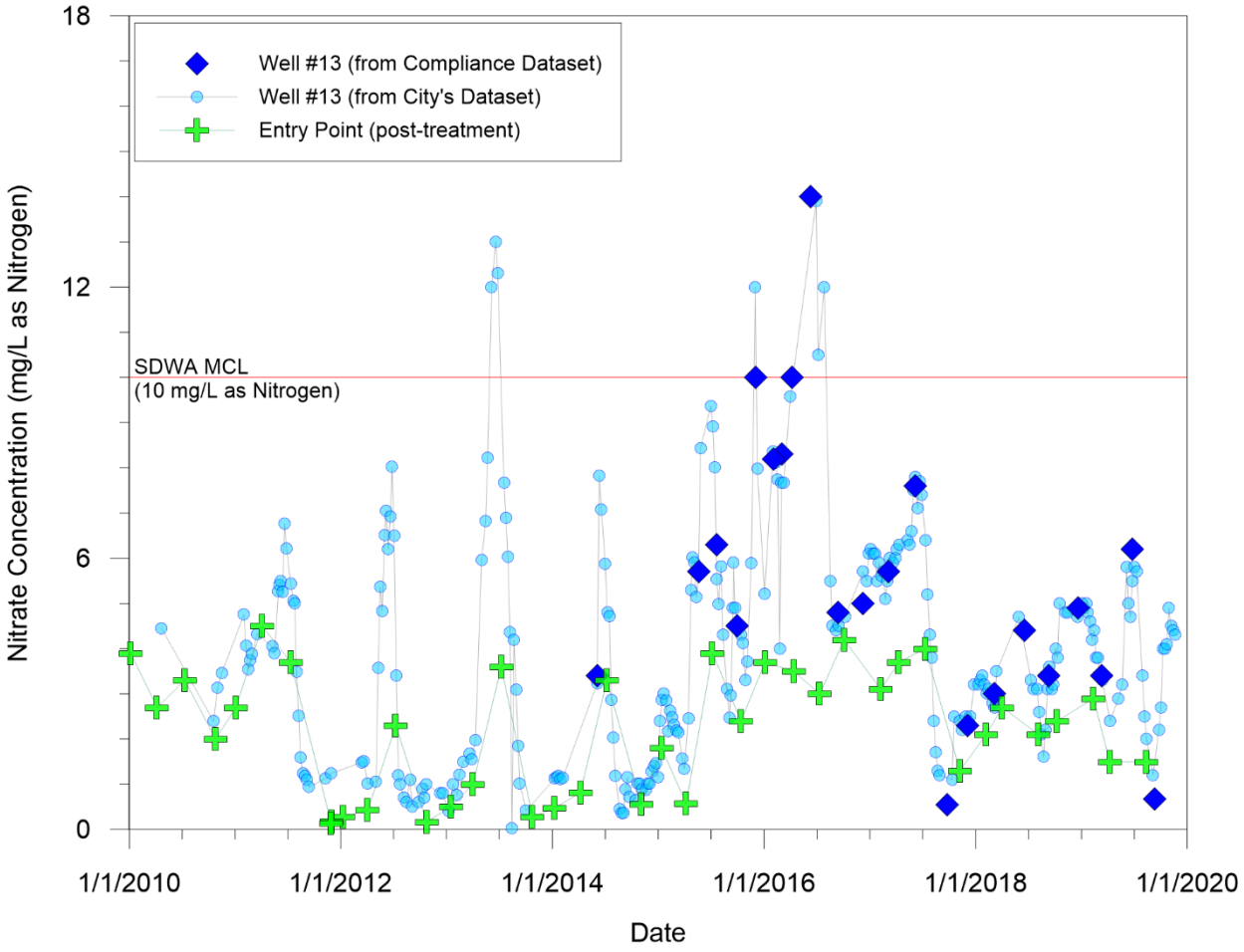

Figure 6—Nitrate concentrations from Mankato Ranney Well #13 compared with finished entry point nitrate concentrations from 2010 to present.

Nitrate concentration in Well #13 has remained below the MCL since, with a maximum concentration of 7.6 mg/L being observed in June of 2017. Post-treatment, or entry point, concentrations of nitrate have been kept below the MCL through blending. The city of Mankato is able to blend water from their shallow wells with nitrate-free well water from deeper aquifers to achieve high quality, low nitrate finished water. As a result, while Well #13 was pumping high nitrate water in 2015-2016, finished water did not exceed 5 mg/L.

In contrast, nitrate data for Ranney Well #15 has only exceeded the MCL once for a short period in 2016, although the data show similar trends overall to that of Well #13 (Figure 7). Data seem to indicate a decreasing trend in nitrate overall since 2015-2016. It is unknown what impact changes in pumping by the city may have had on concentrations in either Ranney well.

