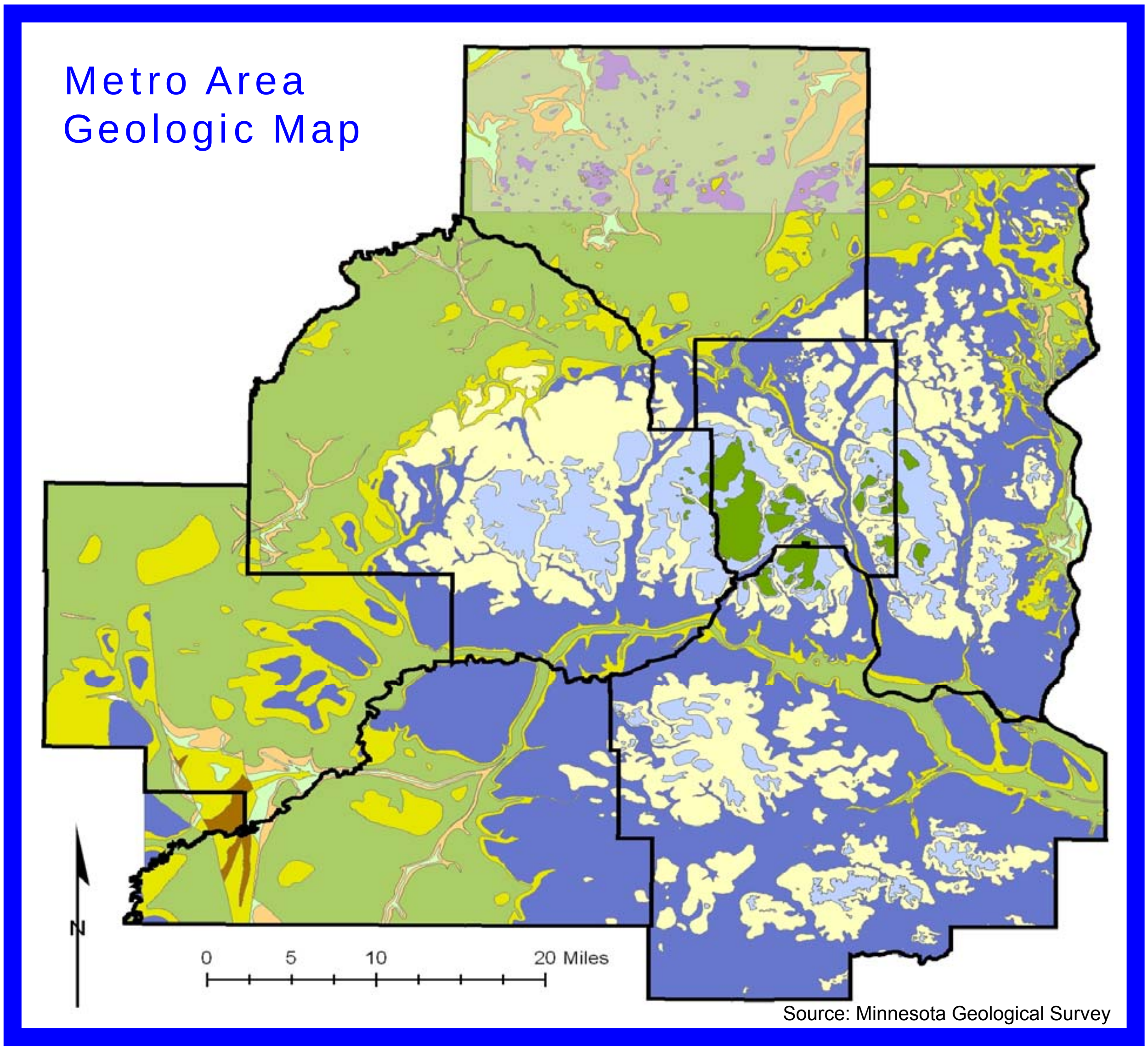
Metropolitan Council

Water Supply Planning in the Twin Cities Metropolitan Area Technical Report

January 2007



Mission
The mission of the Metropolitan Council is to develop, in cooperation with local communities, a comprehensive regional planning framework, focusing on wastewater, transportation, parks and aviation systems, that guides the efficient growth of the metropolitan area. The Council operates wastewater and transit services and administers housing and other grant programs.

General Phone	651-602-1000
Regional Data Center	651-602-1140
TTY	651-291-0904
Metro Info Line	651-602-1888
E-mail	data.center@metc.state.mn.us
Council Web site	www.metrocouncil.org

Metropolitan Council Members

On request, this publication will be made available in alternative formats to people with disabilities. Call the Metropolitan Council Data Center at 651-602-1140 or TTY 651-291-0904.

This report is printed on recycled paper with at least 20 percent post-consumer waste.

Publication no. 32-07-004

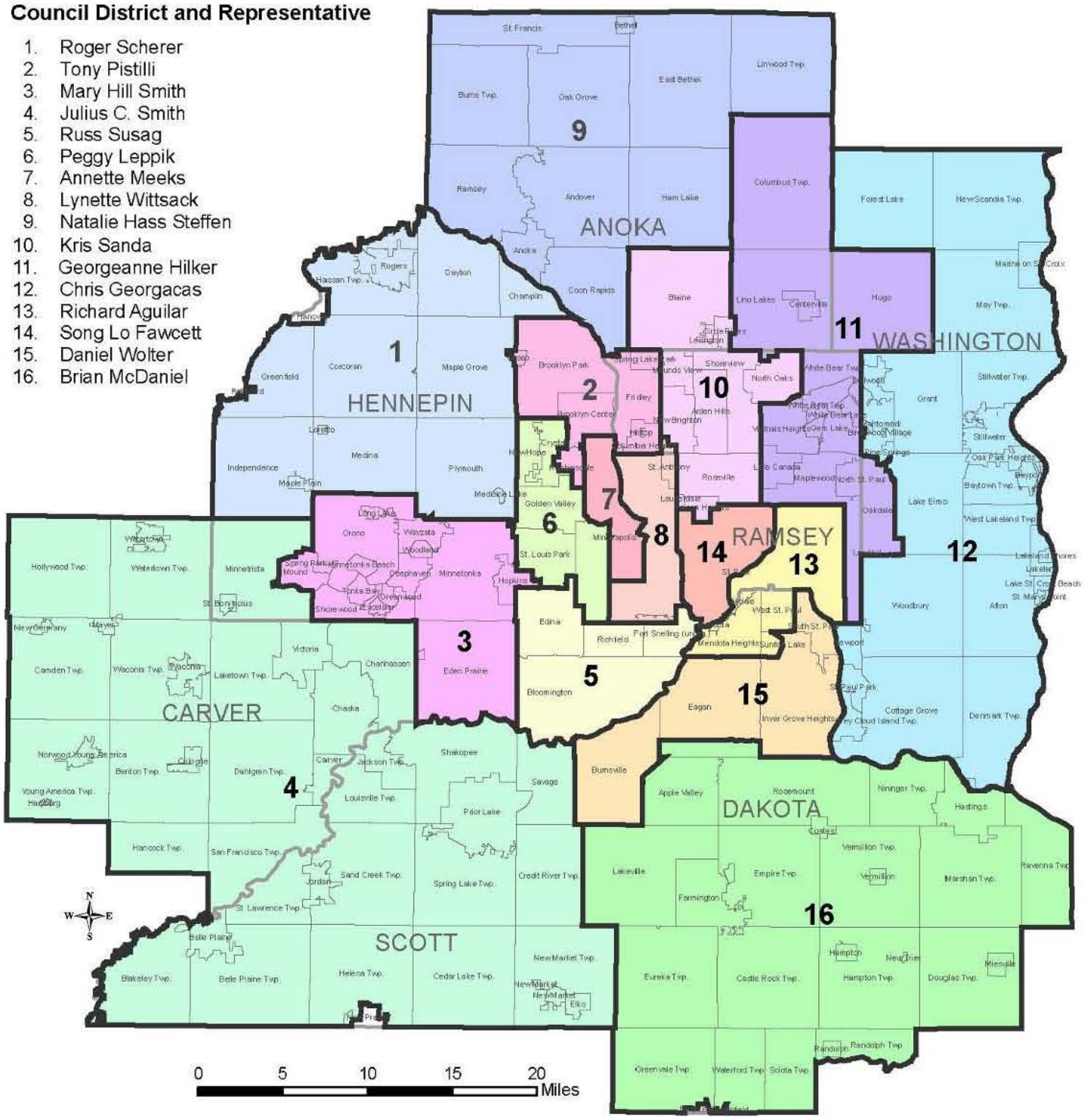
Metropolitan Council Districts

Metropolitan Council

Revised June 19, 2006

Council District and Representative

1. Roger Scherer
2. Tony Pistilli
3. Mary Hill Smith
4. Julius C. Smith
5. Russ Susag
6. Peggy Leppik
7. Annette Meeks
8. Lynette Wittsack
9. Natalie Hass Steffen
10. Kris Sanda
11. Georgeanne Hilker
12. Chris Georgacas
13. Richard Aguilar
14. Song Lo Fawcett
15. Daniel Wolter
16. Brian McDaniel



CONTENTS

List of Tables

List of Figures

List of Appendices

The appendices are contained in a separate document and are posted on the Council's website: www.metrocouncil.org

Appendix A: Advisory Committee Materials

Appendix B: Stakeholder Input

- **Table B-1:** Stakeholder Workshop Participant Comments
- Draft Legislative Report Comments

Appendix C: Water Supply Systems Inventory

- **Table C-1 :** Web Site Activity

EXECUTIVE SUMMARY

The Twin Cities metropolitan area is fortunate to have abundant supplies of generally high-quality water. However, these supplies are not limitless and they are not always located where needed most. Instances have occurred where withdrawals have adversely impacted sensitive natural resources or other users. Groundwater or surface water contamination has led to limits on supplies or increased costs for treatment. In addition, there is often a lack of sufficient information on the extent, capacity and vulnerability of groundwater systems, which has led to delays in the water supply decision-making process in the region. Many of these issues cut across community boundaries; however, municipalities typically make water system investments and conduct resource evaluations on a local level without consideration of regional implications.

The 2005 Minnesota Legislature directed the Metropolitan Council (Council) to “carry out planning activities addressing the water supply needs of the metropolitan area” (Minnesota Statutes, Section 473.1565). Specifically, the Council is charged with developing a base of technical information for water supply planning decisions and to prepare a metropolitan area master water supply plan. The legislature also established a Water Supply Advisory Committee to assist the Council in its planning activities, and directed the Council to submit regular reports to the legislature detailing progress.

In order to address the legislature’s directive, the Council organized its efforts in two phases. During the first phase the Council undertook several activities to assess water supply availability, evaluate the decision-making and approval process and address water supply safety, security and reliability. The Council also collected information on water supply governance structures in other regions. Through these activities, the Council identified several next steps and recommendations which are presented in the *Water Supply Planning in the Twin Cities Metropolitan Area: Report to the 2007 Legislature* (Metropolitan Council 2007) (*Legislative Report)*. This technical report supplements the *Legislative Report* (Metropolitan Council 2007) and focuses on the data, methods and findings from the Council’s stakeholder outreach efforts, water supply system inventory, resource monitoring location inventory, water demand and availability assessment, institutional arrangement evaluation and other studies conducted during the first phase.

