A Water (Supply) Planning Atlas for the Twin Cities Metropolitan Area

Regional and subregional information for sustainable water planning

John Clark & Henry McCarthy: Water Supply Planning

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Background & Motivation

What is a water atlas?

• A compendium of water data and information
• A visual and narrative way to communicate technical and geographic information

Purpose: outreach and engagement

• Develop a tool to:
  • Promote a shared understanding of water and water supply planning
  • Better understand regional and subregional challenges
  • Aid communications with new audiences
Audiences

Anyone interested in learning about water and water supplies

Municipal / public water suppliers

- Engage communities around their local perspectives of water challenges to provide relevant content and inform the development of the next regional plan

Others

- Neighborhood groups, educators & students, advocacy groups..
How can the atlas be used?

By communities and other stakeholders:

• Communicate with residents about water issues and services
• Build support (value) for water and water services
• Engage with neighboring communities around water supply planning challenges
• Educate students and others about water and water planning

By the Council:

• Engage communities around their local perspectives of water supply challenges
• Develop sound data and information to inform regional plan development
• Engage internal audiences to better connect water supply planning to other Council planning efforts
• Reach out to new and non-technical audiences
Challenges

Water supply data is varied and comes from many sources

- Collate data from cities, regulators, watersheds, academia, agencies, Met Council, and others.

How do we describe challenges that cross 186 political boundaries?

- Water resource and supply system sustainability can’t be fully addressed within single political units.

Water supply information can be complex and highly technical

- We need to be able to communicate with folks who don’t do this everyday if we want people to value water and water services and engage in water supply challenges.
Design

- Inspired by large library atlases
- Combines maps, graphics, charts, and other figures.
- Can be updated as new data and information becomes available
- Currently in PDF format but aim is to have a more interactive online format in the future
- Pages are 11” x 17”
Draft Atlas Contents

Regional Setting
- Regional background
- Regulatory roles & regional planning
- Water planning & governance
- Land use, development, & growth
- Water resources
- Water challenges overview
- Water use
- Water demand
- Water efficiency
- Climate & weather
- Source water protection & contamination
- Resource connections & interactions
- Water values & equity

7 Subregional Settings
- Subregion background
- Land use & development
- Water resources
- Water supply systems & treatment
- Water use
- Growth & demand
- Water efficiency
- Climate & weather
- Source water protection & contamination
- Resource connections & interactions
Water Supply Planning Subregions

Criteria:

- Started with existing subregional working groups
- Inclusive of the entire metro
- Looked at broad geologic and hydrologic characteristics
- Shared water source and supply challenges

Note: Some communities are in multiple subregions. This is traditional for some communities, and we want to be flexible.
Water Supply in the Twin Cities Metropolitan Region

The Twin Cities Metropolitan Planning Region (Metro) consists of the seven counties that surround Minnesota's two largest cities of Minneapolis and St. Paul. About 90% of the metro's population lives, works, recreates, and relies on the water resources in the metro. Drinking water is supplied by a combination of over 100 public water suppliers, shared community systems, and private wells.

Public water supply systems are mostly operated by individual communities, although in some areas water pumped and treated by one community may be sold or delivered to another. For example, the cities of Minneapolis and St. Paul provide water to some neighboring communities. Residents and businesses not served by municipal or public water supplies rely on private wells for their drinking water. Farms, industries, even recreational lands like parks and golf courses rely on the same water sources that provide drinking water. Private wells and those operated by commercial interests are the responsibility of the individual owner or business.

Growing Population

The region’s populations continue to grow as more people choose to live, work, and play in the area. By 2040 the population of the region is expected to increase to 3.7 million people. More people and development means more water is needed. To meet current and future water demands, we must understand the challenges of the past and the present, think holistically and innovatively in our water supply systems. We lower risk by planning and preparing for future stresses that will be placed on drinking water resources and on our water supply systems.

The seven-county region consists of many different communities, from farming-based townships to densely developed urban areas. Recognizing that one size does not fit all, the Council uses community designations to group communities with similar characteristics in order to plan more sustainably. Preparing for future growth and development requires considering the water resources, water systems, and water service providers in order to ensure the needs of communities, businesses, and residents will be met and that resources will be available for future generations.