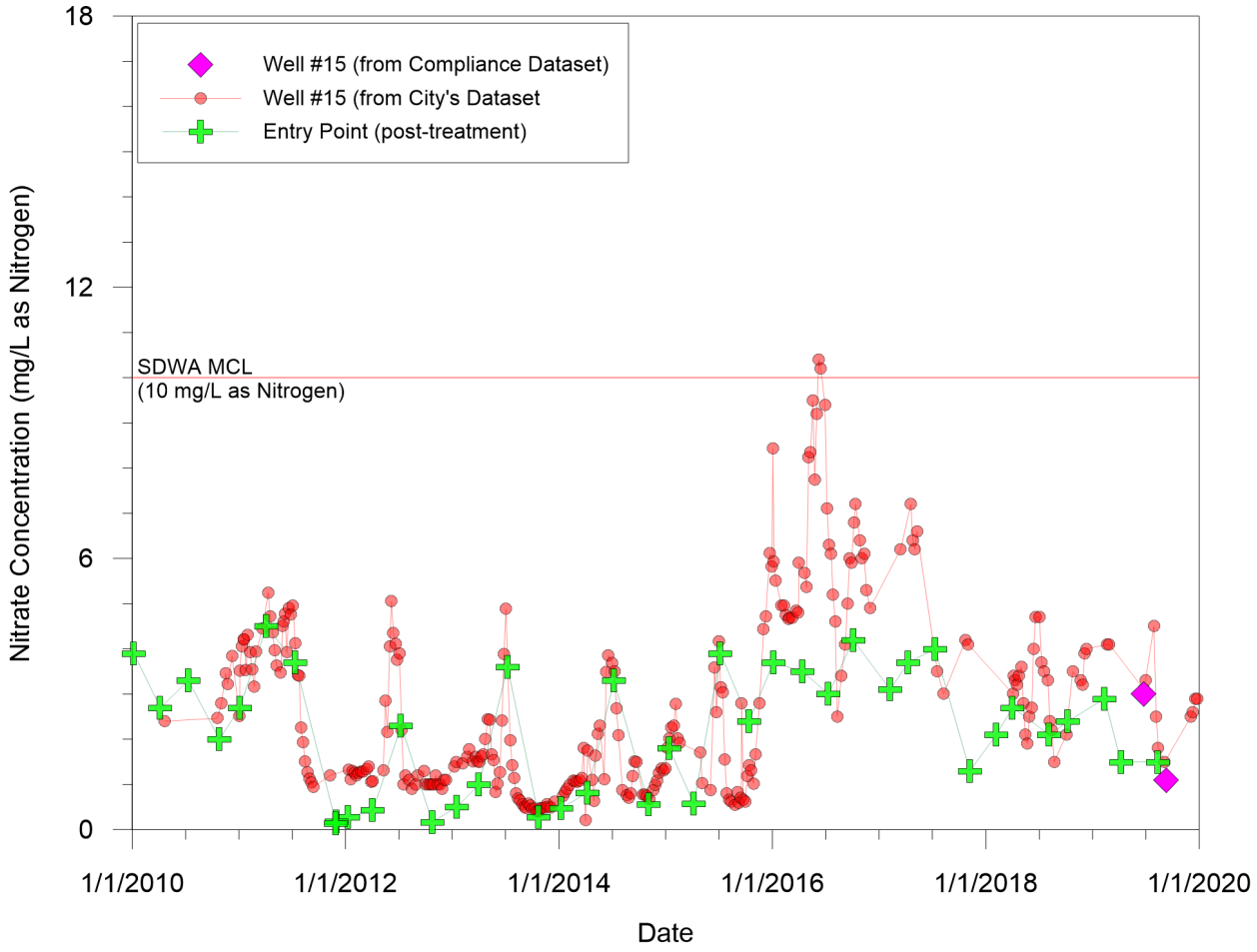

Figure 7—Nitrate concentrations from Mankato Ranney Well #15 compared with finished entry point nitrate concentrations from 2010 to present.

Pesticides

A large number of herbicides and pesticides—50 of 165 chemicals sampled for in all of the HUC12 watersheds within the DWSMA-SW—have been detected in some of the tributaries and main rivers flowing into the Minnesota and Blue Earth Rivers (MPCA, 2020). However, only atrazine and metolachlor were detected in the Mankato entry point data during the pesticide sampling conducted on August 12, 2019.

Chlorpyrifos is a pesticide that has been found in several MPCA-assessed stream reaches within the SWAA (Table 5). These assessment results have led to aquatic life impairments for those reaches and led MDA to conduct a special registration review of its use in Minnesota (MDA, 2020). Because of its toxicity to aquatic organisms, MPCA considers a waterbody impaired for chlorpyrifos at 0.083 ppb, which is a lower standard than the current human health-protective MDH guidance values of 0.6 ppb for chlorpyrifos and 0.4 ppb for chlorpyrifos oxon, a degradate. Note that while chlorpyrifos has been found in tributaries upstream from Mankato, no detections have as yet been found in Mankato's drinking water or in reaches that are within Mankato's ERA or SMA. This may be due to how chlorpyrifos is applied to fields—frequently it is

applied via aerial sprayers, so spray drift, volatilization from leaf surfaces, and transport of chlorpyrifos-laden sediment into streams are possible transport mechanisms to nearby waterbodies (MDA, 2020). To date detections in streams have been ephemeral, as chlorpyrifos has low solubility in water but sorbs readily to soils and sediments. Also, none of the detections found in the state of Minnesota to date have exceeded the MDH health based guidance value. Two of the impaired reaches listed below are within the DWSMA but are not within the SMA or ERA.

