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THE PUBLIC WATER SUPPLY SYSTEM: INVENTORY AND THE POSSIBILITY OF SUBREGIONAL INTERCONNECTION

Working Paper No. 4 For The Long-Term Water Supply Plan

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by

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ABOUT THIS REPORT

This report is Working Paper No. 4 in a series of eight. The reports are being prepared as background technical studies for the preparation of a long-term water supply plan for the Metropolitan Area. The long-term plan preparation was required by the 1989 legislature and must be presented to the legislature on February 1, 1992. Preparation of the long-term plan follows completion of a short-term plan, which was delivered to the legislature on February 1, 1990.

The other technical reports in the series are:

- No. 1. Alternative Sources of Water for the Twin Cities Metropolitan Area. Metropolitan Council Report No. 590-91-011.
- No. 2. Water Demand in the Twin Cities Metropolitan Area. Council Report No. 590-91-009.
- No. 3. Water Availability in the Twin Cities Metropolitan Area: The Water Balance. Council Report No. 590-91-008.
- No. 5. Water Conservation in the Twin Cities Metropolitan Area. Council Report No. 590-91-020.
- No. 6. The Effects of Low Flow on Water Quality in the Metropolitan Area. Council Report No. 590-91-054.
- No. 7. The Economic Value of Water. Council Report No. 590-91-065.
- No. 8. The Institutional Framework for Water Supply Management. Council Report No. 590-91-064.

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INTRODUCTION

The public water supply system in the Metropolitan Area is composed of municipal utilities that supply water to a community or group of communities, and non-municipal systems that independently supply water to enclaves of development that otherwise would not be served. Examples of non-municipal systems would include mobile home parks, camps, and private institutions. Most attention in this report is given to municipal systems because of the tremendous volume of water that they supply, especially when compared to the much smaller non-municipal systems. Approximately 200,000 people in the Metropolitan Area get their potable water from their own wells, and are therefore not mentioned in this report.

The municipal water supply system of the Metropolitan Area has always provided an adequate supply of good quality water to the citizens of the region. The drought of 1987-1989, however, showed us that our supply of water is not unlimited and that conditions might worsen as a growing number of users vie for this finite volume of water.

The short-term water supply plan, prepared by the Metropolitan Council and submitted to the legislature in February 1990, summarized a number of problems that arose in the most recent drought, and pointed to the senseless repetition of these mistakes because of the lack of foresight and good planning. As the population of the region continues to grow, pressure to supply water to an expanding urban perimeter will present possibly the greatest water supply challenge we have yet seen. The reason for this is the thinning-out and actual termination of the Prairie du Chien-Jordan Aquifer in the substrata underlying much of this growth (see also discussion in Working Papers No. 1 and 2).

The time has come in the Metropolitan Area to look into the twenty-second century and devise a system that will meet this water supply challenge. We have never really had a shortage of water; rather, we have a distribution problem with getting the large volume of surface and ground water that we have to those who want to use it. This report assembles information on the municipal infrastructure that exists in the region to withdraw and distribute water. It is one of several technical reports that serve as input into the development of a long-term water supply plan required of the Metropolitan Council under Minnesota Statutes, Ch. 473.156.

The data used for this report come from several sources. Basic data on the municipal water suppliers were obtained from Minnesota Department of Health (MDH) files and were verified with a Metropolitan Council survey of suppliers in the summer and fall of 1990. Total water use was compared with information from the Department of Natural Resources' (DNR) water appropriation permit files. The problem with obtaining data from different sources is that each source has its own criteria for reporting, which results in different temporal reference points. In order to compare data, a period spanning 1987-90 was used, primarily because of MDH's program of collecting data every few years in a staggered format.

MUNICIPAL WATER SUPPLY SYSTEM INVENTORY

The municipal water supply system in the Twin Cities Metropolitan Area has always been operated by a reliable group of independently operated utilities. Table 1 summarizes the data for the 111 municipal suppliers. The table does not include data from a 112th supplier, Lakeland, which will begin service on approximately September 1, 1991. The details of each community system are contained in Appendix A. The total system serves a population just over 2,000,000 and contains about 540,000 residential, commercial, institutional and industrial service connections.