Additional activities based on the information collected during the first phase will be conducted throughout 2007 and 2008. The Council intends to prepare a master water supply plan, also required by Minnesota Statute 473.1565, in late 2008.

1. INTRODUCTION

1.1. Legislative Charge

Minnesota Statutes, Section 473.1565, directs the Metropolitan Council (Council) to carry out planning activities addressing the water supply needs of the metropolitan area. The law requires the Council to develop and maintain a base of technical information that supports sound water supply development decisions. In addition, the Council is directed to provide recommendations to clarify local, regional and state government roles related to water supply, streamline the water supply decision-making and approval process, and establish long-term funding for planning and capital investments. The findings and recommendations of these initial planning activities are presented in the Council's January 2007 *Water Supply Planning in the Twin Cities Metropolitan Area: Report to the 2007 Legislature* (Metropolitan Council, 2007) (*Legislative Report)*. This technical report provides the methods, findings and data for the activities conducted in the first phase of activities.

The legislature also required the Council to develop and periodically update a regional water supply master plan. The master plan will provide guidance for local water supply systems and future regional investments. It will emphasize conservation, interjurisdictional cooperation and long-term sustainability; and will address reliability, security and cost effectiveness. The efforts described in this report, as well as efforts during the second phase of planning activity, will be used in the development of the master water supply plan.

1.2. Water Supply Advisory Committee

In addition to the water supply planning activities, the legislature established the Metropolitan Area Water Supply Advisory Committee (Advisory Committee) to assist the Council in its planning activities. The Advisory Committee is made up of the following members:

Peter Bell	Chair, Metropolitan Council, Committee Chair
Peggy Leppik	Metropolitan Council District 6, Committee Vice Chair
Gene Hugoson	Commissioner, Department of Agriculture
Greg Buzicky	Department of Agriculture, Alternate
Dianne Mandernach	Commissioner, Department of Health
John Stine	Department of Health, Alternate
Gene Merriam	Commissioner, Department of Natural Resources
Jim Japs	Department of Natural Resources, Alternate
Brad Moore	Commissioner, Pollution Control Agency
Faye Sleeper	Pollution Control Agency, Alternate
Dennis Berg	Commissioner, Anoka County
Joe Harris	Commissioner, Dakota County
Tom Furlong	Mayor, City of Chanhassen
Linda Loomis	Mayor, City of Golden Valley
Barry Stock	City Administrator, City of Savage
Bev Aplikowski	Mayor, City of Arden Hills
Chuck Haas	City Council Member, City of Hugo

The Advisory Committee met monthly from January through November 2006. At the meetings, Council staff presented information on a water supply issues and provided water supply planning activity status reports to the Advisory Committee. The Advisory Committee also participated in policy discussions brought before them throughout the first phase. Appendix A includes Advisory Committee meeting agendas and minutes, as well as materials presented at each of the Advisory Committee meetings. The Advisory Committee will continue to be involved in policy discussions through the next phase of water supply planning activities.

2. STAKEHOLDER INPUT

The Metropolitan Council (Council) solicited stakeholder input to help guide its water supply planning activities. In addition to stakeholder workshops and other specific comment periods described here, comments were and will continue to be received on an informal basis throughout the process.

2.1. Stakeholder Workshops

The Council hosted three public workshops in May and June 2006. The workshops were held in Maple Grove, Woodbury and Apple Valley. While not specifically required by the legislature, the workshops allowed the Council to hear the opinions of 115 attendees who represented 32 communities; county, state, federal and tribal agencies; watershed districts; the Association of Metropolitan Municipalities; various chambers of commerce; the Builders Association of the Twin Cities; and the Trust for Public Land. Eight members of the Metropolitan Area Water Supply Advisory Committee (Advisory Committee) attended one or more of the workshops. Comments were also received via email and US mail during the workshop period.

The workshops provided stakeholders in the metropolitan area an opportunity to share their views on drinking water availability and quality, resource data collection and analysis, safety, security and reliability issues and funding.

During the workshops, attendees participated in facilitator led small group discussions, where they shared water supply planning issues and ideas. To initiate discussion, facilitators asked participants the following questions:

- In regards to the entire Metropolitan Area, what are your greatest current concerns related to:
  - drinking water quality and supply,
  - safety and security ,
  - funding or cost issues, and
  - regulatory process?
- Looking ahead twenty years:
  - what do you think the drinking water concerns will be for the region, and
  - what do you think are the opportunities that the Metropolitan Area might seek out to address the concerns identified earlier?

Workshop Results

Participants identified **the need to link water supply to overall planning as a central issue** in the metropolitan area**.** They suggested that evaluating water resources in the context of planned growth is necessary to address potential limitations and should occur prior to development. Input from workshop participants helped the Advisory Committee and Council refine the focus of the water supply planning activities. Appendix B includes a list of all workshop participant comments.

2.2. Report Review

Upon completion of the first draft, the Council solicited public comment on its *Water Supply Planning in the Twin Cities Metropolitan Area: Report to the 2007 Legislature* (Metropolitan Council, 2007) (*Legislative Report)*. Comments were also received via email and U.S. mail. In addition, stakeholders were able to ask questions and provide comments on the draft report at a Council led stakeholder input meeting. Appendix B contains questions and comments received on the *Legislative Report* (Metropolitan Council, 2007).

3. WATER SUPPLY SYSTEM INVENTORY

The Minnesota Department of Health (MDH) maintains a municipal water supply system database with information about each systems' storage capacity, production capacity, treatment type, population served, surface water intakes and groundwater wells. MDH updates its database every 18 months after an inspection of the municipal water supply system. The Metropolitan Council (Council) plans to use MDH's information along with other water supply system information it collects in the development of the metropolitan area master water supply plan.

3.1. Methods

In an effort to have the most complete and up-to-date inventory of information on each municipal water supply system in the metropolitan area, the Council initially obtained data from MDH's municipal water supply system database. The Council broadened its inventory to include information about water level measurements and interconnections, which the MDH does not collect. A web based interface was developed and municipal water suppliers were provided with unique usernames and passwords enabling them to view their systems' information from the Council's inventory. The password protected web site allowed water supply system personnel to verify and update information about their water supply systems. Municipal water suppliers' wellhead protection plans and water emergency and conservation/water supply plans were also used to update the database.

The resulting database includes the following information for each municipal water supply system in the metropolitan area:

- Contact information for water superintendent or designated staff;
- General information about the water supply system as a whole (maximum system capacity, firm capacity, total storage capacity);
- Storage facility information (type of storage, facility name, storage capacity);
- Interconnection information (community name, connection type, # of connections, size, capacity);
- Surface water intake information (water body name);
- Well construction information (well name, unique well number, reference elevation, install date, casing diameter, casing depth, total depth, screen length, screen aquifer, pump rate, column pipe length, pump intake depth, last redeveloped date, continuous water level measurement capability, continuous pump rate measurement capability, presence of a SCADA system); and,
- Well water levels (static water level, average pumping rate, measurement date, pumping water level, drawdown, specific capacity).

3.2. Results

Web Site Activity

The Council recorded users' activities on the water supply inventory web site between August 2006, when user accounts were distributed, and October 2006. Of the potential 108 users, 64 logged into the site and 48 of those users updated or verified their information. Table C-1 in Appendix C shows web site activity by municipality.

Storage Capacity

According to the Council's water supply system inventory there are 315[1] drinking water storage facilities in the metropolitan area. There are, currently, five different types of storage being used in the region, which include: elevated, ground, hydropneumatic, standpipe, and underground. The 315 storage facilities have a combined total storage capacity of 856,114,050[1] gallons. Table 1 summarizes the storage capacity in the metropolitan area and Table C-2, in Appendix C, describes each community's storage type and capacity.

Table 1. Summary of Metropolitan Area Storage Capacity

Storage Type	Storage Capacity (Gallons)	Number of Facilities
Elevated	161,985,000	191
Ground	28,200,000	8
Hydropneumatic	77,500	10
Standpipe	33,414,000	20
Underground	632,437,550	86
Total	**856,114,050**	**315**

Water Supply Wells

Within the Twin Cities metropolitan area, according to the Council's water supply system inventory, there are 599 active municipal water supply wells (as compared to 566 wells in 2004) that draw water from one or more aquifers. For a summary of wells by community and by aquifer see Table C-3, in Appendix C. Municipal wells in the Twin Cities area primarily draw water from the following aquifers: the Prairie du Chien-Jordan, the Mt. Simon-Hinckley, the glacial drift and the Franconia-Ironton-Galesville (FIG) aquifers. Approximately 350 of the municipal wells in the metropolitan area draw water from the Prairie du Chien-Jordan Aquifer. About 56 wells draw water from the FIG aquifer, 55 wells draw from glacial drift and 59 wells draw from the Mt Simon-Hinkley aquifer. The remaining wells draw water from multiple aquifers. In 2006, the total pumping capacity of all municipal wells was approximately 927 million gallons per day (mgd). This is about 33 mgd more than the total capacity in 2004.

Water Treatment Facilities

Municipal water supply treatment in the metropolitan area ranges from adding chlorine and fluoride, to iron and manganese or calcium and magnesium removal.

Interconnections

According to water supply system inventory database, 67 supply systems have some type of interconnection with an adjoining community. Figure 1 contains information about municipal water supply system interconnections by community.

---

[1] Storage facilities, storage capacity and well information were obtained for each of the 108 communities in the region with a public water supply system. These numbers do not take into account data from non-municipal public or private water supply systems. See Appendix C, Table C-1 for a complete list of communities included in the inventory.

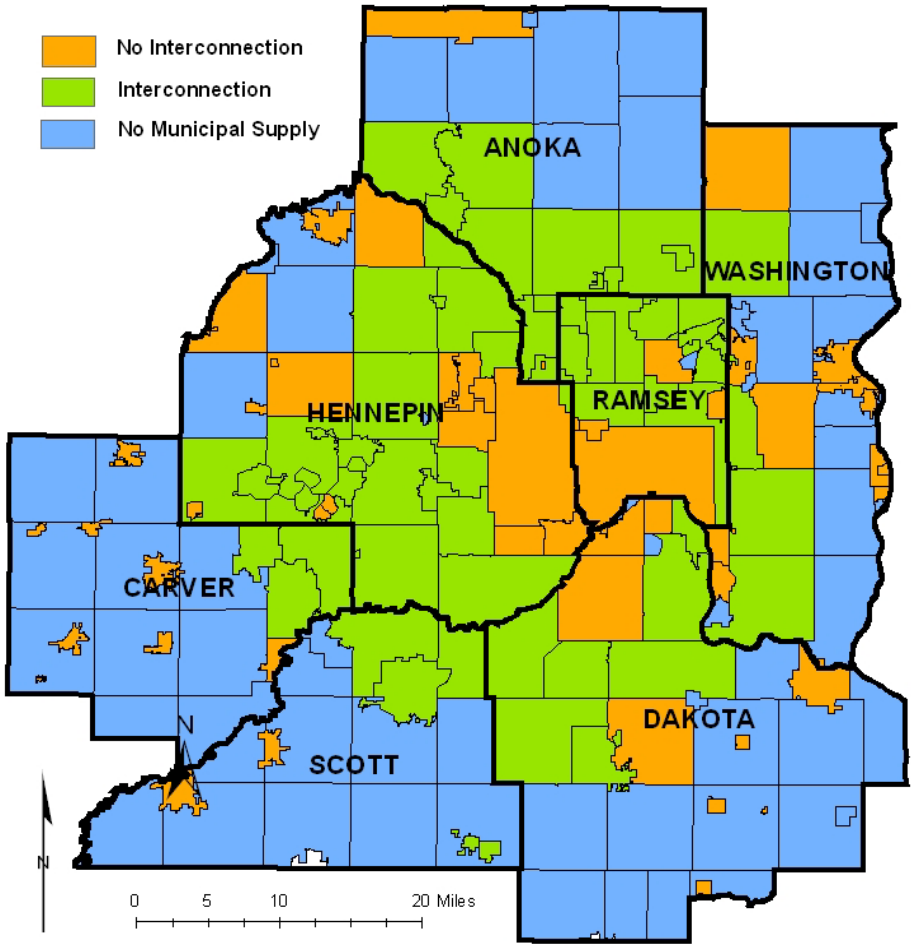


Figure 1. Municipal water supply interconnections.