Table 5 – Reaches Within the SWAA with Chlorpyrifos Impairment

Lake or Stream Name	Reach Description	AUID	Use Classes
Chetomba Creek	T116 R37W S7, east line to Unnamed ditch	07020004-577	2Bg, 3C
Dry Weather Creek	80th Ave NW to Chippewa River	07020005-726	2Bg, 3C
Dutch Creek	94.507 43.626 to T102 R31W S24, north line	07020009-635	2Bg, 3C
Lac qui Parle River	W Br Lac qui Parle R to Tenmile Creek	07020003-501	2Bg, 3C
Sleepy Eye Creek	T109 R33W S5, west line to Cottonwood River	07020008-599	2Bg, 3C
Threemile Creek	T113 R41W S34, west line to T112 R41W S12, east line	07020006-565	2Bg, 3C
Unnamed Creek (Little Beauford Ditch)	Headwaters to Victory Dr (MN22)	07020011-642	2Bg, 3C
Unnamed Creek (Little Beauford Ditch)	Victory Dr (MN22) to Cobb River	07020011-643	2Bg, 3C
Yellow Medicine River	Spring Creek to Minnesota River	07020004-502	2Bg, 3C
Double Lake (North Portion)	--	17-0056-01	2B, 3C

Potential Contaminant Source Inventory

MDH and the city of Mankato conducted a Potential Contaminant Source Inventory (PCSI) to evaluate the different types of contaminants found in the watershed that may threaten the quality of the city's surface-derived source water. This list is not to be confused with the PCSI assembled to inform implementation of the city's Wellhead Protection Plan (SEH, 2014), which addresses potential contaminant sources that could impact the city's deep groundwater wells. The identified potential sources listed in this document can have a direct or indirect threat to public health and the drinking water quality for Ranney Wells 13 and 15. The PCSI is organized by threats and potential risks closest to the intakes (i.e the ERA), and potential contaminants along contributing water bodies (i.e. the SMA). The PCSI is not considered useful for quantifying threats within the DWSMA-SW, as non-point source issues are considered to be the greater threat at larger scales. Non-point source contamination is covered in some detail in the Land Use section below. The data in the tables was collected from various state and local databases and discussed in detail with the city.

An interactive map was created for the PCSI and a Keyhole Markup Language (KML) file version of the map will be provided to the city of Mankato for spatial reference. MDH can provide an archived map and its attributes for these locations to other partners on request.

The following source summaries document the different types of contaminant sources within the ERA and SMA. Contaminant sources were evaluated as being a point or non-point source of contamination. As defined in MDH guidance (MDH, 2021), point sources have been inventoried as being discharges or regulated activities that occur at discrete locations on the land surface. Additionally, certain types of contaminants are indicated as being high priority due to the fact that they can have a significant impact on surface water quality due to the nature of the contaminant and that source's proximity to surface water upstream from the Ranney wells. In contrast, contaminant point sources in the DWSMA-SW are considered to be of lesser threat, due to their increased distance from the surface water that is directly contributing to the Ranney wells. Each identified contaminant source went through a detailed analysis; MDH can provide the criteria for these analyses on request.

Emergency Response Area

Point Sources

The following summary documents the point sources identified in the ERA:

Point Sources in the ERA	
Aboveground Tanks:	3 facilities (high priority)
Feedlots:	5 (high priority)
City of Mankato Stormwater Outlets	8 (high priority)
Industrial Stormwater:	5 (high priority)
Wastewater, Industrial NPDES/SDS Permit:	5 (high priority)
Wastewater, Municipal Collection System:	2 (high priority)
Underground Pipeline:	4 (high priority)
Hazardous Waste Generator:	2
Construction Stormwater Permit:	5
Underground Tanks:	2

There are three aboveground tank sites in the ERA. Magellan Pipeline Co., LP has on-site storage of seven gasoline tanks and 20 oil tanks approximately two miles upstream from Well #15. CHS Mankato, located 0.5 miles upstream from Well #13, has 70 tanks that have the capacity for holding 9,833,432 gallons of soybean oil. In addition, there are nine other tanks on-site that contain various other hazardous liquids, such as: hydrogen peroxide, petroleum, sodium hydroxide, and sulfuric acid. Those tanks can hold up to 547,789 gallons of liquid. The CHS Transportation Facility has one 500 gallon capacity tank containing used oil.