The Council uses these community designations to:

- Guide regional growth and development to areas that have urban infrastructure in place and the capacity to accommodate development and redevelopment.
- Establish land use expectations, including overall densities and development patterns, for different community designations.
- Outline the respective roles of the Council and the individual communities and strategies for planning for forecasted growth.
- Understand how the resources needed to sustain growth are utilized and imported locally and regionally.
Water Resources

The large cities of Minneapolis and St. Paul, and communities they serve, rely on the Mississippi River for their water supply. In the case of St. Paul, that water from the river enters a series of lakes north of the city before it is treated and delivered to customers. Deep groundwater aquifers are usually used as the source for public water supplies, as well as industrial, commercial, and agricultural uses outside of the urban center.

Many communities, firms, and private residents with private drinking water wells rely on shallow sandstone sediments to provide their water supply. Public water suppliers also use these shallow groundwater resources in communities where higher-productive aquifers are more difficult to access. These near-surface sediments are the first to be impacted by contamination from the surface or during periods of drought.

Bedrock Geology

Deep groundwater aquifers are usually used as the source for public water supplies, as well as industrial, commercial, and agricultural uses outside of the urban center. Public drinking water wells are usually in shallow (Quaternary) sediments deposited when continental ice sheets retreated 18,000 years ago.

The Prairie du Chien-Jordan (PCJ) bedrock aquifers are highly productive water sources, and lower mouth of the Central, East and Southeast portions of the metro. In the Western and Southeast part of the metro, communities rely on some combination of the deeper Tunnel City and Mowrano aquifers and shallow sandy (sedimentary) aquifers. The deepest wells pull water from the Mt. Simon aquifer, whose water has been dated to be 60,000-30,000 years old.

The Prairie du Chien and Jordan bedrock aquifers are the most heavily used in the metro. Communities that have access to these aquifers don’t have to drill as deep as other communities to access productive aquifers. However, because these aquifers are closer to the surface and used by many communities these sources may be more Easily stressed during periods of high-use and when contaminants enter the ground.
Water Challenges

Public and private water supplies in the Twin Cities Metro region face a variety of challenges that can limit the availability of plentiful, clean drinking water. The challenges may be local or regional and can occur over long or short periods of time. The sustainability of drinking water resources and water infrastructure is an essential consideration as the metro region continues to grow, weather patterns shift, and economic downturns create budget constraints. While we cannot predict exactly what is to come, we are able to use our past experiences and sound technical information how to protect our water resources and use them efficiently. Water supply issues generally fall into 2 categories: Quantity and Quality. Having enough water now and in the future is essential to the health, well-being, and economic vitality of metro region.
Climate & Weather

Changes in global climate influence local weather, which impact water resources and water supply systems. While we don’t know exactly what the future will look like, we can expect changes in temperature and precipitation. We also should be prepared for greater variability in our weather patterns and extended periods of drought. A less predictable future increases the challenges of maintaining safe and reliable drinking water supplies. These challenges require resilient water resources and infrastructure.

In recent years, increased storm intensity, longer periods of drought, and winter weather conditions have been occurring more frequently. These changes are likely extending the growing season, increasing demand, and raising the risk of contamination and infrastructure damage due to flooding. In the past, long and intense drought periods have occurred leading to unmet water availability and quality.

**Precipitation Trends**

Over the past 40 years, the average annual precipitation is about 25 inches. Most precipitation runs off or is stored temporarily in surface wells or shallow groundwater. Only about 10% of precipitation is available to replenish groundwater aquifers. Groundwater replenishment has not kept up with use over the past 10 years.

Most precipitation in the metro area falls during the late spring and early summer months, with May and June accounting for about 39% of the year's total. Significant periods of drought in the 1980s, 70s, and 60s have had large impacts on water resources and politics. During periods of drought, there is greater water demand and less recharge.

**Climate Modelling: Annual Infiltration**

We can use models of future climate conditions to estimate what groundwater recharge might be like in the future. A future with more greenhouse gases and a warmer atmosphere generally results in less water being available to recharge groundwater aquifers in the future. While models are not a crystal ball that predicts the future, they do provide us a reasonable picture of what the future might look like.
Water Efficiency

Many factors influence how much water is used. Weather, home type and size, the age of infrastructure, and the number of people using water are all related to how much water is needed and used. In many homes and facilities more water is used than is necessary to meet the needs of residents and businesses. Efficient water use is the combination of strategies, practices, and equipment that limit extensive water use.