4. RESOURCE MONITORING LOCATION INVENTORY

The Metropolitan Council (Council), Minnesota Department of Natural Resources (DNR), Minnesota Pollution Control Agency (MPCA), Minnesota Department of Agriculture (MDA), Minnesota Department of Health (MDH), Minnesota Department of Transportation, United States Geological Survey (USGS), counties, watershed districts, watershed management organizations, U.S. Army Corps of Engineers, Minneapolis Park Board, Friends of the Minnesota River, volunteers, private individuals, and others all collect water monitoring information throughout the metropolitan area. However, a central database containing all the water monitoring information does not currently exist. In order to better understand where and when monitoring occurs, the Council began collecting monitoring location information and contact information for entities with monitoring data. This information will be used in both regional and local water resource assessment activities during the second phase of the Council's water supply planning efforts.

4.1. Methods

The Council's water supply planning efforts focus primarily on the seven county metropolitan area; however, watershed boundaries often extend beyond county boundaries. Therefore, the Council included resource monitoring locations within watersheds that extend beyond the seven county metropolitan when developing its resource monitoring inventory. Monitoring locations in adjacent groundwater recharge areas were also included in the resource monitoring inventory. Figure 2 outlines the extent of the surface water and groundwater resource monitoring inventory.

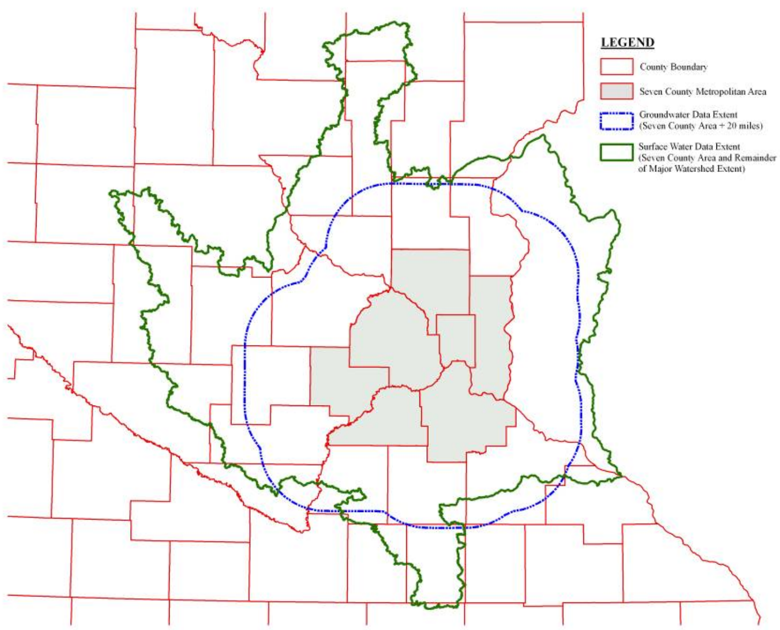


Figure 2. Surface and Groundwater Data Collection Extents

The Council worked with private, federal, state, county and local groups and governmental units to develop an initial contact list of organizations with water resource monitoring information. Once identified, contacts from each organization were asked to complete a 10 question telephone survey (Appendix D contains a copy of the survey). The Council collected information about monitoring locations, parameters, frequency, history, and reason for monitoring. Spatial coordinates and/or a site description for each monitoring site were collected when available.

In addition to the information collected via the telephone surveys, the Council used publicly available data sets, such as those maintained by the Council, MPCA, DNR, MDA, USGS, and local conservation districts.

The Council used the collected information to develop a Geographic Information System (GIS) database, which allows users to view the spatial distribution of monitoring sites. The database may also be used to search for descriptive information about monitoring locations. Figure 3 illustrates the spatial distribution of surface water monitoring locations collected by the Council. These surface water monitoring locations include: rain gauge locations, surface water level monitoring locations, stream discharge measurement sites, flood warning gauge sites, and water sample collection locations. Figure 4 shows the spatial distribution of groundwater monitoring locations collected by the Council. Groundwater monitoring locations include water level monitoring locations and water sample collection sites. Data from the Minnesota County Well Index (CWI) were not included in the figures or appendices due to their immense number; 41,334 groundwater records exist within the metropolitan area. Measurements taken at many of these locations were limited to boring logs and water level measurements when the well was installed.

Figure 3. Surface Water Monitoring Locations

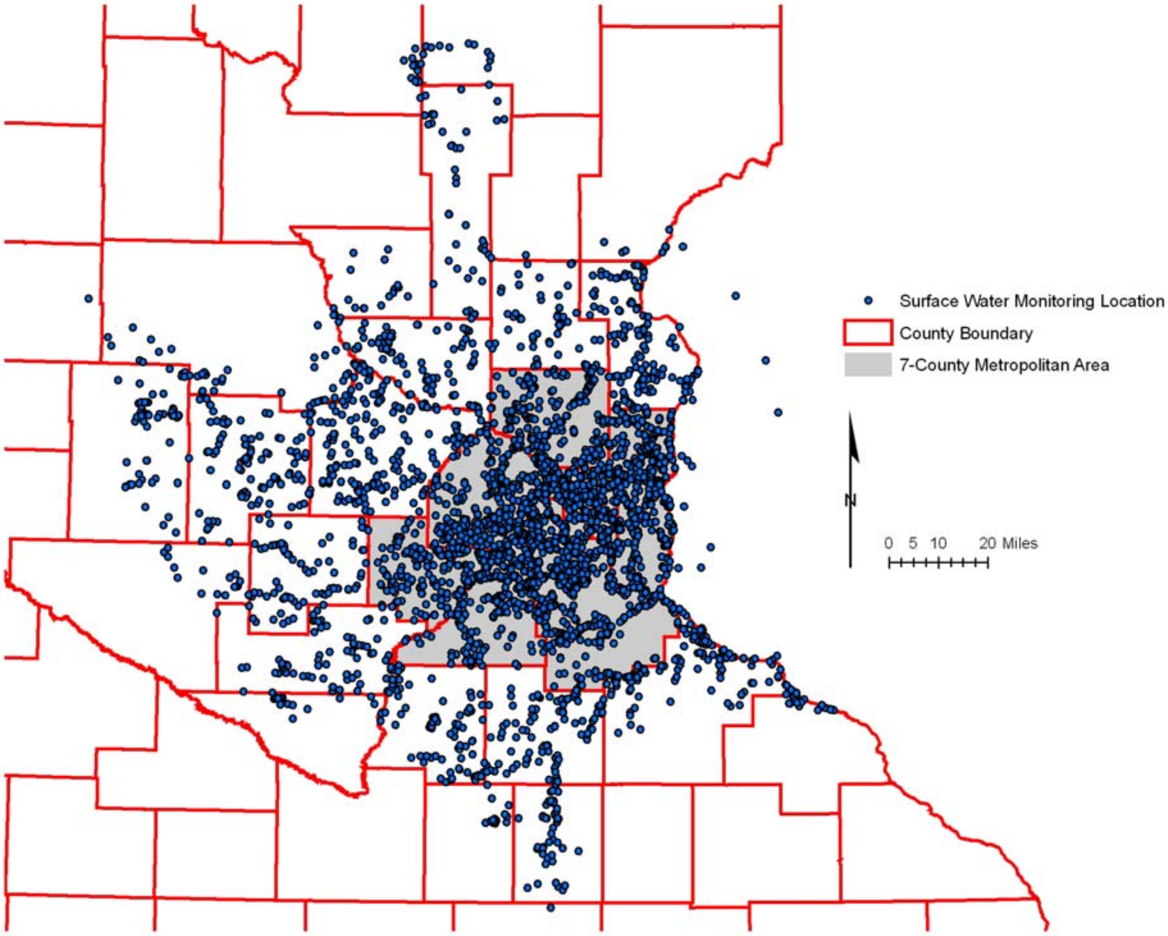
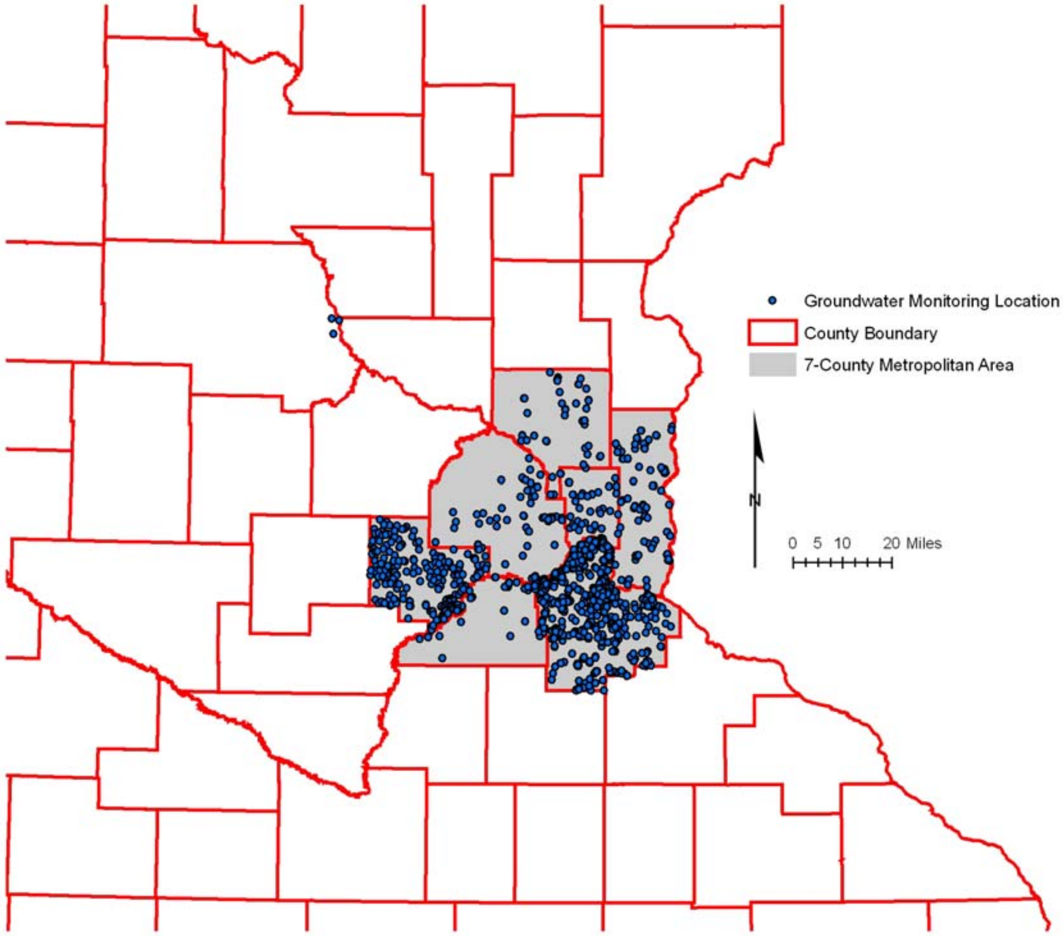


Figure 4. Groundwater Monitoring Locations



4.2. Results

The Council collected information on 8,791 water resource monitoring locations. The resultant Geographic Information System (GIS) database can be obtained through the Council's website: www.metrocouncil.org. The precision and accuracy of the information collected varies significantly depending on the information available to the survey participant or included in the public data sets. Monitoring location spatial accuracy depends upon whether the location was communicated in coordinates or anecdotally such as "the south side of the 2nd Street Bridge." There is also some uncertainty surrounding the status of several of the monitoring efforts. For example, some monitoring locations labeled as "project specific" have start and end dates while others only have start dates. For those monitoring locations that only have start dates it is unclear from the information included in the inventory as to whether monitoring efforts are ongoing at those locations.