There are five feedlots in the ERA. The Michael Powers and the Timothy Braun Farms along the Minnesota River and the Dorothy Paulson, Scott B. Crooker, and Stanley Edwards Farms along Minneopa Creek are all within a quarter-mile of their respective streams. Contaminants

associated with feedlots include soil runoff, bacteria, fertilizer, etc. Proper feedlot and manure management is crucial to operating a compliant feedlot and minimizing water quality impacts.

Stormwater outlets can be a quick avenue for contaminants to be carried to a waterbody. The city of Mankato has jurisdiction over eight stormwater outfalls that are upstream from the Ranney wells. These outlets range in distance from about 925 to 5,500 feet away from the city's Ranney wells. Additionally, there are five industrial stormwater permits that are open and active. Associated Finishing Inc., CHS Mankato, Big Gain Inc., CHS Transportation Facility, and Superior Concrete Block Co. are all within the ERA.

There are five industrial wastewater permits within the ERA. The permits set limits on discharges from Associated Finishing Inc., Magellan Pipeline Co. LP – Mankato, CHS Mankato, Forrey Sand & Gravel Pit, and Hillcrest Rehabilitation Center. In addition, the Mankato and North Mankato Collection Systems are under municipal wastewater collection permits that operate within the ERA.

There are five construction stormwater permits that are considered open and active, including the Minnesota River bank stabilization project permit for the Land of Memories Park. This project was done to stabilize the river bank immediately adjacent to Well #15, which had been eroding during high-water periods and had the potential to render Well #15 unsafe and inoperative had the erosion been allowed to continue. Generally, runoff from these types of sites can contaminate the city's source water if not handled appropriately. A simple on-site visit to these locations can determine if the construction areas are a potential contamination source. Permits that are for completed projects can be closed by the MPCA if they receive written notification from the permit owner.

There are four underground pipelines that cross under the Le Sueur River and one that crosses underneath the Blue Earth River in the ERA. Mid-American Pipeline Company and Williams Brothers Pipeline Company own and operate these pipelines. Three of these four pipelines contain some unspecified type of petrochemical liquid, while the fourth conveys natural gas. Approximately five miles south of Mankato both pipelines travel underneath the Le Sueur River within a half mile stretch.

Associated Finishing Inc. and CHS Mankato are both small-quantity hazardous waste generators in the ERA. Both firms generate between 220 and 2,200 pounds of hazardous waste per month.

Underground tanks are not typically a high priority for surface water systems, but three underground tank sites were added due to their proximity to the Ranney wells. Le Hilllier Quick Mart operates five tanks that contain gasoline and diesel. CHS Mankato has two tanks onsite that contain an unknown chemical. These sites are of concern due to their proximity to the Ranney wells, however the likely combination of relatively slow groundwater travel times and chemical attenuation of gasoline products in the subsurface, along with dilution and volitilization that would be expected on mixing with the river water, makes these tanks a relatively low level threat to drinking water in Mankato.

Non-Point Sources

The following summarizes the non-point sources identified in the ERA:

Non-Point Sources in the ERA	
Road Near or Bridge Over Surface Water:	31 (high priority)
Hazardous Waste, Small quantity generator:	3 (high priority)
Railroads:	15 (high priority)
Trailer-Launch Boat Landings:	3 (high priority)
Superfund Site:	1
Open Green Spaces (Baseball Fields, Parks, Cemeteries, etc.):	4

Inside the ERA, there are 13 bridges that cross over waterways and 18 roads that come near waterways. In addition, there are 15 railroads that travel over or near waterways. These major rail and transportation corridors are a high priority for protection as they can easily contaminate the source water in the event of a leak or spill. Emergency response plans for incidents that can occur in these corridors are important for addressing these contaminant sources.

Associated Finishing Inc., Magellan Pipeline Co. LP, and CHS Mankato are three small quantity hazardous waste generators that can each produce up to between 220 and 2,200 pounds of hazardous waste per month.

There are six boat landings inside the ERA, three of which are trailer landings wherein gasoline-powered boats can be launched. Of these trailer landings, two are on the Minnesota River at Land of Memories Park and Judson, and one is on the Blue Earth River at the County Road 90 bridge crossing. The Land of Memories Park access is the closest—within one-quarter mile of both Ranney wells—and could be a contamination threat during high water. However during low flow conditions the access could be considered downstream from both wells. Because these accesses are used by gasoline powered boats and could quickly carry contaminants to waterbodies, these three landings should be considered a high priority. The three other boat landings are carry-in canoe landings, and due to the lack of gasoline-powered boat access, should be considered low priority and do not need further discussion in this document.

The Lehillier Mankato Site is a designated State and Federal Superfund site. It is still in the active cleanup phase, and is currently considered to have a minimal potential for contaminating the city's drinking water. This has been an ongoing project since 1980, but appears to be in the final stages of cleanup and reporting.

Large green spaces such as parks, golf courses, and outdoor recreational sports spaces can be a sources of nutrient and pesticide runoff and contamination, depending on how they are managed. Woodland Hills Funeral Cemetery, Minneopa Cemetery, Sibley Park, Land of Memories Park, Minneopa Park, West Mankato Park, and Red Jacket Valley Park all have large green spaces that could be sources of contaminant runoff.