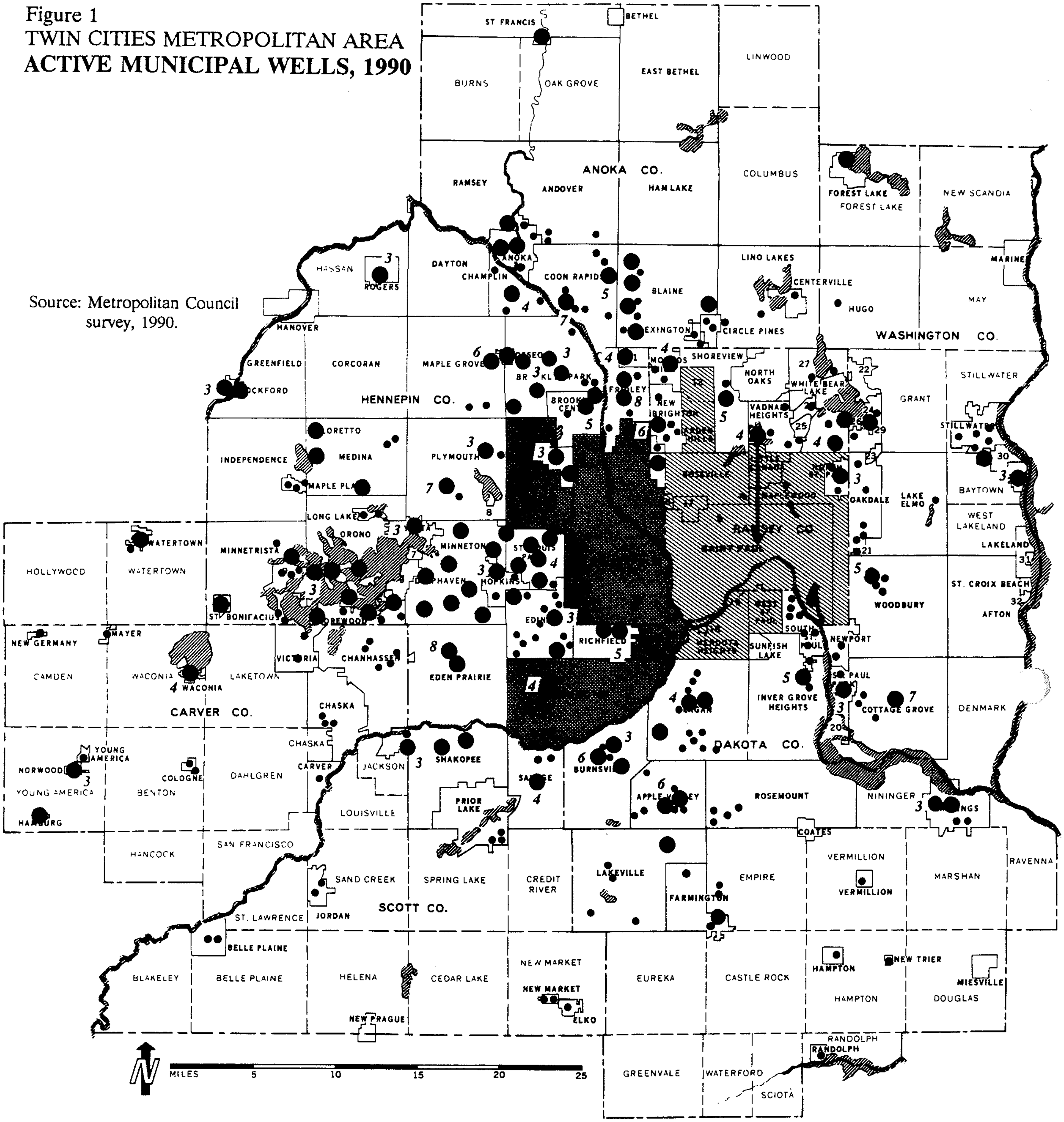
Table 1
MUNICIPAL WATER SUPPLY SUMMARY

CHARACTERISTIC	TOTAL
Population Served	2,019,894
Connections	539,832
Design Capacity	904.191 Million Gallons Per Day (MGD)
Average Daily Demand	277.428 MGD
Highest Daily Demand	709.234 MGD
Storage Capacity	494.8401 Million Gallons
Number of Wells	490
Well Capacity	703 MGD

As noted in Appendix A, the water utilities of Minneapolis and St. Paul also serve several surrounding suburbs. The Minneapolis Water Works relies entirely upon the Mississippi River to supply about 380,000 people in Minneapolis, plus an additional 91,500 people in Columbia Heights, Hilltop, Golden Valley, New Hope, and Crystal. A portion of the city's supply for Bloomington and Edina are also provided by the Minneapolis Water Works. The St. Paul Water Utility relies upon the Mississippi River for an average of about 70% of its supply to about 275,000 people in St. Paul, plus about 112,000 additional people in Lauderdale, Falcon Heights, Roseville, Arden Hills, Little Canada, West St. Paul, Maplewood and Mendota Heights. The remaining 30% comes from a combination of surface water sources in the Vadnais Lake chain of lakes (through which the Mississippi River water is also diverted) and the Rice Creek chain of lakes, and from a well system at the Utility's Vadnais Heights facility. Figure 1 shows the service areas for these two utilities that rely substantially upon surface water. The unshaded portion of the figure relies upon ground water for its source of water.

Figure 1
TWIN CITIES METROPOLITAN AREA
ACTIVE MUNICIPAL WELLS, 1990

Source: Metropolitan Council survey, 1990.



- Single well
- Well cluster (number given if more than two)
- Minneapolis service area
- St. Paul service area

The information contained in Appendix A was collected from the Minnesota Department of Health and verified by the Metropolitan Council through direct contact with the suppliers and through DNR permit records. The data indicate an average daily municipal demand of about 277 million gallons per day (MGD) from a supply system with a total design capacity of 904 MGD. The system capacity exceeds by about 200 MGD the sum of the highest daily demands of the suppliers (709 MGD). This comparison is academic since the likelihood of all suppliers experiencing peak demands and pumping their system at its capacity is extremely low. The excess capacity indicates the preparedness of suppliers to meet peak demands, although localized problems do occur. DNR permit records for the period 1984-1989 show that more water was pumped (303 MGD) than the averages reported by the suppliers. The reason for this was the dry weather that occurred from 1986 through 1988. Increased use during this period is not reflected in the "average" use figures reported to MDH and contained in Table 1.

The Metropolitan Area system contains a total of 490 wells that withdraw ground water from throughout the region and from various aquifers. Another 29 wells are currently planned for installation in the early 1990s. Specifics on these wells were not available as this report was being prepared. Appendix A lists the wells that each supplier uses to meet their demand. Figure 1 displays the location of the municipal wells. The combined capacity of the 490 wells is about 703 MGD, again only an illustrative number since the likelihood of all systems running at capacity is extremely low. The aquifers from which the suppliers withdraw ground water and the percentage of municipal water they supply are noted in Table 2.