The Council recognizes that there are likely monitoring locations in the region that are not currently included in its water resource monitoring inventory. Examples include non-recorded project-specific sampling, Brownfields sampling, and monitoring data associated with due diligence investigations.

The completed survey and resulting data set provide the following primary information about each monitoring location: 1) who collects information from this location; 2) where does this monitoring station reside; and 3) for what purpose is this monitoring location sampled.

Entities Collecting Water Resource Monitoring Information

Table 2 summarizes the types of entities that have groundwater and surface water monitoring data.[2]

Table 2. Data Source Organization Summary

Data Type	Federal	State	Regional	WD/WMO	County	Local	Unknown	# Locs
Surface water	686 11.58%	3010 50.83%	798 13.48%	610 10.30%	656 11.08%	113 1.91%	49 0.83%	5922 100.00%
Groundwater	18 0.63%	336 11.75%	0 0.00%	0 0.00%	2488 87.02%	17 0.59%	0 0.00%	2859 100.00%

Note: Local classification includes cities and tribal entities, WD/WMO also includes Joint Powers Organizations.

The state appears to be the main data source for surface water monitoring information, whereas counties take the lead on groundwater monitoring efforts. Many cooperative agreements within the region exist, thus the entity with the data may not actually be the entity that originally collected the data. Sites monitored by citizen volunteers were classified under the volunteers' supporting agencies.

Monitoring Locations

5,922 of the 8,791 monitoring locations identified were surface water monitoring locations that include rain gauge locations, surface water level monitoring locations, stream discharge measurement sites, flood warning gauge sites, and water sample collection locations. The remaining monitoring locations were groundwater sites. Table 3 broadly summarizes the distribution of monitoring locations contained in the Council's inventory.

[2] A complete list of all the entities with monitoring data can be found on the Council's web site (http://www.metrocouncil.org/).

Table 3. Resource Monitoring Data Summary

Data Type	Total	Within 7 county area	Outside 7 county area	In WI
Surface water	5,922	4,156	1,766	82
Groundwater*	2,859	2,855	4	0

Reasons for Monitoring

Water resource monitoring occurs for a variety of reasons. In this inventory, monitoring activities were characterized as unknown, baseline/routine, project specific or some combination of reasons. The data suggest that surface water and groundwater resource monitoring primarily occurs as a means for collecting baseline data or for routine monitoring purposes (Table 4).

Table 4. Reasons for Monitoring

Data Type	Unknown	Combination	Baseline/Routine	Project Specific	Total
Surface water	1365 23.05%	10 0.17%	3511 59.29%	1036 17.49%	5922
Groundwater	31 1.08%	9 0.31%	2514 87.93%	305 10.67%	2859

Type of Data Collected

Table 5 summarizes the types of monitoring data collected. The Council developed four general classifications (quality, quantity, chemistry and biology) to simplify the survey results. Quality refers to field sampled water quality information such as secchi disk readings, temperature, turbidity, ph, or dissolved oxygen. Quantity refers primarily to water level or flow information, and depth to water, discharge or precipitation data. Chemistry refers to laboratory data such as total suspended solids, total dissolved solids, chloride, metals, nutrients, etc. Biology contains information on macro invertebrate identification, chlorophyll typing, or fish counts.

Table 5. Types of Monitoring Data Collected at Locations

Data Type	Quality	Quantity	Chemistry	Biology	Total
Surface water	1942 32.79%	1464 24.72%	1356 22.90%	1252 21.14%	5922
Groundwater	2466 86.25%	35 1.22%	2496 87.30%	0 0.00%	2859

Note: Where known, not all location points have discrete data

5. WATER DEMAND AND AVAILABILITY

The adequacy of water supplies to meet local demand is related to the combined influences of local water supply demands and the availability of water resources. In some cases, the availability of resources may be limited due to drought, contamination or the impacts pumping groundwater may have on surface water features. As an initial step in evaluating the adequacy of local supplies to meet future demands, the Metropolitan Council (Council) projected water supply demands and conducted a preliminary evaluation of water resource availability throughout the metropolitan area.

5.1. Water Supply Demand

Water supply demand varies depending on water user characteristics, conservation practices and types of water use. While power generation accounts for a majority of water appropriated in the region, most of this water is returned directly to the source at a slightly higher temperature and is therefore considered a non-consumptive use. In 2004, municipal water use accounted for about 70% of the total non-power generation water use in the metropolitan area. Residential water use accounted for approximately 70% of municipal water use. The Council, therefore, used population forecasts as the primary variable to project water supply demand.

Population

For its water supply demand projections, the Council used the 2010, 2020 and 2030 population forecasts for each community developed for the *2030 Regional Development Framework* (Metropolitan Council, 2004). Preliminary 2040 and 2050 population forecasts for each community were also developed in order to project water demand to 2050. Some communities purchase their water, wholesale or retail, from other communities. In these cases, the populations of communities purchasing their water supply were combined with the population of the community from which they purchase their water. For example, the population forecasts for St. Paul Regional Water Services (SPRWS) include the City of St. Paul and the nine other communities served by SPRWS.

The Council characterized populations as either served or unserved[3]. Served populations receive water from municipal supply systems, while unserved populations rely primarily on private domestic wells. Municipal water suppliers are required to report their served populations annually to the Minnesota Department of Natural Resources (DNR) with their annual water use information. The Council used the reported served population estimates and its own population forecasts to project future water supply demand. For communities with municipal supply systems, it was assumed that the unserved population would remain constant through 2030 and that the served population would include any forecasted population growth. After 2030, the previously unserved population in those communities was assumed to become served. Table E-1 in Appendix E contains the served population forecasts for each community.

Water Supply Demand

The Council used 2001-2004 water use data from the DNR State Water Use Data System (SWUDS), which contains monthly water use data from all water appropriation permittees throughout Minnesota. The more specific water use data collected for the Council's *Water Demand and*

[3] Many communities provide municipal water to their entire population. In those cases, served population equals total population.

Planning in the Twin Cities Metropolitan Area: An update to the Long-Term Water Supply Plan (Metropolitan Council, 2004) report was also used for the water demand projections.

Municipal Water Demand (served population)

Municipal suppliers provide water to residential, commercial, institutional and industrial customers. The Council calculated the mean average day and maximum day water demand for each municipal water supplier. Average day demand is the total water pumped in one year divided by the number of days in the year. Maximum day demand is the maximum volume pumped on a single day in a given year. The Council then divided the average and maximum day water use by the served population to obtain per capita per day demands for each municipal water supplier.

The average per capita per day use demands were adjusted to account for likely changes in water supply demand resulting from maturing landscapes, conservation practices, and rapid suburban growth. For example, if a given supplier's maximum day per capita demand was higher than 350 gallons, the average day per capita demand was reduced by 5% in 2020, and 10% per 10 year period thereafter. Table 6 reflects the Council's methods for adjusting the maximum day values.

Table 6. Methods for Adjusting Maximum Day Water Demands in the Future

Historical Max Day (gallons per capita per day)	2020	2030 – 2050
<350	No change	No change
<375	No change	350
375-400	375	350
400-500	400	350
>500	450	350

Where data were insufficient to directly calculate the per capita demand factors, water supply demands were estimated based on data from municipal systems with similar characteristics. The Council multiplied the adjusted maximum day per capita values by the forecasted served population to project maximum day usage for each municipal supplier. Table E-2 in Appendix E shows the projected average day and maximum day water use for each municipal supplier.

Private Residential Water Demand (unserved population)

Based on the calculated metropolitan area average residential per capita per day water use value (88 gallons per capita per day in 2004), the Council projected water demands for private water suppliers, including domestic wells and private waterworks (e.g. waterworks operated by mobile home parks, housing associations or other entities). The metropolitan area average residential per capita per day water use value is the mean of the metropolitan area municipal supplier's average residential per capita per day water supply demand[4]. The Council multiplied the metropolitan area average residential per capita per day water use value by the total population of each community minus the served population to obtain the private water supply (unserved population water use)

[4] Private water use generally occurs in suburban or rural settings. St. Paul, Minneapolis and the communities they serve were excluded from the metropolitan area average per capita per day water use calculation, because it was assumed that suburban suppliers' water use rates better reflected water use rates of those privately supplied.

average water supply demands. Appendix E, Table E-3 shows the projected private water supply demands.

Other Non-Municipal Demands

Based on 2001-2004 water use data from SWUDS, the Council projected non-municipal industrial, commercial, agricultural, and other permitted water use. It was assumed that nearly all new non-residential water use would be accounted for in the projected municipal water demands. However, in some cases, the Council assumed a reduction in non-municipal and non-residential water use in areas where land-use change is planned. For example, it was assumed that major-crop irrigation use will decrease in areas where urban development is planned. Similarly, water use projections were lowered in areas where it is known quarry operations are going to close down and associated dewatering will cease. Most once-through water use was removed because these permits will be terminated by the end of 2010. While likely to grow slightly, non-crop irrigation water use was not increased because the locations of future permits are unknown. Similarly, the Council did not account for new industrial processing demands and other special categories in its water supply demand forecasts because future permit locations are unknown. Non-permitted projected water use data from the Shakopee Mdewakanton Sioux Community in Scott County is also included in the category of non-municipal water demands. Table E-4 in Appendix E shows the non-municipal water supply demand forecasts.

Water Demand Projection Results

Compared to 2004 populations, the metropolitan area population is expected to grow by about 33% by 2030, and about 60% by 2050. The Council's projections for related municipal water use demands include a 27% increase by 2030, and 52% increase by 2050. Total water demand (Table E-5, Appendix E), due to improved efficiency and reductions in industrial and agricultural uses during this period, is projected to increase 16% between 2004 and 2030, and 35% from 2004 to 2050. For both projections, the rate of water use increases at a slightly lower rate than population growth based on the assumption that use of water efficient appliances and general water conservation will increase in the future. Table 7 summarizes the projected population growth and water supply demands.