Spill Management Area

Point Sources

The following summary documents the point sources identified in the SMA:

Point Sources in the SMA	
Aboveground Tank:	3 (high priority)
Feedlots:	5 (high priority)
Wastewater, Municipal NPDES/SDS Permit:	3 (high priority)
Underground Pipeline:	2 (high priority)
Construction Stormwater Permit:	8
Industrial Stormwater:	2
Underground Tank:	2

There are three aboveground tank sites in the SMA, located at the Collis C-Store & Bakery LLC, the Farmers Coop of Hanska – Burdick Location, and Southside Auto Salvage. The Collis C-Store & Bakery LLC has a gasoline tank that can hold up to 1,000 gallons, while the Farmers Coop has a diesel tank that can hold up to 2,000 gallons. Southside Auto Salvage has four used oil tanks with up to 2,265 gallons of storage capacity.

The five feedlots in the SMA are a source water protection priority because of their proximity to surface water, similar to the reasons outlined in the preceding discussion about the ERA.

There are three municipal wastewater permits within the SMA. The permits set limits on discharges from New Ulm Wastewater, Good Thunder Wastewater, and Lake Crystal treatment facilities.

The eight construction stormwater permits are considered open and active. The runoff from these sites can contaminate the city's source water if not handled appropriately. A simple on-site visit to these locations can determine if they are a potential contamination source. Two industrial stormwater permits are also within the SMA.

There are two underground pipeline crossings under the Blue Earth River and Le Sueur River at two locations. These are owned and operated by Mid-American Pipeline Company and Williams Brothers Pipeline Company.

Kevin's Market and Collis C-Store & Bakery LLC. contain underground tanks that contain gasoline and/or diesel. If a leak were to occur underground they would have some potential to contaminate nearby surface water. However the likely combination of relatively slow groundwater travel times and chemical attenuation of gasoline products in the subsurface, along with dilution and volitilization that would be expected on mixing with the river water, makes these tanks a relatively low level threat to drinking water in Mankato.

Non-Point Sources

The following summarizes the non-point sources identified in the SMA:

Non-Point Sources in the SMA	
Railroads:	11 (high priority)
Roads/Bridges Over Surface Water:	93 (high priority)
Trailer Launch Boat Landings:	5 (high priority)
Open Green Spaces (Golf Courses, Baseball Fields, Parks, etc.):	7

There are 15 total boat landings in the SMA, with five trailer launch boat landings that are on the Minnesota and Watonwan Rivers and Minneopa Creek. These five trailer launches can pose a threat to surface water, as flow from runoff or spills nearby could be funneled into these boat landings and then into the waterbodies. The other ten landings are canoe launches, and as mentioned above are considered to be low priority contaminant sources.

There are 93 roads or bridges that cross over a river or lake in the SMA, of these 44 are bridges. The remaining 49 roads are near a waterbody, which can also effect the source water. However, the time of travel and dilution factors are much higher on roads outside of the ERA. In addition, there are 11 railroad segments that are in close proximity to or cross the Minnesota River, Cottonwood River, and Morgan Creek.

As mentioned above, large green spaces can be a source of nutrient runoff and contamination. The New Ulm Country Club is located north of the Cottonwood River. Two cemeteries—Zion and Lake Crystal Cemeteries—are within the SMA. Flandrau State Park, Riverside Park, Minnecon Park, and Junior Pioneer Park are also open spaces that could be sources of nutrient runoff.

Drinking Water Supply Management Area – Surface Water

Point source contaminants are not considered for management within the DWSMA-SW by definition, as outlined in MDH draft guidance (2021). Non-point source management through analysis of land use, existence of drain tile, and nutrient and pesticide sourcing within the DWSMA-SW is addressed below.

Land Use

Land use and nonpoint contaminant source management plays an important role in protecting and improving drinking water quality. Managing nonpoint sources is also important for directing implementation activities in the ERA, SMA and DWSMA-SW. The following section

describes land uses found in these areas and associated impacts to surface water quality and drinking water. The area is mostly made up of three major types of land use: cultivated crops, open water, and development.

Emergency Response Area

As discussed above, the primary purpose for delineating the ERA is to highlight point source contaminants in close proximity to surface water. However, land use also features as a prominent issue that will need to be discussed in the city's Surface Water Intake Protection Plan.

The majority of the ERA is west of the city of Mankato, and includes reaches of three major rivers and one creek: Blue Earth, Le Sueur, and Minnesota Rivers, as well as Minneopa Creek. These rivers stretch a total of 32 river miles through a mix of cultivated crops, forest, and wetlands. As shown in Table 6, the ERA contains almost as much forest (24.2%) as cultivated crops (24.7%). Moving upstream on the Minnesota River and Minneopa Creek, the dominant land use changes from wetland and forest to more cultivated crops.