Table 2
SOURCES OF MUNICIPAL GROUND WATER

SOURCE AQUIFER	PERCENTAGE OF TOTAL MUNICIPAL GROUND WATER SUPPLY*	VOLUME OF MUNICIPAL GROUND WATER SUPPLIED* (Million gallons per day, MGD)
Drift	9.8	68.6
Prairie du Chien-Jordan	66.5	467.2
St. Lawrence-Franconia	0.9	6.3
Ironton-Galesville	1.9	13.1
Mt.Simon-Hinckley	7.1	49.8
Multi-aquifer	13.2	92.7
Unknown	0.6	4.4

* Numbers apply to design volumes

The Prairie du Chien-Jordan Aquifer supplies (66.5%) by far the largest volume of ground water to municipalities in the Metropolitan Area. Surprisingly, multi-aquifer wells that pass through several units are the second largest supplier (13.2%); most of the multi-aquifer wells take full advantage of the deep system and pass from an upper unit through to the Mt. Simon or Hinckley formation. The drift and Mt. Simon-Hinckley wells follow at 9.8% and 7.1%, respectively.

Most of the population living in the suburban Twin Cities area obtains its water from ground water sources. As the population continues to grow outward from the urban center, a demand for ground water will therefore occur. Unfortunately, the Prairie du Chien-Jordan Aquifer is absent or thin in much of the area into which this population growth will occur. This means that these communities will rely upon the drift, Ironton-Galesville Aquifer, or Mt. Simon-Hinckley Aquifer to meet their needs. As discussed in Working Papers No. 1 and 2, this could present some water supply problems because the drift is relatively unprotected from contamination at the land surface, and the other aquifers (including the drift) are not capable of supplying as large a volume of water as the Prairie du Chien-Jordan. An analysis of this potential supply problem will occur in Working Paper No. 8 on the institutional evaluation of meeting future water demand.

COMMERCIAL AND INDUSTRIAL USE OF MUNICIPAL WATER

Although much of the need for commercial and industrial water is met by privately-owned wells, 87 MGD of the water supplied by municipal suppliers also goes to these uses. Appendix B contains details on the portion of water from each municipal system that goes toward supplying commercial and industrial uses, which also include institutional uses. Reference to Appendix B shows that close to one-third (30.3%) of water supplied by municipalities in the Metropolitan Area goes for commercial-industrial uses. Portions of local community supplies going for these uses vary from zero to 65%. Data on the amount of water used by self-supplied users are contained in Working Paper No. 2.

Seventy-four of the 99 municipal suppliers responding to a survey question, indicated that they had an inventory of commercial-industrial users. Eighteen of the respondents did not have an inventory, and another seven had too few such users to be concerned. Twelve suppliers did not respond to this question. Because much of the direct input on the commercial/industrial use is estimated either by the supplier, the Council or the MDH, caution is advised on using the numbers for other than general analysis when a supplier has not identified a specific percentage in Appendix B.

A total of 100 suppliers responded to a question concerning commercial-industrial shut-off in a supply emergency. Forty-eight of the respondents indicated they would shut-off commercial-industrial uses in an emergency, while 32 said they definitely would not. An additional six suppliers said they could not easily shut these uses off and another five said it would depend upon circumstances. The same seven as noted above said they had too few commercial-industrial users to worry about it. Many of the "no" respondents said they knew who the commercial-industrial users were, but that they would not be willing to shut-off supply to them. There was no apparent relationship between size of municipal supply and willingness to shut-off commercial-industrial users.

PER CAPITA USE OF MUNICIPAL WATER

Appendix B also contains a calculation of per capita use of water, broken down for all uses and for residential uses only. The mean per capita use with all uses included is 128 gallons, while the residential-only use rate is 102 gallons. Per capita usage for all uses for peak demand for each municipality was also calculated in Appendix B and averaged 328 gallons, or about 2.5 times the average daily demand. Peak per capita use for residences only cannot be determined because it is not possible to determine which fraction of peak municipal use comes from just residential use, as opposed to commercial/industrial.

Caution is advised while using the overall per capita figures because of the variability of the commercial/industrial component in the number. As noted previously, many of the commercial and industrial numbers are estimates by the suppliers, or in lieu of their opinion, an estimate by the Council or MDH.

PRICING OF WATER BY MUNICIPAL SUPPLIERS

The municipal water supply survey also asked the price the municipality charged for water, and whether the price varies by volume and by type of use. The results of this survey question are tabulated in Appendix C, along with three examples of the price for a certain volume of water. Table 3 summarizes the information in the appendix. In order to interpret Appendix C, a few definitions are needed. "Single block" pricing means that only one rate is charged for all of the water used during a billing period. "Decreasing block" and "increasing block", respectively, are lowered per unit (usually 1,000 gallons) and higher per unit rates as volume used increases. "Flat rates" mean that there is one charge during a billing period, no matter how much water is used.

Table 3

SUMMARY OF WATER PRICING IN THE REGION

USE TYPE AND MODE	AVERAGE PRICE (RANGE)
Residential, 30,000 gallons per quarter	$34.75 ($10.50 - $89.20)
Commercial/Industrial, 30,000 gallons per quarter	$35.35 ($10.50 - $89.20)
Commercial/Industrial, 100,000 gallons per quarter	$110.38 ($37.00 - $281.70)
Modes: Decreasing Block	45
Increasing Block	7
Single Block	54
Flat	5

Many communities do not apply a single method, but instead use, for example, a single block with a service charge or a minimum volume of water that must be paid for in a billing period. Theoretically, it would seem from a wise use of water standpoint that the increasing block is the best pricing method because it encourages conservation in order to avoid escalating per unit costs. However, use of increasing block pricing with prices that start low as a beginning point might not in fact save any water at all. For example, reference to Appendix C shows that Blaine uses an increasing block structure, but begins pricing at an extremely low $0.35 per thousand gallons. When compared to Bloomington, which uses a single block price of $1.20 per thousand gallons plus service and minimum charges, we find that Blaine charges only 25% as much as Bloomington for the same volume of water. Therefore, one can certainly ask "Does increased block pricing really save water?" The answer is obviously, "Only when started at a reasonable base price."