Table 7. Projected Average Day Water Demands for the Metropolitan Area

Year	Population	Avg. Day Municipal Water Demands	Avg. Day Non-Municipal Water Demands	Total Avg. Day Water Demands
2004	2,769,550	318.9	126.7	445.6
2010	3,056,100	351.4	110.6	462.0
2020	3,430,100	385.4	111.3	496.7
2030	3,683,500	403.9	112.2	516.1
2040	4,113,400	447.7	114.8	562.5
2050	4,463,400	485.5	116.6	602.0

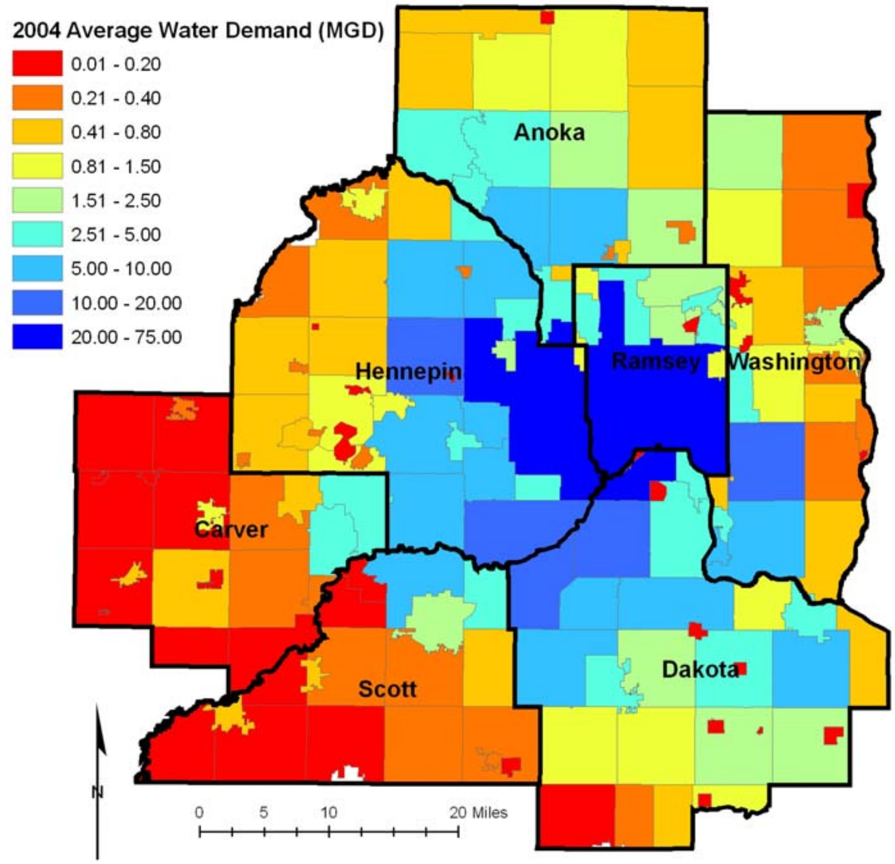
The Council projects that large increases in water use will occur in several rapidly growing suburbs and rural growth centers. Projections show several older suburbs and most rural areas experiencing nominal increases or even small decreases in water use. Similar water use trends are expected to continue in the region through 2050. Figure 5 identifies average water demands in 2004. Figures 6 and 7 illustrate projected demands for 2030 and 2050, respectively.

Ranking Demand Projections

A ranking system was developed based on each community's projected water supply demands. First, average and maximum water supply demand were converted from gallons per capita per day to gallons per day per acre based on the total area served by each community's water supply system. Then a community scoring system was developed (Table 8). A list of each community's projected supply demand code, or ranking, is located in Appendix F, Table F-1.

Table 8. Projected Demand Ranking System

Demand Score	Demand Code	Demand Description
Average Municipal Demand		
gallons per acre < 180	L	Low
180 ≤ gallons per acre < 360	M	Medium
360 ≤ gallons per acre < 670	H	High
gallons per acre ≥ 670	VH	Very High
Maximum Municipal Demand		
gallons/acre < 500	L	Low
500 ≤ gallons/acre < 1100	M	Medium
1100 ≤ gallons/acre < 2200	H	High
gallons per acre ≥ 2200	VH	Very High



Note: Communities receiving water from the same sources are grouped together.

Figure 5. 2004 Water Demand

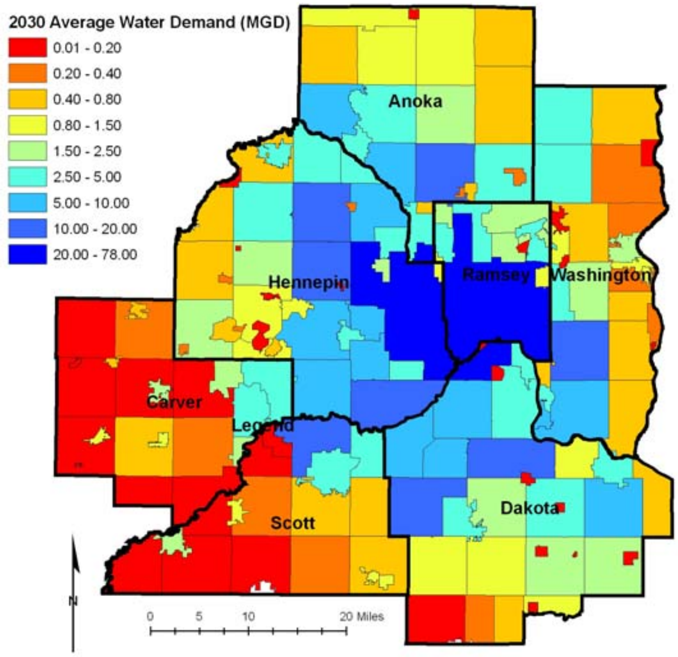


Figure 6. Projected Water Demand 2030

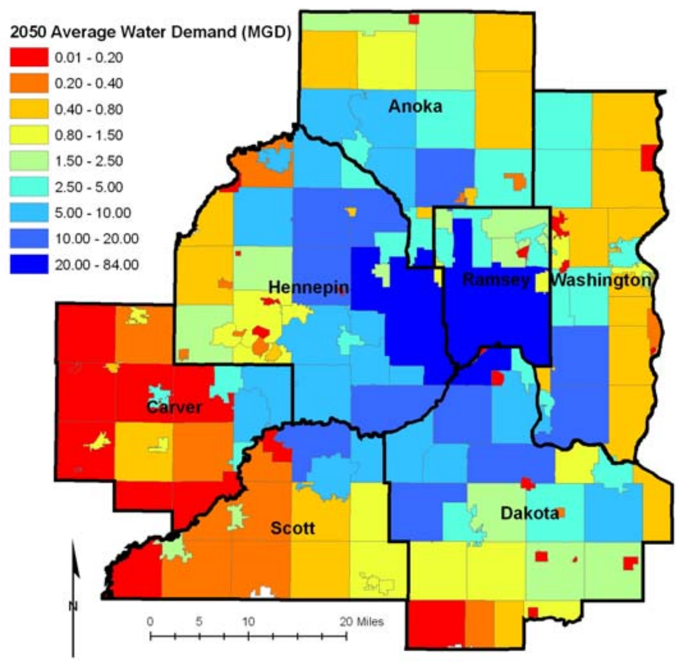


Figure 7. Projected Water Demand 2050

5.2. Surface Water Availability Analysis

The Mississippi River serves as the primary water source for Minneapolis, St. Paul and the several surrounding communities they serve. Under most conditions, the Mississippi River supplies far more water than needed by the communities that rely on it. In times of drought or contamination, however, use of river water may be limited. Several entities have documented potential impacts of Mississippi River low flow and contamination events on local water supplies. During the first phase of planning activities, the Metropolitan Council (Council) reviewed this information and identified areas where further research and clarification may be needed, as described in the *Report to the Legislature* (Metropolitan Council, 2007).

5.3. Groundwater Availability Analysis

Groundwater supplies are relatively abundant throughout the metropolitan area and are the primary water source for much of the region's suburban area. However, communities' withdrawals can be limited due to low aquifer yields, impacts to surface water features, contamination and/or well interference. The Council conducted an initial groundwater availability analysis during the first phase of planning that considered the issues of aquifer yield, groundwater withdrawal limitations and water supply demand.

Aquifer Yield Potential

In order to characterize aquifer yield potential throughout the metropolitan area, the Council developed a semi-quantitative scoring system based on geologic influences on potential recharge, the presence/extent of each aquifer, observation well trends, and specific capacities and pumping rates of existing wells. Each community or group of communities relying on the same water source(s) was evaluated based on aquifer availability. Because the extent and potential yield of unconsolidated aquifers is uncertain, areas where they are not currently in use were not considered as part of the aquifer productivity analysis. The Mt. Simon-Hinckley aquifer system was not included in the aquifer yield evaluation because Minnesota Statutes, Section 103G.271, Subdivision 4a, allows new water appropriation permits from the Mt. Simon-Hinckley aquifer only when there are no feasible or practical alternatives to this source and restricts any such allocation to potable use.

Data sources used for this analysis include the Minnesota County Well Index (CWI), DNR State Water Use Data System (SWUDS), and existing digital surficial and bedrock geologic maps. The *Geologic Map of Minnesota, Quaternary Geology* (Hobbs and Goebel, 1982) and the *Bedrock Geology and Structure of the Seven-County Twin Cities Metropolitan Area, Minnesota* (Mossler and Tipping, 2000) were used to calculate the area of each geologic unit within each municipal water supply system area.

The Council developed an aquifer score (AQ_{score}) for each community using the following formula:

$$AQ_{score} = \frac{(R_{score} + OPCJ_{score} + FIG_{score} + Quat_{score})}{3.5}$$

R_{score} quantifies geologic influences on potential recharge within each community. Potential influences on recharge include the aerial extent and hydraulic properties of surficial and bedrock geologic units; potential recharge parameters were weighted to reflect the relative permeability of different units.

$$R_{score} = \frac{1}{2}\,(Q_{score} + B_{score})$$

Where Q_{score} is based on a relative ranking of the permeability of surficial Quaternary sediments and on the area of each surficial Quaternary sediment unit within the community boundary:

$$Q_{score} = \frac{Area_{\text{outwash, bedrock}} + \frac{1}{2}\,Area_{\text{lake sand, alluvium, peat}} + \frac{1}{5}\,Area_{\text{colluvium, sandy till}} + \frac{1}{10}\,Area_{\text{loamy till, lake clay}}}{Area_{\text{Community}}}$$

and where B_{score} is based on a relative ranking of the permeability of bedrock units and on the area of each bedrock unit within the community boundary:

$$B_{score} = \frac{Area_{\text{Prairie du Chien}} + Area_{\text{Jordan}} + Area_{\text{Ironton-Galesville}} + Area_{\text{Mt. Simon}} + \frac{1}{10}\,Area_{\text{St. Peter}}}{Area_{\text{Community}}}$$

The St. Peter Sandstone is assumed to behave as a semi-confining unit allowing significant leakage making it a less productive aquifer; therefore, the extent of the St. Peter Sandstone formation within a community was multiplied by 1/10. The St. Lawrence and Franconia formations are not differentiated on the metropolitan area bedrock geology map and were considered to be a single confining unit. Although the upper Franconia is often used as an aquifer, the vertical resistance of the upper Franconia is expected to be high even though the unit is characterized by high horizontal permeability zones.