Spill Management Area

Land use evaluation in the SMA, like the ERA, is necessary to clearly outline how nonpoint contaminants may be introduced into the city of Mankato's drinking water.

The SMA encompasses reaches of nine major streams: Blue Earth River, Cobb River, Cottonwood River, Le Sueur River, Little Cottonwood River, Maple River, Minneopa Creek, Minnesota River, and Watonwan River. These streams in the SMA flow through 192 miles of wetlands, forest, and cultivated crops. There are two lake basins in the SMA: Crystal and Lily Lakes are both located in the Minnesota River – Mankato watershed.

The Minnesota buffer law was established in November 2017 for all public waters and November 2018 for public ditches. Buffer strips along stream reaches have been shown to help prevent direct nutrient and nonpoint run-off into those streams. The law provides flexibility to all landowners to comply with the law by using practices that are outlined in the Natural Resources Conservation Service Field Office Technical Guide. The SMA is primarily located within Brown, Blue Earth, and Nicollet counties, and all three counties are at greater than 95 percent compliance with the buffer law.

Buffered waterbodies that are fully in compliance are considered a low priority for Source Water Assessment and planning purposes. Improving compliance along public waters and ditches that are not in compliance should be considered high priority for local planning partners. Protecting waters that directly contribute to the drinking water supply should be addressed first. Implementation activities will require collaboration and communication with Brown, Blue Earth, and Nicollet counties. While vegetated buffers do not address nitrate

concentrations downstream, compliance with the buffer law can be beneficial for managing erosion and sediment issues in downstream waterbodies. With the prevalence of drain tile in the DWSMA-SW, the management of land use and fertilizer practices also needs to be addressed.

Drinking Water Supply Management Area – Surface Water

The DWSMA-SW, as delineated, covers 429,532 acres in both the Minnesota and Blue Earth River HUC8 watersheds. Over 75 percent of the land use within the DWSMA-SW is cultivated crops. The second largest land use component is development (seven percent) and is comprised of impervious surfaces such as roads, buildings, and other infrastructure.

Given the large percentage of cultivated crops, the amount of drain tile present, and the relatively low adoption of cover crops in the DWSMA-SW, this area would benefit from better fertilizer and drainage management best management practices to help reduce the overall loading effects on Mankato's source water.

The following table describes land uses within the ERA, SMA, DWSMA-SW, and compares them to the Minnesota and Blue Earth River HUC 8 watersheds in Minnesota. Proportionally, development is similar in all four areas listed. Other land uses show marked differences, however. Comparing only the DWSMA-SW to the larger Blue Earth River watershed highlights differences in wetland (6.9 versus 3.3 percent, respectively) and forested areas (6.5 and one percent, respectively). Proportionally, land areas in cultivated crops for the two areas—75.1 percent for the DWSMA-SW and 78.6 percent in the greater watershed—highlight the influences on drinking water quality that are present for the city of Mankato, as the water chemistry issues noted in the Contaminants of Concern section are all traced to agricultural practices.

Table 6 – Land Uses within Delineated Protection and Watershed Areas

Type of Area (unit size)	Emergency Response Area	Spill Management Area	Drinking Water Source Management Area – Surface Water	Source Water Assessment Area (Minnesota and Blue Earth Rivers HUC 8s in MN)
Area (acres)	9,422	15,450	429,532[3]	8,272,355[4]
Lake area in acres (# of lakes)	No Lakes	577 (4 Lakes)	2,286 (33 Lakes)	259,135 (1,523 Lakes)
Stream length[2]	32.2 miles	192.2 miles	1,009 miles	7,070 miles
Open Water (acres)	950 (10.1%)	2,150 (13.9%)	7,936 (1.8%)	260,927 (3.2%)
Development (acres)	947 (10.1%)	878 (5.7%)	29,540 (6.9%)	381,284 (4.6%)
Barren Land (acres)	301 (3.2%)	55 (< 1%)	1,775 (< 1%)	11,587 (< 1%)
Forest (acres)	2,273 (24.2%)	3,140 (20.3%)	27,712 (6.5%)	188,383 (2.3%)
Shrub land (acres)	7 (< 1%)	2 (< 1%)	13 (< 1%)	1,141 (< 1%)
Herbaceuous (acres)	244 (2.6%)	647 (4.2%)	3,365 (< 1%)	95,282 (1.2%)

Type of Area (unit size)	Emergency Response Area	Spill Management Area	Drinking Water Source Management Area – Surface Water	Source Water Assessment Area (Minnesota and Blue Earth Rivers HUC 8s in MN)
Hay/Pasture (acres)	532 (5.7%)	849 (5.5%)	7,715 (1.8%)	325,614 (3.9%)
Cultivated Crops (acres)	2,328 (24.7%)	2,594 (16.8%)	322,696 (75.1%)	6,504,560 (78.6%)
Wetlands (acres)	1,827 (19.4%)	5,128 (33.2%)	28,771 (6.7%)	503,579 (6.1%)

[1]Stream were determined by historical photo analysis showing perennial flow, combined with status as Public Waters (from DNR buffer dataset), and NHD perennial flow status
[2]Streams are based on MPCA assessed stream dataset interpretation of the National Hydrography Dataset (NHD) flowlines
[3]Area is a combined acreage of the ERA, SMA, and DWSMA-SW
[4]Area is a combined acreage of the ERA, SMA, DWSMA-SW, and all upstream watersheds of the Minnesota and Blue Earth Rivers in Minnesota

Summary of High-Priority Issues

The issues below are the highest priority for action within the delineated Source Water Assessment areas for the city of Mankato.