Some of the same type of questions can be raised for decreasing block pricing, which has always been assumed to be counter-conservation oriented. Carrying the above figures one more step, we can see that Carver uses decreasing blocks, but charges about seven times as much as Blaine for the same volume of water. Again, the comparison for flat rate pricing, such as with Belle Plaine charging three times as much as Blaine for 30,000 gallons, can be confusing. Of course Belle Plaine would charge the same price no matter how much water the customer used. A single block is generally thought to be fairly neutral because it neither encourages nor discourages high use to obtain favorable pricing; yet as with the other methods, it depends on where the method places its base price.

Appendix C shows that of the 111 communities in our survey, most (54) use a single block pricing approach. Forty-five communities still give preferential pricing to larger water users with decreasing blocks, while five charge a flat rate for all of the water that a user wants to use. Only seven communities in the Metropolitan Area price water using an increasing block method.

Any attempt to reduce water use through pricing is meaningless if a community does not meter the amount of water used by its customers. The municipal water suppliers survey showed that most of the Metropolitan Area's municipal systems do meter their customers. Appendix D lists whether the city has metering and if it does, the year in which it began to meter. Of the 111 surveyed suppliers, only five do not fully meter. Of the five that do not fully meter, one meters 15% of the community and another meters the commercial accounts only. Mandatory metering would certainly be a good first step that the legislature could undertake to assure wise use of water in the region.

Table 3 shows that the average quarterly cost to a residential household for 30,000 gallons of water supplied by a municipality in the region is $34.75, or $1.16 per thousand gallons, or slightly over one-tenth of a cent per gallon (0.1 cent/gallon). The per gallon cost ranges from a low of about 0.04 cent/gallon to a high of only 0.3 cent/gallon. The residential figure rises only slightly to $35.35 or $1.18 per thousand gallons if the user is a commercial or industrial customer. For larger commercial-industrial customers using 100,000 gallons of water, the average price is $110.38. These numbers indicate that water generally costs just slightly over $1.10 per 1,000 gallons, or about 0.1 cent/gallon, in this region for any use.

Table 4 shows water and sewer prices from several metropolitan centers around the country. The data show that with few exceptions, water prices in the Twin Cities area are comparable to prices elsewhere, even the apparently water-short West. Sewer rates were included in the table for informational purposes so that a comparison with Metropolitan Area sewer prices contained in Appendix E can be made by those interested.

A Metropolitan Council survey of municipal water suppliers in 1979 can be used to make some comparisons and note our progress over a decade. A tabulation of 108 respondents in 1979 showed that 65 were using single block pricing, 34 decreasing block, 9 flat charges and zero increasing block. These numbers show that even though we have begun a slight movement toward increasing block pricing, we have actually increased the number of decreasing block communities and lost only a few flat rates. The residential price for 30,000 gallons charged by 106 respondents in 1979 was $16.93, or about one-half of the current price.

One of the survey questions asked this year was the technique used to arrive at a price for water. By far, the most common response was the need to cover all capital, operational and administrative costs of supplying the water without losing any money. Some communities survey adjoining communities to see what they are charging, and price their's accordingly. Those communities served by another utility, such as the St. Paul Water Utility or the Minneapolis Water Works, merely tag-on appropriate costs to the wholesale price they pay to the supplier. In some cases, the larger supplier actually bills the customers directly.

Table 4

WATER AND SEWER PRICES FROM OTHER REGIONS

CITY	WATER RATE	SEWER RATE
Atlanta, GA	$2.27/1000 gallons	$1.60/1000 gallons
Austin, TX	$5.46/1st 2000 gallons $3.58/1000 gallons over 2000	$5.61/1st 2000 gallons $3.58/1000 gallons over 2000
Chicago, IL	$0.89/1000 gallons	$0.71/1000 gallons
Columbus, OH	approx. $25.00/person/quarter	sewer included in water price
Fargo, ND	$10.80/0-6000 gallons $1.80/1000 gallons over 6000	$23.10 quarterly
Las Virgenes, CA	$0.22/1000 gallons for 0-1875 $0.81/ " " 1876-9375 $0.96/ " " 9376-19875 $1.09/ " " over 19875	No information
Los Angeles, CA	$0.78/1000 gallons---winter $0.88/1000 gallons----summer - base charge $4.50/month - discounts for seniors	No information
New York City, NY	$1.27/1000 gallons	$1.42/ 1000 gallons
San Diego, CA	$0.89/1000 gallons for 0-7500 $1.03/ " " over 7500	No information
Santa Barbara, CA	$1.29/1000 gallons---summer $1.11/1000 gallons---rest of year	No information
Tucson, AZ	Volume......Winter.....Summer (gallons) 0-3750.......$1.07......$1.07 3751-7500....$1.20......$1.20 7501-15K.....$1.43......$1.65 15-22.5K.....$1.63......$2.05 22.5-37.5K...$1.80......$2.32 over 37.5K...$2.00......$2.61	No information
Washington, DC	$3.82/1000 gallons	$3.82/1000 gallons

It would seem quite obvious in reviewing the information contained in Appendix C that we could obtain some savings in overall water demand if we made a major switch toward increasing block pricing, but only if the starting price is close to the overall regional average price. Establishing an increasing block structure at a low beginning price does not lead to any cost incentive, as evidenced by the numbers in Appendix C.

To test whether overall demand is a function of block pricing structure, a regression analysis was performed, with cost regressed as an independent variable against water demand for the municipal suppliers. The analysis showed that currently is no discernible relationship (r^2 = -.05) between cost and demand in the region. However, the small number of increasing block communities meant that the input data were few for the increasing block pricing approach.

The anomalously low base prices previously noted also tend to confuse data on pricing structure. We do not want to suggest that we abandon efforts to move in the direction of increased block pricing, rather, that it makes sense to use this type of pricing to achieve water savings only if the base price is set at a high enough price to economically motivate consumers to conserve. Setting the base price extremely low does not encourage anyone to reduce use because they pay so little anyway.