$OPCJ_{score}$ reflects the total extent of the full to near-full thickness of the Prairie du Chien-Jordan Aquifer in each community. The extent of the Prairie du Chien-Jordan Aquifer was calculated as the sum of the area of the Decorah Shale (ODCR), the Platteville Limestone (OPVL), the St. Peter Sandstone (OSTP), the Prairie du Chien Group (OPDC) and one-half of the area of the Jordan Sandstone (CJDN). The Jordan Sandstone is divided by two to represent partial thickness of the Prairie du Chien-Jordan Aquifer. The maximum $OPCJ_{score}$ is 1.0.

$$OPCJ_{score} = Area_{\text{ODCR}} + Area_{\text{OPVL}} + Area_{\text{OSTP}} + Area_{\text{OPDC}} + \frac{1}{2}\,Area_{\text{CJDN}}$$

FIG_{score} quantifies the productivity of the Franconia-Ironton-Galesville (FIG) Aquifer in each community. A default value of 0.3 was chosen to represent the FIG Aquifer because it is generally less productive than the Prairie du Chien-Jordan Aquifer. If pumping or specific capacity data in a community indicates that the FIG Aquifer has a higher than normal productivity, that community was assigned a value greater than 0.3.

FIG_{score} =

<0.3, if the reported specific capacity values for FIG wells in that community were very low, or pumping rates were less than approximately 200 gallons per minute

0.30, if the reported specific capacity values for FIG wells in that community were considered typical, if pumping rates were less than approximately 1000 gallons per minute, or if no data was reported

0.60, if the reported specific capacity values for FIG wells in that community were considered high to very high, or if well pumping rates were on the order of 1,000 gallons per minute

0.75, if the reported specific capacity values for FIG wells in that community were considered very high, or if well pumping rates were greater than 1,000 gallons per minute

$Quat_{score}$ quantifies the productivity of the Quaternary aquifer(s) in each community, based on the use and the availability of Quaternary aquifers.

$Quat_{score}$ = 0, if no high capacity wells utilize the Quaternary aquifer(s) within the community

0.1 – 0.3, if a high capacity well(s), pumping greater than 300 gallons per minute, utilizes the Quaternary aquifer(s) in the community

0.75 – 0.95, if there are several high capacity wells, each pumping at approximately 1,000 gallons per minute, utilizing the Quaternary aquifer(s) in the community

The Council developed a scoring system to rank the communities based on aquifer recharge and yield (Table 9). Figure 8 illustrates aquifer potential by community based on the ranking system.

Table 9. Aquifer Potential Yield Ranking System

Aquifer Potential Score	Aquifer Potential Code	Aquifer Potential Description
≥ 0.45	A	Very High
0.40 - 0.45	B	High
0.25 - 0.40	C	High Moderate
0.10 - 0.25	D	Moderate
< 0.1	R	Restricted

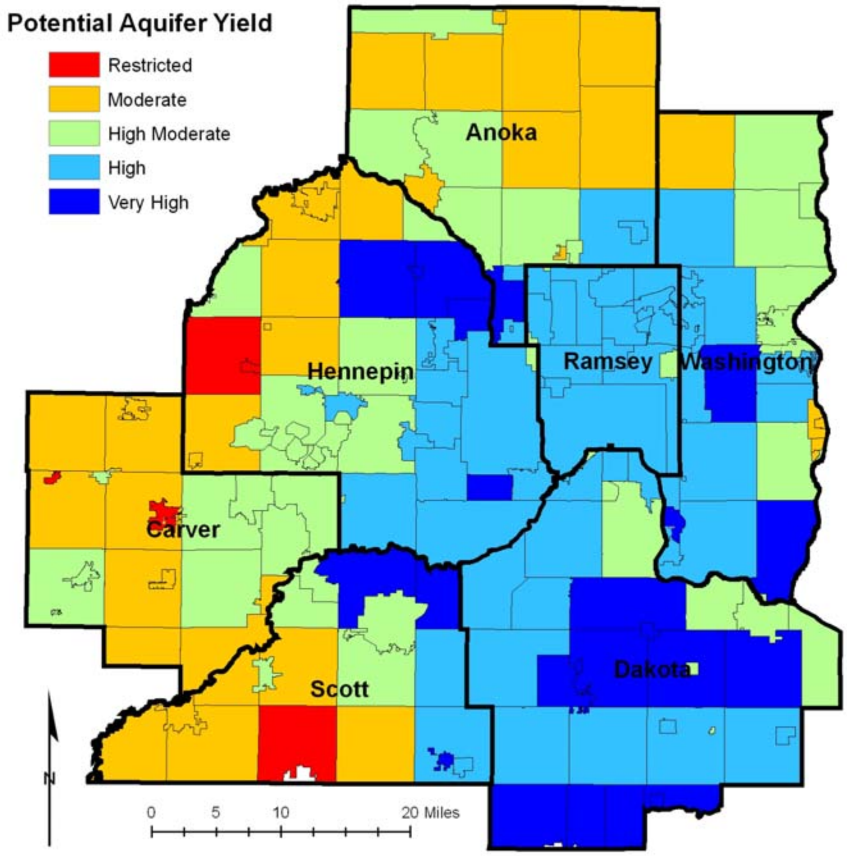


Figure 8. Aquifer Availability

Withdrawal Limitations

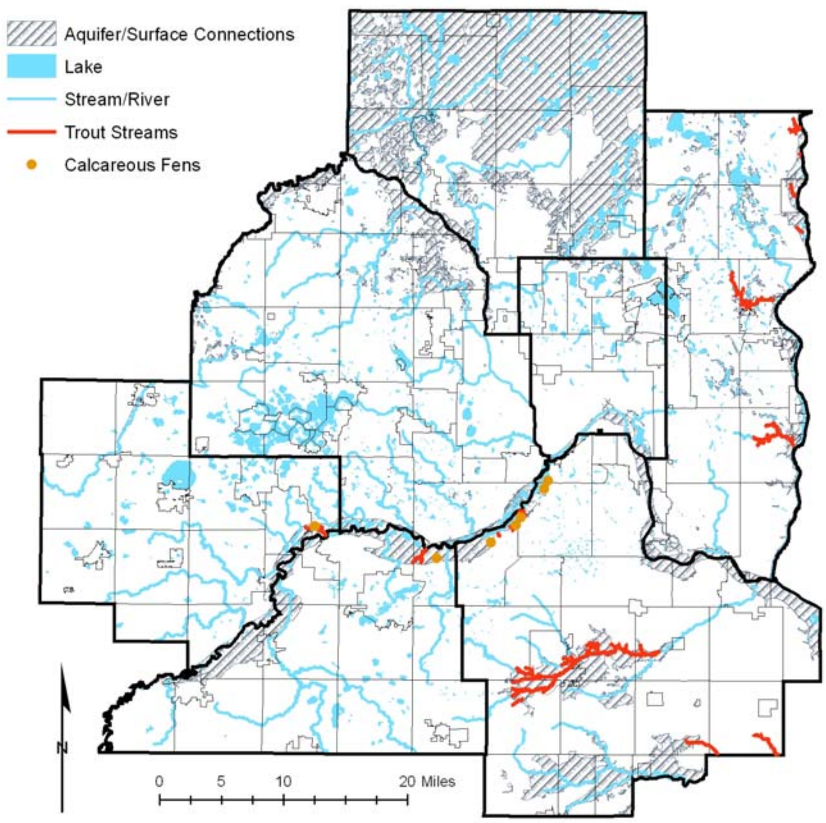
While geologic characteristics provide an estimate of the potential yield from aquifers, groundwater withdrawals may be restricted in the metropolitan area due to impacts on surface water features, groundwater contamination, well interference or other factors.

Impacts of Groundwater Withdrawals on Surface Water

Impacts of groundwater withdrawals on surface water features have already limited withdrawals in certain areas throughout the region. For example, the City of Savage must limit withdrawals from the Prairie du Chien-Jordan and drift aquifers due to pumping impacts on the Savage Fen. In most instances, however, it is difficult to predict or quantify the impact groundwater withdrawals may have on surface water features before the impact occurs. While assessing the impacts of groundwater withdraws on surface water features is difficult, the Council recognizes the importance of identifying groundwater and surface water connections when evaluating the adequacy of local supplies to meet projected water supply demand.

The Council used regional-scale digital geographic information on surficial and bedrock geology, land-surface elevation, aquifer water levels, and trout stream and calcareous fen maps to identify areas where withdrawals from a major aquifer may impact surface water features (Hobbs and Goebel, 1982; Minnesota Geological Survey, 1990; Meyer and Tipping, 1998; Minnesota Pollution Control Agency, 2004; Minnesota Geological Survey, 2004; Seaberg, 2000; Minnesota Department of Natural Resources, 2002; Minnesota County Well Index (CWI), 2006). For this analysis, it was assumed that groundwater withdrawals could impact surface water features when: 1) surficial geologic units are characterized by high sand content (≥20%) and thin (<20-50 foot thick) till units, 2) Ordovician bedrock confining units are absent, and 3) depth to the potentiometric surface of the shallowest major aquifer is less than 25 feet. While the results of this analysis (Figure 9) are imprecise, particularly where small "islands" of non-sensitive areas occur or where topographic relief is high and actual sensitive areas are small or narrow, the analysis does provide a general understanding of where potential impacts to surface waters could occur. The Council recognizes that groundwater withdrawals could impact surface water features in areas not identified in this analysis.

Figure 9. Surface Water Under the Influence of Groundwater



After determining where groundwater withdrawals may impact surface water features, the Council developed a scoring system to rank each community's potential for impacting surface water features (Table 10).

Table 10. Groundwater Withdrawal Impacts on Surface Water Limitations Ranking

Score	Description
1.0	If a trout stream or calcareous fen is located within 15,000 feet of a well or the community boundary
0.5	If a trout stream or calcareous fen is located within 15,000 feet of a well or the community boundary and a known semi-confining unit(s) or extensive surficial aquifer is present, thus buffering the impacts from pumping
0.25	If other known surface water and groundwater connections exist within the community

Impacts of Groundwater Pollution

In an effort to delineate the extent of groundwater pollution throughout the metropolitan area, the Council collected data from Soil and Water Conservation Districts, remediation wells listed in the CWI, and SWUDS to generally locate polluted areas. The Council also included the 8 Minnesota Department of Health (MDH) designated special well construction areas in the seven-county metropolitan region (Table 11) in its delineation.

Table 11. Special Well Construction Areas

County	Special Well Construction Area
Anoka	East Bethel Sanitary Landfill Twin Cities Army Ammunition Plant
Dakota County	Inver Grove Heights – Pine Bend Area
Hennepin County	CMC Heartland Lite Yard Site (Minneapolis Area) Twin Cities Army Ammunition Plant
Ramsey County	Twin Cities Army Ammunition Plant
Washington County	Baytown/West Lakeland Township Lakeland/Lakeland Shores St. Paul Park & Newport Washington County Landfill (Lake Jane Landfill)

Using the information collected, the Council developed a scoring system to rank each community's water supply limitation potential based on the existence of groundwater pollution (Table 12). For instance, the City of Baytown was given a score of 1.0 because the entire community is within a MDH designated special well construction area. Lake Elmo, with two large, separately mapped contamination plumes within the community, received a score of 0.5. Communities that have small clusters of remediation or recovery wells, indicating some localized contamination, were given a score of 0.25.