Indoor Efficiency

As buildings and infrastructure age, new technologies come online, and construction codes change, the amount of water being used by individuals and equipment can be more than is needed. Indoor efficiency increases when equipment in homes and businesses is exposed by more efficient versions and indoor water use practices change (i.e., taking shorter showers or changing a manufacturing process). As new buildings are built and older buildings are retrofitted, efficiency is gained.

Outdoor Use

About 15% of all water used in the metro is for outdoor purposes, such as irrigation. This use almost exclusively occurs during the summer months and more water is used outdoors in communities that rely on ground water for their drinking water. These areas tend to have larger 100-year than cities and newer homes that have irrigation systems installed.

In communities where efficient water use for residential homes and lawns has been promoted, more water can be conserved by helping local industries, commercial properties, and multi-unit residential facilities to use more efficient water users.

<table>
<thead>
<tr>
<th>Monthly Savings (dollars)</th>
<th>Cumulative Savings (dollars)</th>
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<tbody>
<tr>
<td>1,000</td>
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<td>3,000</td>
<td>30,000</td>
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<tr>
<td>4,000</td>
<td>40,000</td>
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<table>
<thead>
<tr>
<th>Year</th>
<th>Savings (dollars)</th>
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<tr>
<td>2012</td>
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<tr>
<td>2013</td>
<td>20,000</td>
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<tr>
<td>2014</td>
<td>30,000</td>
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<tr>
<td>2015</td>
<td>40,000</td>
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<tr>
<td>2016</td>
<td>50,000</td>
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</tbody>
</table>
Source Water Protection

Water suppliers, MPCA, and MDH work to ensure that our water resources, water supply wells, and distribution systems, and citizen health are protected. There are extensive well and drinking water testing programs and monitoring requirements that protect drinking water supplies in Minnesota.

Other areas are identified due to specific resource management concerns. Those concerns may be related to water availability or contamination concerns that need to be considered to ensure safe and reliable drinking water supplies. However, there are long-term and short-term drinking water challenges in all parts of the state.

Across much of the metro there are drinking water management areas for wells and surface water supplies. These areas are identified to help protect and manage water resources. However, many of the areas extend beyond the political boundaries of the communities they are meant to protect. This presents a management and planning challenge that requires collaboration between communities and state agencies.

Groundwater Drinking Water Supply Management Areas (DWSMAs) represent the 10-year time horizon of travel to public water supply wells. Wellhead protection planning in these areas helps to ensure that contamination at the surface does not reach public drinking water supplies.

Contamination sites are urban areas of the metro area and Upstate in triple. This map to the EF shows suburban parts of Metropolitan and northeast Minnesotas. Littered waste, investigation and cleanup, tests, and multiple program sites are concentrated in this area.

Multiple Programs | Food Wells | Investigation and Cleanup | Solid Waste | Tanks | Air Quality | Hazardous Waste | Stormwater | Water Quality

Contamination sites are also numerous in rural parts of the areas. The map to the left shows suburban parts of Waseca and Currie County. Since agriculture is the dominant land use type in the area, feedlots are by far the most common contamination site, but other contamination types are present as well.
The Western water supply planning area spans a large area of the metropolitan planning region stretching from the most western suburbs surrounding Minneapolis and the communities around Lake Minnetonka to the more rural areas of western Hennepin and Carver Counties. Density in this part of the metro generally follows growth and development patterns, with the most dense areas being older suburban areas near Minneapolis and areas farther west that have seen continued growth over the past few decades.