If a shift were to occur, and more people began to be charged based on volume starting at a reasonable base price, water demand reduction as a function of cost could be affected. Currently, however, the price of water is so low that substantial increases would likely be needed to induce people to reduce their use. At an average of only $1.15 per 1,000 gallons, there is little incentive to cut water use. In any event, a resource-oriented wise use or conservation program should have increased pricing as an integral component so that users recognize the true value of water as their use goes up.

Further details on the economic aspects of water are included in another technical report in this series. Working Paper No.7 addresses the economic value of water in much greater detail than contained in this report.

INTERCONNECTION OF MUNICIPAL SYSTEMS

Perhaps the question most often asked pertaining to the Metropolitan Area municipal water supply system is, "Why don't these 100-plus suppliers connect their systems so that we have fewer suppliers and a better-planned approach to the withdrawal of water?" Further significance was given to this question when the U.S. Geological Survey reported, as part of its ground water modeling of the Twin Cities Basin, that we cannot extract an optimum amount of water from the ground water system because we do not go about it in an efficient manner. That is, we have over 100 independent suppliers all obtaining water within their own boundaries, wherever their particular needs happen to be. Fortunately, the problems associated with this disjointed approach have not yet caused any serious supply problems.

The existing and possible system interconnections among the 100-plus suppliers were inventoried as part of the water supplier survey undertaken in conjunction with this report. We found that there are a surprising number of system interconnections in the region. We also found many conflicting opinions as to whether particular cities were in fact interconnected at all; typically in these cases, one city claims an interconnection to an adjacent city that has no knowledge of any such interconnection. These discrepancies will be detailed later in this section.

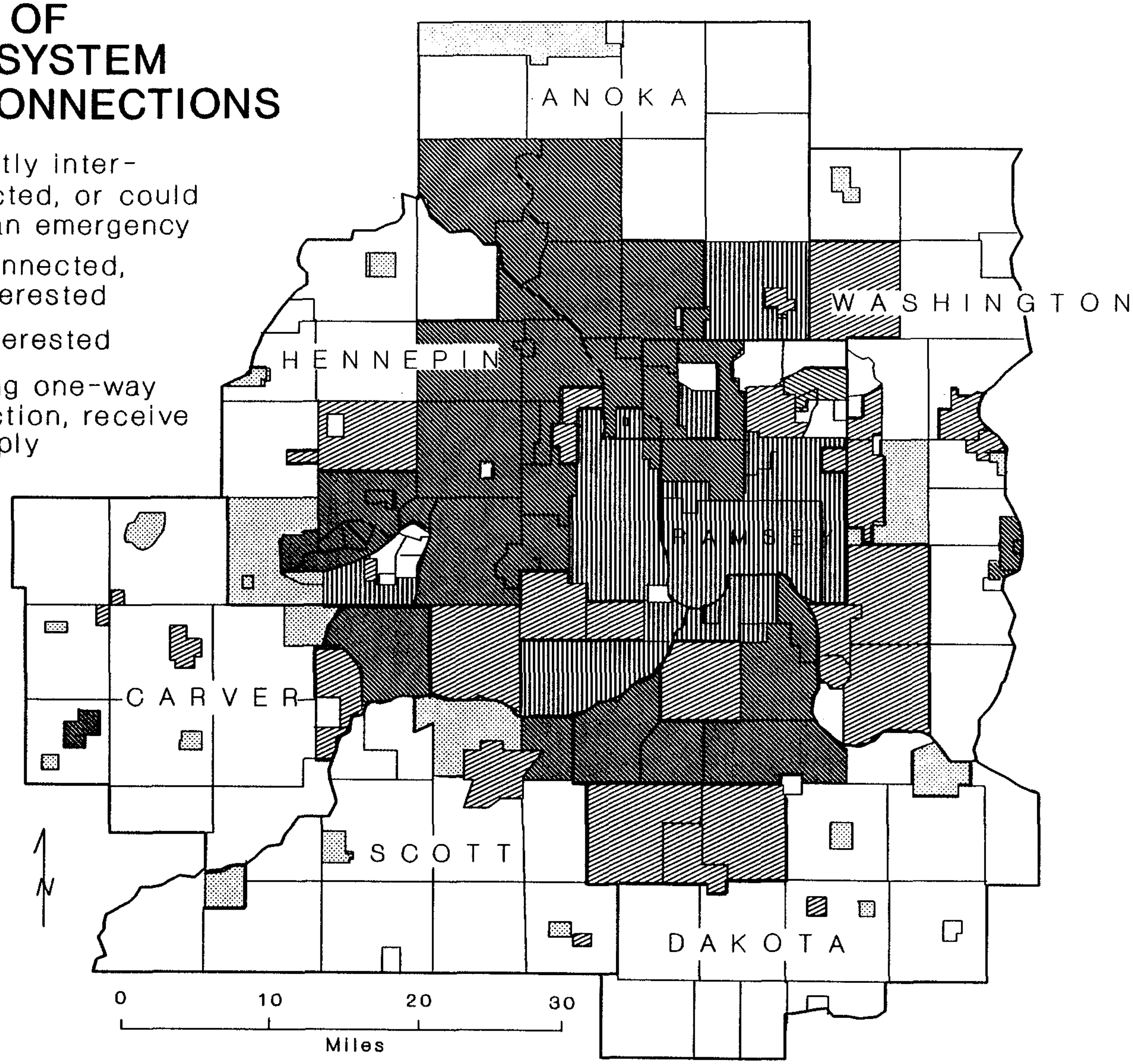
Pursuant to the receipt of the survey responses, individual contact was made with all of the suppliers to query them further. Initial tabulation of these responses (Appendix F) indicates that we have 62 municipal suppliers that somehow claim an interconnection to a neighboring supplier. An additional 31 state that they are not currently interconnected, but are interested in it, with many of them having studied the possibility. Only 23 suppliers stated no interest in interconnecting, and most of these were because of the large distance that separates them from the nearest potential supplier. The vast majority of the connections listed in Appendix F are small connections (12" or less) for "emergency use only", and in fact could not meet the entire demand of either of the participants for an extended period of time.