Table 12. Groundwater Pollution Limitation Ranking System

Score	Description
1.0	Known groundwater pollution plumes are present throughout most of or the entire community
0.5	Known groundwater pollution plumes exist in part(s) of the community
0.25	Groundwater pollution has been found in scattered, localized areas of the community

The Council will continue its groundwater contamination analysis with MDH and other stakeholders to improve groundwater contamination mapping throughout the region.

Withdrawals Limitation Ranking System

In order to identify areas where use of local supplies may be limited in the future, the Council developed a scoring system that incorporates both the impacts groundwater withdrawals may have on surface water features and the presence of groundwater contamination within a community (Table 13). The limitation score is the summation of the potential for groundwater withdrawals to impact surface water features and the presence of groundwater contamination scores. Table F-1 in Appendix F shows each community's limitations ranking.

Table 13. Withdrawals Limitation Ranking System

Limitation Score	Limitation Code	Limitation Description
0	0	No major limitations
0 – 0.5	3	Some limitation(s) possible
0.5 – 1.0	2	Some significant limitation(s)
Greater than 1.0	1	Important limiting factor(s)

5.4. Integrating Water Supply Demand and Availability

The projected water supply demand and availability analysis was used to assess the adequacy of local supplies to meet projected water supply demands.

Methods

The Council developed an adequacy score (uncertain, adequate or potential excess) for each community based on the adequacy of its supplies to meet projected water demand. The score is a combination of the demand projection, aquifer potential yield, and withdrawal limitation ranking scores. In general, communities with important limiting factors, or with some significant limitations likely, and high or very high water supply demand projections were designated as uncertain. Communities with relatively low demand projections and very high or high aquifer potential were scored as having a potential surplus. Factor combinations that were not assigned as uncertain or as having a potential surplus were considered to have adequate supplies to meet projected water supply demands. Specific knowledge about a city was also taken into account. Appendix F, Table F-1 shows category combinations for each community and each community's assigned adequacy ranking.

The adequacy of existing local supplies to meet future water demands in well-developed communities was determined first. Then, other communities were compared against similar-sized ranked cities. For example, Apple Valley is one of the larger communities in the metropolitan area and it has one of the highest rates of withdrawal. Apple Valley's water supply availability was determined to be adequate, but municipalities with demand densities much greater than Apple Valley were assigned an 'uncertain' designation, unless the city was very small and only required two or three wells. A hydrogeologic study for the City of Carver indicated some uncertainty in the ability of that city to meet the ultimate maximum demand; that information was used to determine the adequacy of local supplies in other communities with the same or similar aquifer yield classification code. Known limitations were also taken into account when determining communities' water supply availability. For example, trout streams and calcareous fens have restricted the City of Savage's use of certain aquifers. Other communities with the same or similar adequacy code as Savage were rated as 'uncertain', unless there was specific information to indicate that their water supply is not limited. A similar approach was used with communities that rely on the Franconia-Ironton-Galesville Aquifer.

Results

Through its analysis, the Council identified 23 communities as having a possible excess of supplies, 120 communities as having adequate supplies and 18 communities as having potentially limited supplies to meet 2050 projected demands. Figure 10 illustrates the water supply adequacy rankings by community.

The Council categorized communities using surface water supplies as having adequate water supply availability under normal conditions, but noted that supplies may be limited during drought or contamination events.

This is a preliminary evaluation of the adequacy of local supplies to meet future water supply demands, and it is important to recognize that limitations on potential water supplies could occur in areas designated as having adequate water supplies. For example, unexpected impacts to surface water features resulting from groundwater withdrawals are possible in many areas. This evaluation is intended to be only a preliminary regional analysis to help guide future efforts. It is not intended to replace local analysis when communities expand their supplies.

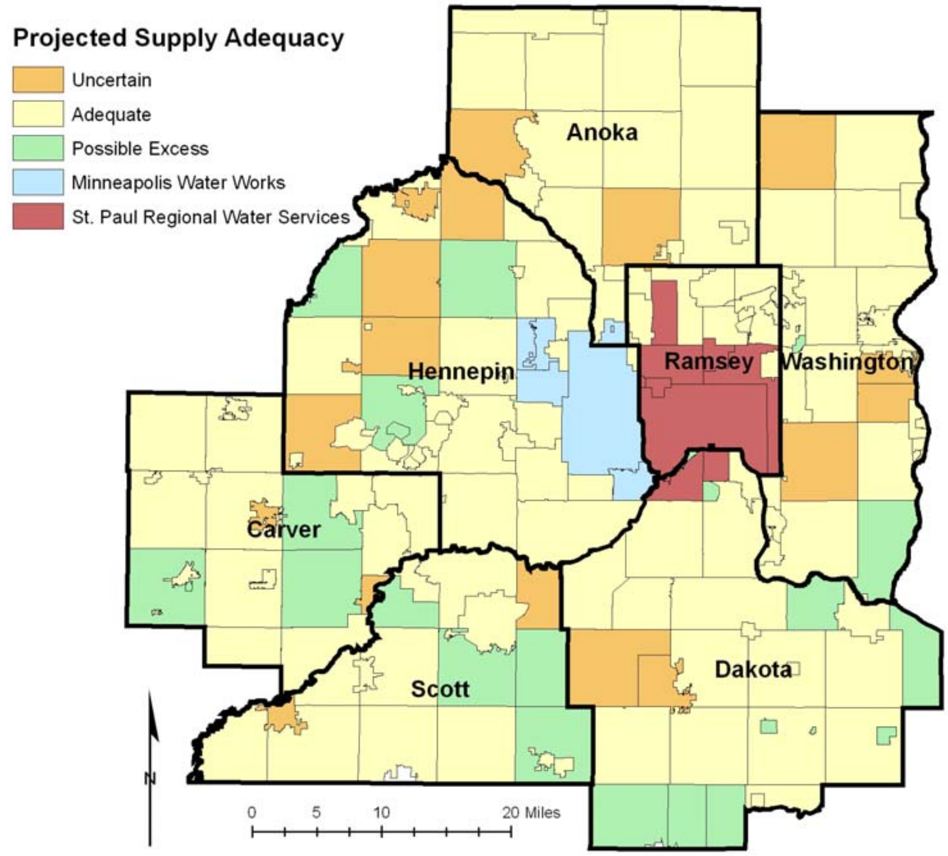


Figure 10. 2050 Projected Adequacy of Local Supply

Note: The supply of water for the Minneapolis Water Works and St. Paul Regional Water Services is adequate for projected demands except under certain circumstances such as drought or contamination of the Mississippi River.

6. ADDITIONAL TECHNICAL STUDIES

Several other studies currently underway are intended to provide additional information about the availability and reliability of water supplies in the Twin Cities metropolitan area. The results of these studies will be included in the development of the master water supply plan.

6.1. Recycling Treated Municipal Wastewater for Industrial Water Use

Recognizing the need to further evaluate the potential for using treated municipal wastewater to supply industry, in 2005 the Legislative Commission on Minnesota Resources provided a grant to the Metropolitan Council (Council) to determine the feasibility of recycling treated municipal wastewater for industrial use throughout Minnesota, characterize industrial water demand and quality needs, and determine the costs to treat municipal wastewater to meet specific industrial needs.

The goal of the grant is to conserve Minnesota's groundwater and surface water resources by recycling treated municipal wastewater for industrial water use. Results of the project will be applicable to communities throughout Minnesota. Benefits of recycling treated municipal wastewater include: (1) less groundwater aquifer depletion due to one-time use and discharge to surface waters; (2) lower demand on finite water resources to support business and growth; and (3) reliable and potentially lower cost water source for industry in the long-term.

The project involves several key tasks including:

- Determining the feasibility of recycling treated municipal wastewater for industrial use
- Characterizing industrial water demand and quality
- Determining the cost to treat municipal wastewater to meet industrial needs
- Ranking potential industrial users with respect to feasibility
- Mapping industry, institutional (e.g., regulatory) and stakeholder relationships, constraints, and drivers for implementing industrial reuse
- Recommending reuse alternatives for further development

The grant concludes June 30, 2007, at which time the Council will report on its findings to the Legislative Commission on Minnesota Resources. Information from this effort will also be used in the development of the master water supply plan, where applicable.

6.2. Aquifer Recharge Study

The Minnesota Geological Survey (MGS) is in the process of compiling and analyzing groundwater chemistry data and mapping surficial and subsurface glacial geology to identify where and how aquifers within the metropolitan area are recharged. Improved aquifer recharge is important when considering policies that protect the quality and quantity of water in recharge areas. The Council will use this information in the development of the master water supply plan. The MGS project has three components:

Twin Cities Metropolitan Area Surficial (Glacial) Geology Mapping

Existing surficial geologic mapping is being compiled, and revised as necessary, to create a seamless map of consistent geologic units for the area of Minnesota east of longitude 94º and between latitude 44º 30’ and 45º 30’ at a scale of 1:100,000. The map will be compiled in a geographic information system (GIS) and supported by a table of map unit properties such that derivative maps of particular characteristics (i.e., lithology, age, color, range of saturated hydraulic conductivity) may also be generated.

Groundwater Chemistry Database and Analysis

A database is being designed and populated with existing groundwater chemistry, isotope, and residence time analyses data, along with location and elevation coordinates for each sample. The database will be viewed and analyzed in a three-dimensional GIS to identify indicators of groundwater recharge to glacial aquifers and underlying bedrock aquifers.

Quaternary Subsurface Geologic Mapping

The groundwater chemistry analysis will be used to identify areas where bedrock aquifers are being recharged most rapidly. A number of these areas will be selected for subsurface mapping. The selection process will consider the data available for mapping, the size of the areas, the groundwater demand of the areas, and the diversity of geologic settings represented.

The subsurface mapping will be based on information from well records currently available from the County Well Index database, and from other geologic information at the MGS. The mapping will be delivered in formats appropriate for a wide range of technology levels and will likely include cross-sections, maps, digital elevation models of various geologic surfaces, and a three-dimensional geologic model, or illustrations derived from such a model. This mapping is intended to support analysis of the pathways by which water recharges bedrock aquifers in this area.

The improved understanding of the geologic framework gained from this effort will support the higher resolution hydrologic modeling that is required for managing anticipated growth in population and water demand.

6.3. Groundwater Contaminant Mapping

The Minnesota Department of Health (MDH) in cooperation with the Council and other stakeholders is in the process of developing a Geographic Information System (GIS) layer with known groundwater contaminant plumes that impact a geographic area of at least one square mile. This effort focuses on the seven county metropolitan area. The approach is to 1) summarize information from investigations conducted through the Minnesota Pollution Control Agency, Minnesota Department of Agriculture, and other sources and 2) establish a mapping index that will be used for referencing areas of documented groundwater contamination.

The MDH is also in the process of evaluating the presence of naturally occurring radium and arsenic in community water supply wells. These evaluations are based on existing data and do not reflect a region-wide sampling project. A draft of the radium occurrence report will be available in January 2007. The draft report of arsenic occurrence should be available in March 2007. This information will also be used in evaluating new groundwater sources in the development of the master water supply plan.

7. INSTITUTIONAL ARRANGEMENTS

As part of its first phase of water supply planning activities, the Metropolitan Council (Council) reviewed governance models to provide background for future discussions.