Source Water Issues: The city's Ranney wells have been impacted by nitrate contamination due to nutrient loading within the Source Water Assessment Area, forcing the city to blend with less sustainable deep groundwater sources. Nitrate has been a recurring issue, particularly for Well #13, with concentrations trending upwards since the early 2000s due to agricultural practices in the watershed. The highest nitrate concentrations observed tended to be in the late spring to early summer and in late fall, presumably due to flushing of residual soil nitrogen and fall-applied manure to surface water from tile drains. Herbicides and pesticides have been observed in treated water samples in the past, and these chemicals have been found in surface water samples collected by MPCA as well (MPCA, 2020).

Emergency Response Area Potential Contaminant Sources: The city should address the management of and emergency plans for spills to mitigate any contamination events. The main concerns are the Magellan Pipeline Co. LP and CHS Mankato facilities. Each of these facilities have many above ground tanks that contain different types of liquids that have the potential to contaminate the source water.

Stormwater permitted facilities in the ERA, whether they are for industrial or construction purposes, can quickly convey contaminants to streams, potentially increasing or magnifying impacts to drinking water. The five industrial outlets within the ERA are of concern. The five construction stormwater permits open in the ERA should be inspected and potentially closed if those construction projects have been completed.

There are boat landings, bridge crossings, and railroads that are inside of the ERA. These locations can quickly contaminate the source water during spills. These sites should be a focus in an emergency spill management plan. In addition, stream bank erosion is a major issue that

could have a catastrophic affect on the Ranney wells. The locations of the wells and extreme runoff have contributed to an increase in bank erosion events within the past few years. Recent reconstruction of the streambank immediately adjacent to Ranney Well #15 has stabilized the erosion issue for now, but future reconstruction may prove necessary and should be monitored on a continual basis.

Spill Management Area Potential Contaminant Sources: The primary concerns in the SMA are railroads, bridges, and boat landings, and stream bank erosion. These sources, along with feedlots, above ground tank, and wastewater discharge inside the SMA, have the potential to contaminate the source water.

Drinking Water Supply Management Area – Surface Water Land Use Issues: The DWSMA-SW is heavily dominated by agriculture. Fertilizer and drainage management, as well as agricultural best management practices, are crucial for maintaining and improving the long-term health of the watershed, which will in turn improve source water quality. Managing fertilizer, stream bank erosion, and runoff issues should help mitigate harmful algal bloom risks, as well.

Recommended Actions

The SWA is a tool for the PWS and local partners. These groups should consider implementing the activities below to protect the source water and its surrounding watershed. The activities should also be included in the city of Mankato's Surface Water Intake Protection Plan, when it is developed.

Monitoring Source Water

Continued monitoring of source water quality is needed to determine the best approaches for addressing the water quality concerns in the watershed, especially with regard to nutrient loading and run-off. Reaches within the ERA and SMA should be the main focus for implementation of measures that address point source contamination. As was mentioned in the "Contaminants of Concern" section, a number of reaches in the DWSMA are impaired for aquatic recreation, aquatic life, and drinking water uses.

A dye-trace study, coupled with watershed flow modeling of the Minnesota and Blue Earth River watersheds, would help refine the delineation of the SWA areas identified in this document. And studies aimed at assessing the transit time for river water moving through river bed sediments to the Ranney wells could help inform their risk from contamination episodes that could occur on the rivers. Two main topics should be explored by MDH and the city:

- The length of time it takes for river water to move through the river bottom sediments to the Ranney wells. This could be accomplished via the use of data-logging probes in the wells and the rivers immediately adjacent to the wells. Trends in temperature, conductivity, nitrate, chloride, water stable isotopes or some combination of all the of above observed in both the river and well water could be useful for determining this length of time.

- The times of travel of water through all major streams in the watershed, with particular attention paid to those streams that lack stream gaging. The larger contributing streams that lack flow gage data should be the main focus of the study, particularly Minneopa Creek and the Cobb and Maple Rivers, although all of the larger gaged streams should also be studied to better differentiate flow velocities during different stream stages (for instance during low flow and flood stages). Also important to study would be the impact that damming of the Blue Earth River at Rapidan has on travel time during all stages.

Creating a valid model requires large amounts of flow data. Once established, a model can be used to refine the delineated areas and determine potential impacts from contaminant sources throughout the watershed. A model could also help to better outline nutrient, pesticide, and sediment erosion budgeting in the watershed. Once this work has been completed, a list of approximate times of travel given high, low, or moderate flows on the rivers should be generated for emergency response activities.