Figure 2 summarizes the follow-up responses contained in Appendix F. The most striking feature of Figure 2 is the tremendous percentage of municipal suppliers who are either currently interconnected or are interested in pursuing system interconnections. It seems the drought of the late 1980s might have had some impact on how municipalities view their "finite" source of water. Of additional note in Figure 2 is the fact that the Lakeland-Lakeland Shores-Lake St. Croix Beach system is included for informational purposes, although it is not yet operational.

One of the dominant themes that came from a Metropolitan Council day-long conference (December 1, 1989) on the water supply of the Metropolitan Area was the need to pursue regional approaches to solving our water supply problems. Among the most commonly mentioned options for instituting such an approach was the development of regional or subregional water distribution systems, planned regionally but operated by the parties participating in each subregion. A key factor in arriving at this approach was the fact that surface water flowing into the region was far greater than needed most of the time. Reference to previous work in this water supply planning effort (Working Paper No. 3) documents the extremely high inflow relative to demand for our river system. Relying on this surface water system makes a great deal of resource sense, since failure to use it as it flows through the area means that it is lost to us forever. The logical complement to this approach is that our

Figure 2

STATUS OF WATER SYSTEM INTERCONNECTIONS



ground water system then can be relied upon to supply water during those few occasions when surface water cannot meet demand.

Working Papers No. 1 and 2 of this water plan series indicated that a five-year average of about 165 MGD of Mississippi River water is used to meet municipal demand. The remaining approximately 140 MGD of municipal demand is met by ground water sources, as shown in Table 1 of this report. Meeting the entire demand of about 305 MGD from the river would be very easy most of the time (Working Paper No. 3). Under this water use focus, ground water would be kept for periods of peak demand and for periods when surface water could not be used for some reason, such as a contamination event or an extreme drought.

Obviously, a shift to a system that supplies all urban communities with water from the Mississippi River and ground water during low flow would require a substantial amount of time and infrastructure change. The existing system of interconnections could not meet the need because of the small size of most of the connections. If a long-term decision is made to pursue regional water supply, a river withdrawal and far-reaching distribution network would be needed to not only distribute surface water outward, but also to reverse this in order to get ground water toward the center of the system during periods of need. The most direct approach to accomplish this would be for the cities currently withdrawing, that is Minneapolis and St. Paul, to enlarge their intake capabilities and serve as regional water distributors. The city of Brooklyn Center also has a permit from DNR to withdraw water from the Mississippi River, although the city has never used it. Large-scale distribution of surface water outward could occur via a pipeline system that could feed the raw (or possibly finished) water to the subregional systems, which in turn treat and distribute it to the system members.

Difficulties with a regional distribution approach could be substantial. Perhaps the most serious drawback is the potential cost of the infrastructure. Most municipal water systems have been developed with the current mode of distribution in mind, and therefore, have not structured their system to receive and/or distribute water that comes from a regional source. Exceptions to this are, of course, the Minneapolis and St. Paul suburban systems. As a result of the large expenditures and planning that communities have invested in their systems, a changeover to a different mode of supply might be difficult to justify. Options for regional system development that acknowledge these conditions are, for example, existing, older systems that serve communities not experiencing growth could continue to rely upon their wells, whereas rapidly growing communities at or beyond the limits of the Prairie du Chien-Jordan Aquifer could look at future infrastructure development in a subregional context. Any large-scale move towards subregional distribution systems would have to long-term, occurring over the next 20 or more years.

Other difficulties with subregional systems include differing system pressures and costs of supplying treated water, loss of system autonomy, a wider impact from contamination of a supply, and revenue distribution. Each of these difficulties would have to be addressed on a cooperative system basis before coordinated efforts could ever proceed.

Possibilities for subregional system development could include shared ground or surface water systems wherein several suppliers get together to plan source development and distribution. The Minneapolis and St. Paul suburban approach is a good example of this, as is the New Hope-Golden Valley-Crystal arrangement for the distribution of Minneapolis-supplied water. Based on the survey responses from the municipal suppliers and their interest or current participation in interconnecting, different groupings of potential subregional systems can be made. One such example grouping in Table 5 lists the various systems and Figure 3 portrays them. Each of these groups could be linked to share water sources and distribution, with water coming from internal supplies and/or external sources. The current demand listed in Table 5 will obviously change as some of the more rapidly growing communities develop their water supply systems to meet growth expectations. This characterization is an example of potential linkages that could be made: details of any such proposal would need to be analyzed with engineering level studies.

Table 5
POTENTIAL SUBREGIONAL WATER DISTRIBUTION SYSTEMS

SYSTEM	CURRENT DEMAND (mgd)	POSSIBLE SOURCES
Northwest	26.1	Ground water; surface water from Minneapolis
Southwest	49.2	Ground water; surface water from Minneapolis
East	14.8	Ground water; surface water from St. Paul
North	28.0	Ground water; surface water from St. Paul
South	25.9	Ground water; surface water from St. Paul
St. Croix	2.5	Ground water

Another difficulty that would need to be overcome if suppliers rely on different sources of water at different times is the treatment of this water. Each community has developed its system to treat the chemical and physical characteristics of surface or ground water. St. Paul is the only supplier to treat a mix of both sources. Bloomington treats ground water and then mixes it with surface water from Minneapolis in the distribution system.

Difficulties in mixing sources might arise, for example, from the introduction of a lower pH (ground water) source that would be more corrosive than a high pH surface water. It would seem as though this problem would only occur during a source-reversal for the Minneapolis and St. Paul supplies and could be addressed by introducing the "raw" water prior to the treatment process. If there is an emergency and ground water would have to be directly introduced to the distribution system, the inconvenience of a high iron content for a short period, for example, would be far easier than living with no water. If the replacement water resulted in water not totally safe, perhaps it could be used for non-potable uses only, thus easing at least part of the emergency condition.