7.1. Examples of Governance Structures

Palm Beach County Water Utilities

Palm Beach County Water Utilities (Palm Beach) (www.pbcwater.com) in Florida is an official department of the county, governed by a county board. Palm Beach provides both wholesale and retail water and wastewater services. The regional organization also addresses issues related to limited supply of drinking water, salt-water intrusion into wells, and Everglades restoration. Palm Beach has a very active citizen advisory board to speak to the concerns of the 450,000 end users. A substantial asset and achievement of the organization is its 20 year water use permit, in a state where all other permits are limited to five years.

Cascade Water Alliance

The Cascade Water Alliance (Cascade) (www.cascadewater.org) in northwestern Washington State evolved from an local group of cities conducting some planning together, to a nonprofit corporation with an appointed Board of Directors developing supply and transmission facilities. Cascade provides wholesale water and planning to municipal suppliers who serve a total of 300,000 end users from the Cities of Bellevue and Redmond, Washington. The members achieved some measure of local control through joint action; they previously felt at the mercy of their common supplier, the City of Seattle. Cascade, a non-profit corporation with a board of elected officials from member jurisdictions, has also achieved economies of scale allowing it to develop alternative supplies, and purchase bulk water from Seattle.

Tampa Bay Water Authority

Tampa Bay Water Authority (Tampa Bay) (www.tampabaywater.org) is a Special District of the State of Florida that provides wholesale water to member jurisdictions, who serve a total of 1.8 million end users. Its board consists of elected officials from each participating jurisdiction, two per county and one per city. The members have made use of economies of scale to diversify their water resources. One achievement by Tampa Bay is its development of a high-tech computer tool to analyze the best combination of sources to use at any given point in time: groundwater, reservoir, desalination, or reclaimed water from rivers. This analytical tool uses real-time data received from instruments in the field. The region has been able to prepare water resources to meet a significant anticipated growth in population.

Southern Nevada Water Authority

The Southern Nevada Water Authority (Southern Nevada) (www.snwa.com) is a classic financing authority whose formation was driven by financial concerns. The Authority pumps, treats and delivers Colorado River water (from Lake Mead) to public providers who in turn serve over a million end users. Economies of scale allow maintenance of the system, as well as investment in expansion, that no partner could afford on its own. Southern Nevada's board of directors consists of elected officials from member jurisdictions. Local conditions required a regional approach to fund new infrastructure so that the region could accommodate significant growth.

Ruhr Association

The Ruhr Association (Ruhr) (www.ruhrverband.de) in Germany is an example of an organization from outside the U.S.A. It is the largest and most regulated organization of the groups reviewed, and it is becoming a model within Europe. It is a municipal association that provides water and wastewater management services to five million end users. Ruhr is a self-governing "Water Parliament" that plays a major role in regulation in conjunction with its responsibility of supplying water. The association has substantial power to control its source water and, as a result, has reduced pollution and alleviated water supply problems. A costly challenge in the near future will be meeting new rigorous European water quality standards. Ruhr is effective, in part, because it provides centralized technical expertise and financial support for it's members.

7.2. Comparison of Various Models

Functions of Regional Water Organizations

All of the organizations studied supply drinking water on a wholesale basis, develop water resources, and provide regional water planning services. Two groups serve the multiple purposes of water and wastewater. Only Palm Beach provides retail water service, and only in unincorporated areas of the county. Some organizations transmit water to local suppliers (municipalities or water districts) that provide retail service to their end users. Table 14 shows the functions of the model regional water organizations.

Table 14. Functions of Regional Water Organizations

	Palm Beach	Cascade	Southern Nevada	Tampa Bay	Ruhr
Wholesale supply	Y	Y	Y	Y	Y
Regional planning	Y	Y	Y	Y	Y
Single vs. Multiple Purpose	Multi	Single	Single	Single	Multi
Retail Local Distribution	Y*	N	N	N	N

Powers of Regional Water Organizations

Each organization has the authority to charge fees for service, acquire property, and issue bonds. Some organizations can condemn property, charge connection fees, and levy taxes. None of the regional organizations play a direct role in zoning and land use regulation, however, some do review permit applications for compatibility with water plans. Table 15 summarizes the powers of these regional water organizations.

Table 15. Powers of Regional Water Organizations

	Palm Beach	Cascade	Southern Nevada	Tampa Bay	Ruhr
Fees for service	Y	Y	Y	Y	Y
Acquire property	Y	Y	Y	Y	Y
Issue bonds	Y	Y	Y	Y	Y
Condemnation	Y*	*N*	Y	Y	Y**
W (Connection fees)[5]	Y	Y	Y	*N*	*N*
Levy taxes	Y*	*N*	Y	*N*	Y
Zoning and land use	Y*	*N*	*N*	*N*	*N*

[5] Water Availability Charge (WAC) is a charge for having water supply available to meet projected demands. This charge may be in addition to a retail connection charge.

Accomplishments of Regional Water Organizations

Each of the regional organizations the Council reviewed has experienced increased ability to develop infrastructure, increase capacity, and diversify sources. The organizations have provided vehicles for their members to invest in the future of their own jurisdictions through the regional organization. Each member has benefited financially through enhanced access to capital and by spreading the risk and lowering the cost of money. Economies of scale have been critical to these successes. Table 16 summarizes the accomplishments of these regional water organizations.

Table 16. Accomplishments of Regional Water Organizations

	Palm Beach	Cascade	Southern Nevada	Tampa Bay	Ruhr
Rates, Cost efficiency	Have kept rates low. Economies of scale.	Projects 7-8% rate increases due to capital programs.	Some costs are paid for through ¼ cent sales tax.	Have developed (more costly) alternatives to groundwater.	Economies of scale. Centralized planning and admin.
Supply and capacity	Near 20% reclaimed water goal.	Developing own water source, less dependent on Seattle.	Coordinates use of limited water sources from CO River.	End of water wars; supplies keep pace with demand.	Successful conjunctive groundwater and river water use allocation.
Finance	AAA bond rating. Pay-as-you-go financing. Large cash reserve.	Enhanced access to bond markets, by spreading risk.	Debt financing supported by regional sales tax and connection fees.	Obtained new $$. Ended litigation. Partners share risks and lower financing costs.	Member fees. Enhanced access to capital by spreading risk.

Local vs. Regional Control

One method of comparing local vs. regional control is the degree to which control is retained by members, usually municipalities. On one end of the scale, Palm Beach features a high level of local control, as the municipalities within the county can choose both whether to join and whether to develop independent water resources. On the other end, Ruhr represents a highly regulated environment. Table 17 summarizes the balance between local and regional control at each of these regional water organizations.

Table 17. Local vs. Regional Control of Regional Water Organizations

Most local control	**Palm Beach**	Not limited to singular source; maintains local choice in both partnership and water source.
⇕	**Cascade**	Partners had no source control (Seattle). Created choice through regional action. Partnership is optional.
	Southern Nevada	Partnership is optional, but resources very limited.
	Tampa Bay	Mandatory partnership and resources very limited. Exclusive provider of water for partners.
Least local control	**Ruhr**	Membership is mandatory. Highly regulated. Resources very limited.

8. SUMMARY

Despite abundant water supplies in the region, local water resource issues and complaints about the decision-making and approval process prompted the 2005 Minnesota Legislature to direct the Metropolitan Council (Council) to “carry out planning activities addressing the water supply needs of the metropolitan area.” Specifically, the Council was directed to develop a base of technical information for water supply planning decisions and prepare a water supply master plan for the metropolitan area. The legislature also established a Water Supply Advisory Committee to assist the Council in its planning activities, and directed the Council to submit regular reports to the legislature detailing its progress. The first report is due by the date the legislature convenes in 2007, and subsequent reports are due every five years thereafter. The Council’s *Water Supply Planning in the Twin Cities Metropolitan Area: Report to the 2007 Legislature (Legislative Report)*(Metropolitan Council, 2007), written in conjunction with this report, satisfies the requirements of Minnesota Statutes, Section 473.1565, Subdivision 3, as the first report to the legislature; subsequent reports are due to the legislature every five years hereafter.

During the first phase of implementing the legislature’s water supply planning directive, the Council collected information and conducted analyses of water supply systems, water demand projections, resource availability, and water resource monitoring. In addition, the Council evaluated the current decision-making and approval process, agency roles, and water supply safety, security and reliability issues in the region. Information about water supply governance structures in other regions was collected. The recommendations and next steps outlined in the *Legislative Report* will result in an evaluation of water resources in the context of long-term projected growth, ensuring sustainable and reliable water supplies throughout region, and improving the decision-making process.

This report contains the methods, data and findings for each of the technical studies performed during the first phase of water supply planning activities and provide the basis for several of the recommendations and next steps found in the *Legislative Report*.

9. REFERENCES

Glacial Drift Sand – Content Maps. Eds. Andrew Streitz, Doug Hansen, and John Seaberg. 8 Nov. 2004. Minnesota Pollution Control Agency. <http://www.pca.state.mn.us/water/groundwater/metromodel.html#projectreports>.

Hobbs H.C. and J.E. Geobel, 1982: Geologic map of Minnesota, Quaternary geology. Scale 1:500,000, digital map.

Metropolitan Council, 2004a: 2030 Regional Development Framework, Metropolitan Council Publication No. 78-04-013, St. Paul, Minnesota.

Metropolitan Council, 2004b: Water Demand and Planning in the Twin Cities Metropolitan Area: an update to the Long-Term Water Supply Plan, Metropolitan Council Publication No. 32-04-021, St. Paul, Minnesota.

Metropolitan Council, 2007: Water Supply Planning in the Twin Cities Metropolitan Area – Technical Report, Metropolitan Council Publication No. 32-07-004, St. Paul, Minnesota.

Meyer, G. and R.G. Tipping, 1998: Thicknesses of four tills within Washington County, Minnesota: Minnesota Geological Survey, Unpublished Manuscript Maps, Scale 1:50,000, four digital files.

Minnesota County Well Index. 2006. Minnesota Department of Health. <http://www.health.state.mn.us/divs/eh/cwi/>.

Minnesota Geological Survey, 1990: Dakota County Geologic Atlas C-6, Scale: 1:100,000, two digital files.

Minnesota Geological Survey, 2004: Unpublished study of bedrock geology and structure in southern Washington County.

Minnesota Trout Streams. 29 Mar. 2002. Minnesota Department of Natural Resources, Division of Fisheries. <http://deli.dnr.state.mn.us/>.

Mossler J. H. and R. G. Tipping, 2000: Bedrock Geology and Structure of the Seven-County Twin Cities Metropolitan Area. Scale 1:250,000, digital map.

Seaberg, J. K., 2000: Overview of the Twin Cities Metropolitan Groundwater Model, Version 1.00, Minnesota Pollution Control Agency.

10. ACRONYMS

CJDN	Jordan Sandstone
Council	Metropolitan Council
CWI	County Well Index
DNR	Minnesota Department of Natural Resources
FIG	Franconia-Ironton-Galesville
GIS	Geographic Information System
MDA	Minnesota Department of Agriculture
mgd	million gallons per day
MDH	Minnesota Department of Health
MGS	Minnesota Geological Survey
MPCA	Minnesota Pollution Control Agency
ODCR	Decorah Shale
OPDC	Prairie du Chien Group
OPVL	Plateville Limestone
OSTP	St. Peter Sandstone
SPRWS	St. Paul Regional Water Services
SWUDS	State Water Use Data System
USGS	United States Geological Survey