Water resource and supply system challenges exist in all communities and are as diverse as the areas the West Subregion spans. Small towns and rural areas face some challenges that are very different than growing suburban communities or more highly developed areas. The Mississippi and Crow River, Lake Minnetonka, Minnehaha Creek, and other streams and wetlands are important social, cultural, and economic parts of the West Metro landscape. Many of these features are connected to groundwater aquifers and supported by upwelling groundwater.
Land Use & Development

The Northwest Subregion is covered a large portion of the metro planning area with a variety of community types ranging from urban to rural. This subregion is bisected by the Mississippi River, which flows from the northwest portion of the subregion to the more urban and highly developed southeast. A mix of single family detached housing, industrial areas, parks, and commercial centers lie both sides of the river. In addition to parks along the Mississippi River, there is extensive, and fairly evenly distributed petroleum in this subregion, often surrounding large wetland and lake complexes. Many communities in this subregion are designated as suburban or ex-urban communities, meaning this is a growing subregion. Agriculture in this subregion is less densely concentrated than in other parts of the metro, and is instead interspersed with developed land and housing. As growth continues agricultural and natural areas will likely be converted into more urbanized landscapes.

Thrive MSP 2040
Community Design Guidelines

Impervious Surfaces and Runoff

An impervious surface is an area where water is unable to percolate through the ground (typically a water-resistant, artificial surface like a sidewalk). Impervious surfaces increase the volume and speed of runoff and increase groundwater recharge, which can negatively impact water resources and ecosystems. In the Northwest Subregion, most impervious surfaces are concentrated in and around urban and suburban development. As the region continues to grow and develop more land conversion to impervious surface is likely.
Water Supply Systems & Treatment

Many Southeast Metro residents receive treated groundwater from a municipal or public water supplier. Water suppliers go through many steps to ensure water quality and then treat the water to ensure their customers are able to have clean and safe drinking water. Many people also own and operate individual private wells. Those residents are responsible for their own infrastructure and any water treatment in their homes. Businesses may receive water from a water supplier or have individual permits to pump water for agricultural or other industrial purposes. To be sustainable communities and the region must consider how growth, land use changes, climate impacts, inequality, and other challenges affect water resources and supply systems.

As the Southeast Metro continues to grow, more people will begin to rely on municipal/potable water supplies for their water needs. To deliver service to more homes and businesses, communities may need new infrastructure like additional wells and new service lines. Expansion of water supply systems comes with costs and is not without financial, social, or environmental risk.

**Groundwater Treatment**

- **Intake:** Water is pumped from a surface water or groundwater source.
- **Filtration:** The water passes through a series of filters that help remove additional particles, bacteria, and more.
- **Disinfection:** Hot steam, dry heat, or chlorine are added to the water to kill any remaining bacteria, viruses, and bacteria.
- **Fluoridation:** Fluoride is added to water to promote oral health by preventing tooth decay and strengthening enamel.
- **Storage:** Water is stored in tanks to prepare it for distribution.
- **Distribution:** Clean-tasting water is delivered to homes and businesses.

**Communities Planning for New Well Infrastructure by 2040**

- Roseville
- Apple Valley
- Rosemount
- Hastings
- Farmington
Water Use

Many factors influence the amount of water pumped for municipal/public water supplies. The number of homes and businesses connected to the system, weather conditions, use behaviors, and other factors all influence water demand. By looking at historical pumping and use trends we can understand how water demand is influenced by these factors and better prepare for the future.

Water Use Trends

Many factors influence the amount of water pumped for municipal/public water supplies. The number of homes and businesses connected to the system, weather conditions, use behaviors, and other factors all influence water demand. By looking at historical pumping and use trends we can understand how water demand is influenced by these factors and better prepare for the future.

Regional Municipal/Public Pumping by Source

Across the metro, about 65% of all water consumed by municipalities and public water suppliers is groundwater. Surface water use is concentrated in the central metro.

Percent of Groundwater Pumped by Subregion

Central metropolitan pumps about 19% of all groundwater pumped by municipalities and public water suppliers across the metro region. 81% of surface water is pumped in the Central subregion although some other communities use water from sources that are treated as surface water.

Outdoor Use Percent of Subregion Pumping

Almost 66% of water pumped in the Central subregion goes to outdoor use.
Climate & Weather

Pumping Impacts on Groundwater

When wells are pumping they are using energy to pull water from underground aquifers. Whole summers and extended periods of drought can lead to increased groundwater demand and aquifer drawdown creating larger cones of depression. Excessive groundwater pumping can lead to well conflicts, where one well is pumping so much that it’s cone of depression impacts neighboring wells. If new wells need to be dug deeper to access water this increases costs to communities and private well owners, making our water resources less resilient and increasing energy use.