Obviously, the development of any subregional system that routes water from surface sources outward and ground water sources inward, requires a great deal of planning and a long time to implement. The problems encountered in a severe drought and the likelihood of ground water shortages as the region grows outward, however, merit such an evaluation.

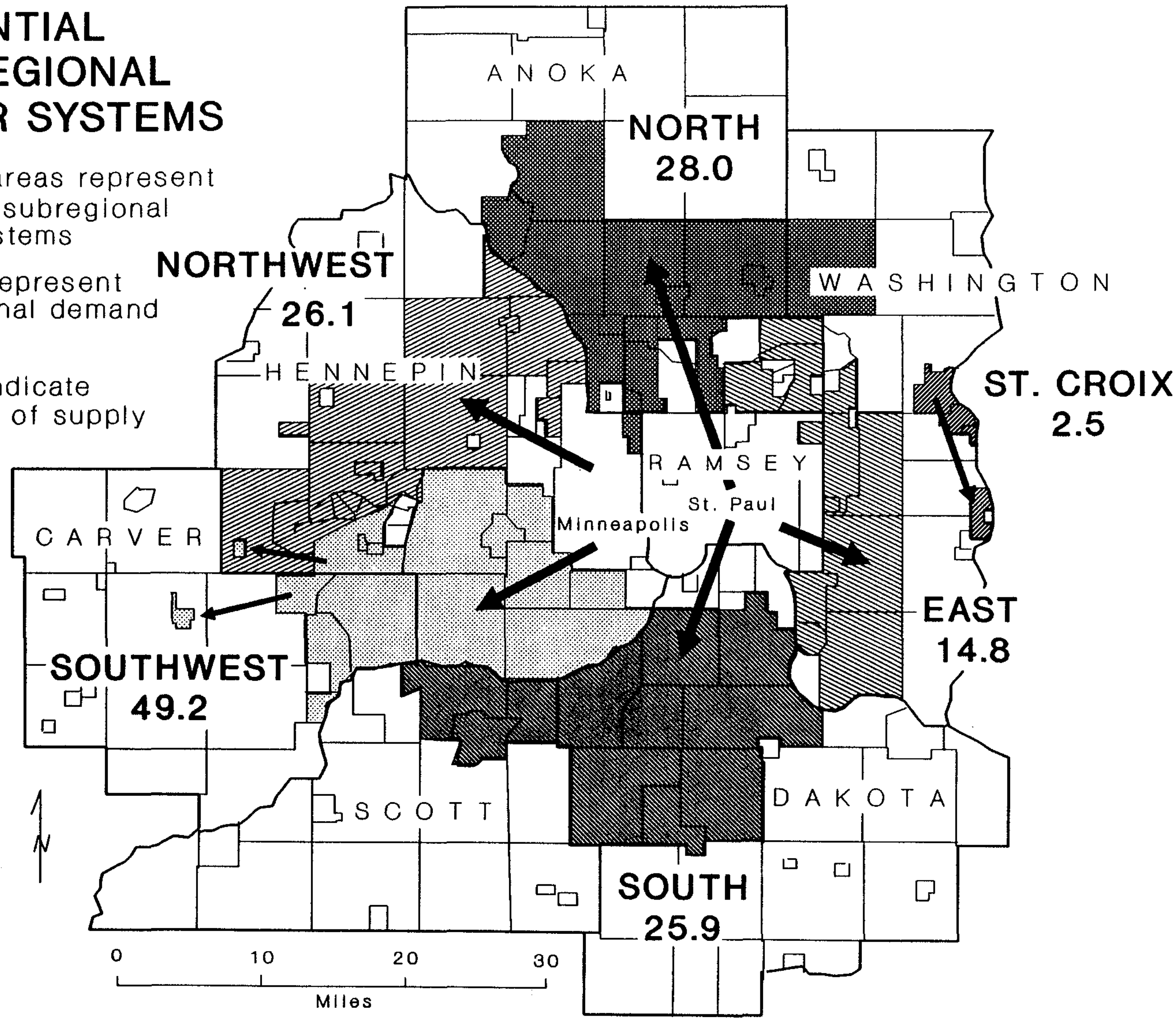
Figure 3

POTENTIAL SUBREGIONAL WATER SYSTEMS

Shaded areas represent possible subregional water systems

Figures represent subregional demand in mgd

Arrows indicate direction of supply



MUNICIPAL SUPPLY PROBLEMS ENCOUNTERED

The municipal survey also asked water suppliers if they encountered any supply problems with their wells during the recent drought and what problems, if any, they encounter in their normal operations. The responses to the drought-related question are contained in Table 6 (see also Working Paper No. 1) and the normal operating problems are summarized in Appendix G.

The drought of 1986-1989 presented many problems to many different water suppliers, but among the most serious were the well drawdown problems that some suppliers experienced. These problems were not experienced by all ground water suppliers, but seemed to occur in some rapidly growing suburbs and in some communities at the outer edge of the Prairie du Chien-Jordan. Table 6 summarizes the drought-related problems.

Table 6

DROUGHT-RELATED GROUND WATER SUPPLY PROBLEMS

COMMUNITY	PROBLEM ENCOUNTERED
Blaine	Well levels seem to be dropping 1' per year
Burnsville	One well broke in 1988
Chanhassen	Noticed lowering of static levels
Coon Rapids	All wells experienced decline in capacity, ranging from 5-50%; one well shut-down
Edina	Pump bowls lowered 40-60' in several wells
Farmington	Static levels dropped 3-4' in wells
Fridley	Excessive drawdown
Long Lake	Noticeable lowering of static water levels
Maple Grove	Static levels lower by 10'
Mounds View	Two wells lowered 40' to get sufficient water
Norwood	Dropped 3' in well #1 and lost well #2
Plymouth	One well failure to draw water
Rockford	Noticeable lowering of water levels
St. Paul Park	Three wells could not keep pace with demand
Spring Park	No problem but noticed 2' drop in static levels
Tonka Bay	Experienced some minor static level lowering
Woodbury	Pumping at maximum daily to meet demand

It is important to note that the problems listed in Table 6 are not a reflection of poor system management, but are rather an indication of local ground water system limitations in keeping up with demand under drought conditions, when demand is high. Also, the communities listed in Table 6 are those that were not reluctant to identify their difficulties; other communities might not have been so willing, resulting in a somewhat lesser number of identified problems than actually exist.