Existing nitrate monitoring conducted by the city at points along the Minnesota and Blue Earth Rivers, and raw water from both Ranney wells, should also continue. Trend tracking at all points will be important for future SWA amendments and will be excellent tools for monitoring watershed health into the future.

Emergency Preparedness

Emergency spill prevention and response preparedness is a vital aspect of protecting the source water. The PWS emergency plan is necessary and should continue to be updated annually to include the SWA and coordinated with MPCA Emergency Response unit, first responders, city planners, and local government staff. Efforts should be made to work with Blue Earth, Brown and Nicollet counties, as well as local businesses, railroads, and pipelines to coordinate spill prevention and emergency response.

Potential Contaminant Source Management

Point and non-point source nitrate contamination is a high priority for protecting source waters and public health. The point source locations of highest concern are listed in the Potential Contaminant Source Inventory (PCSI) section. Each one of the PCSI points is associated with an agency (MPCA, MDA, etc.), local authority, or contaminant source owner. These entities should work together to set up an approach to mitigate the contaminant issue.

Contaminant Conveyance and Potential Release Management

Stormwater in the ERA is a major concern for the public water supplier. The runoff that is closest to the city's Ranney wells are of greatest concern. Understanding the directional flow and contributing surfaces to the stormwater system is key to understanding how to mitigate any potential contamination.

Non-Point Source Pollution and Land Management

Non-point source nitrate is the contaminant of greatest concern for the Mankato Ranney wells. The MDA has designated some portions of the city's DWSMA-SW to be subject to the Nitrogen Fertilizer rule (Minnesota Statutes, chapter 1573) due to underlying groundwater vulnerability. This designation means that fall fertilizer applications are restricted in those areas. While this rule does not apply directly to the Mankato surface water DWSMA, some reduction in nitrate may occur as a result of rule activities in these smaller sections of the DWSMA-SW. The Fall Nitrogen Fertilizer Application Restrictions online map tool (https://mnag.maps.arcgis.com/apps/webappviewer/index.html?id=47a342afe6654640b935c8e76023da92) shows these areas. Nitrate should continue to be addressed in cooperation with the MPCA, MDA, watershed authorities, local government units, local producers, and agronomists. Education of these groups about drain tile and nutrient runoff should be key components of the plan.

Pesticides are of concern due to their potentially harmful public health effects. Educating residents and farmers on manure management and pesticide occurrence should also be considered.

Alternative Water Supply Exploration

Alternative and emergency water sources are an important factor in source water protection planning. Expansion of alternative groundwater sources has been discussed and studied. Discussions have been ongoing with the DNR concerning amendments to the city's surface water appropriations permit, and potential backup sources are more likely to include deeper wells that can be used when contaminant levels in the Ranney wells need to be blended to acceptable levels.

The "System Characteristics" summary above states that the city of Mankato has storage capacity for about two days of water supply. The existing set of deep aquifer wells are not able to provide a full-volume back-up for the Ranney wells, should they be non-functional for an extended length of time. Exploring and possibly establishing additional back-up capacity should be considered to ensure that Mankato's water supply is more resilient during times of Ranney well water quality and quantity shortcomings.

Education and Greater Watershed Planning

MDH can assist the city in educating local watershed partners, conservation groups, and the general public on how watershed health affects drinking water quality in the watersheds that contribute to Mankato's source water. Participation by the city in One Watershed One Plan planning activities for the Watonwan, Le Sueur, Blue Earth, and Minnesota River watersheds should be considered. MDH is already representing drinking water concerns for local and state watershed planning groups through Groundwater Restoration and Protection Strategies (GRAPS) and One Watershed One Plan, but continued participation by the city of Mankato at the local level is crucial for making lasting change in water quality at a local or regional scale.

Source Water Protection Planning

MDH can assist the city in developing a Surface Water Intake Protection Plan (SWIPP) that will lay out strategies for protecting and improving source water quality. The city of Mankato can receive assistance from MDH surface water planner and hydrologist to complete the planning document. Upon completion of the SWIPP, the city of Mankato may be eligible for MDH plan implementation grants to fund documented plan activities. The SWIPP will also guide the PWS and local planning partners by documenting other potential complementary watershed-level activities to protect drinking water on a larger scale than can be accomplished by the PWS alone. The DWSMA-SW stretches into Brown County, Nicollet County, and Blue Earth County. All contribute to the source water for the city of Mankato. All three of the these counties have local water management plans, but Blue Earth County is the only one that recognizes surface water sources that contribute to Mankato. Additionally, the implementation strategies developed in the SWIPP can be used to inform drinking water-focused activities in the various One Watershed One Plan areas within the DWSMA when they are written.

The SWA is designed to be a guidance for planning purposes for the next 10 years. After the 10 years have elapsed MDH will reassess the SWA, which can then inform future amendments to future plan amendments.

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