Initial Water Table Position

Extreme Weather and Changing Climate

Climate and weather are always changing but over recent decades the impacts of ever-increasing greenhouse gases have been felt locally. Across the state we are seeing less extreme cold and a warming of winter nights. Winters are becoming shorter, extending the growing season. More precipitation is falling in the form of rain, but it’s happening more during intense storms and there seems to be more variability in precipitation predictability with weather.

These changes create challenges for water resources and drinking water suppliers. Less predictable weather means demand is less predictable. Increases in storm intensity and frequency means a greater chance of flooding, stormwater issues, and increases the opportunity for wells to be overwhelmed and contaminated. During extended wet periods, rising water tables can cause localized flooding impacting homes, infrastructure, and public spaces.

Average Temperature Change in the Metropia Region

<table>
<thead>
<tr>
<th></th>
<th>Summer (Max)</th>
<th>Winter (Min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961-2010</td>
<td>81.1°F</td>
<td>7.6°F</td>
</tr>
<tr>
<td>2000-2070</td>
<td>83.7°F</td>
<td>17.2°F</td>
</tr>
<tr>
<td>Projected</td>
<td>47.7°F</td>
<td>49.6°F</td>
</tr>
</tbody>
</table>

Average Precipitation Change in the Metropia Region

<table>
<thead>
<tr>
<th></th>
<th>Early Summer</th>
<th>Early Fall</th>
<th>Precipitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961-2010</td>
<td>4.4&quot;</td>
<td>2.9&quot;</td>
<td></td>
</tr>
<tr>
<td>2000-2070</td>
<td>5.0&quot;</td>
<td>2.9&quot;</td>
<td></td>
</tr>
<tr>
<td>Projected</td>
<td>6.6&quot;</td>
<td>Projected</td>
<td></td>
</tr>
</tbody>
</table>

Changing Seasons

Temperature and precipitation trends tell us that the metro region is generally getting warmer and wetter and will continue to do so in the future. However, these temperature and precipitation changes are not evenly distributed throughout the year. Although we are getting wetter overall our winter lows are rising faster than our summer highs. Similarly, we seem to be getting wetter during some parts of the year and dryer during others. These changes along with greater weather variability are making water demand predictions more difficult and increasing the stresses on our drinking water resources and supply systems.
Source Water Protection

Protection of drinking water starts by protecting our water sources and is everyone’s responsibility. This means respecting and conserving the natural streams and ground waters that flow through our municipalities. It also means being aware of our current activities and how they might impact water resources. Road salt, fertilizers, and pesticides all infiltrate the ground and find their way to our waterways, lakes, rivers, streams, and groundwater aquifers. Once these pollutants get into the environment they can be very difficult to remove. Limiting our use and instituting best management practices help to protect our drinking water supplies.

Groundwater Contamination in the East Metro

PFAS contamination of ground and surface waters in the East Metro has created public health concerns and water treatment challenges for public suppliers and private well owners. PFAS chemicals can be found in the environment, requiring significant time and financial resources to remediate.

From the Minnesota Pollution Control Agency:

Poly- and polyfluoroalkyl substances (PFAS) are a large group of nearly 5,000 different synthetic chemicals that are resistant to heat, water, and oil. Invented in the 1970s, PFAS have been used since the 1940s and are still commonly used for their water- and grease-resistant properties in many consumer applications and consumer products such as carpeting, waterproof clothing, upholstery, food paper wrappings, coatings, personal care products, fire-fighting foams, and metal plating. A few of the most studied PFAS are known to be hazardous to human health. Some manufacturers have chosen to stop using them and States have established rules on some of their uses, but generally speaking PFAS continue to be used widely in industrial applications and consumer products.
Next Steps

Seek draft content feedback
- Internal: water resources planning staff
- External: public water suppliers
  - Working with EOR and Young Consulting to facilitate conversations

Revise draft content
- As input and/or new data comes in update content
- Our intent is to update this content on an ongoing and as needed basis

Prepare to publish
- Print, digital, web, etc.