Many communities (35) responded that they have encountered no problems in their water supply. The most common (53) routine problem noted in Appendix G is the high level of iron (Fe) and manganese (Mn) in ground water. This problem, although common to many supplies, can be overcome by filtration or treatment with polyphosphates. An associated "rotten egg" smell, usually hydrogen sulfide, and other taste, odor and color problems were noted by nine suppliers. Some communities (4) have begun to report radium as a problem, and several others (10) reported problems associated with an aging infrastructure, such as leakage and breaks. Other problems that were mentioned include various chemical problems (3) and excessive hardness (2). Eight suppliers did not respond to the question.

Overall, the ground water supply system in the Metropolitan Area operates with few problems other than the ability of the resource to locally keep up with high demand. Unfortunately, a fair amount of the growth expected in the region for the next 20 years will occur in areas that occur at or beyond the lateral extent of the Prairie du Chien-Jordan Aquifer. This is likely to mean that supply problems such as those noted in Table 6 will become more common. Again, a possible solution to this is a series of subregional systems tied in to a surface water supply source.

CONSERVATION MEASURES

Yet another question asked in the municipal water suppliers survey was what, if any, conservation measures used during a drought or routinely to avoid demand problems. Table 7 summarizes the responses. Note that the numbers in the table are not additive because many suppliers listed more than one measure.

Table 7
CONSERVATION MEASURES USED BY MUNICIPAL WATER SUPPLIERS

CONSERVATION MEASURE	NUMBER OF COMMUNITIES USING MEASURE	COMMENTS
Sprinkling restrictions	71	Most restrictions are odd/even as needed
Public education	24	Usually instituted with other measures
Leak detection and repair	19	To reduce system losses
Pricing	15	Pay more for water
Indication of program but no details offered	7	Specifics unknown
Reuse/recycling	6	Mostly industrial programs
Pressure reduction	5	Reduce service pressures
Plumbing code revisions	4	No details given
Low water landscaping	3	For public areas
No program	23	No measures instituted

By far the most commonly used measure to reduce demand is the use of sprinkling restrictions. The variety of restrictions is quite large, but most communities use an odd/even approach on an as-needed basis; that is, when demand gets high in the summer and the city begins to notice some difficulty in keeping up with it, the water utility implements restrictions. Several communities have instituted permanent bans because of the difficulty they have had in meeting seasonal demands. Permanent restrictions can assist a community by eliminating the need to build very expensive pumping and storage facilities for short-term, seasonal demand peaks (see also Working Paper No. 5). During wet years, the need for restrictions lessens as demand for outside use drops.

Many communities have supplemented their conservation programs with public information. This type of conservation approach can be easily accomplished through brochures sent to consumers with their quarterly bills. A tremendous amount of information is available to municipal suppliers to assemble educational programs for homeowners, schools, commerce and industry.

System upkeep and maintenance efforts are also used in the region, but not nearly as much as sprinkling restrictions. Leak detection and repair, pressure reduction to service connections or service areas, reuse/recycling, low water public landscaping, and plumbing code revisions are all methods to achieve water use reductions.

The 15 responses claiming to use pricing to achieve water reduction are confusing because the pricing systems to which most refer are not thought of as "conservation pricing". Perhaps the pricing reform to which the communities referred is indicative of changes in their pricing systems from several years ago rather than a concerted effort to price water in order to achieve demand reduction. Of the 15 respondents claiming pricing as a means to achieve conservation, one actually uses a flat rate structure, which is the least water-efficient pricing method; five use decreasing block pricing, which is not much better than a flat rate; eight use single block pricing; and only one (Burnsville) uses the water-efficient increasing block method, but the overall low cost of Burnsville's water because of a low starting price were noted earlier in this report. Of the eight single block utilities claiming price controls their water demand, only three actually charge more than the regional average for 30,000 gallons of water. Obviously, many utilities that claim pricing reform still encourage water use to achieve cheaper per unit prices.

Of final note in Table 7 is the surprisingly high number of communities (23) that have not instituted any use reduction programs at all. It is surprising that a supply system could make it through the recent drought without a need to reduce demand in their system. It is also surprising that these communities did not respond to the statewide call for water use reduction with even an informational program for their customers. Equally surprising is the total number of suppliers (66) noting that they have no emergency plan for their system. These findings are a good indication of the work that remains to be done in the region to attain wise and efficient water use, and preparation for future shortages.

NON-MUNICIPAL PUBLIC WATER USE

Another category of public use of water regulated by the Minnesota Department of Health (MDH) is non-municipal use. These typically small systems serve such uses as mobile home parks, small developments, and public and private institutions. Table 8 summarizes the non-municipal, public use of water. Most of the use information on these 65 permitted systems has not been provided to MDH, so a total amount of water used is not available. However, it appears that over 27,000 people are served by 103 wells. Applying the regional municipal system residential per capita use rate of 102 gallons from Appendix B yields an estimate of daily use of approximately 2.75 million gallons. There is a total storage capacity of about 1.4 million gallons in these systems.

Table 8

WATER USE IN THE METROPOLITAN AREA - NON-MUNICIPAL, PUBLIC SYSTEMS

COUNTY	NO. OF PERMITS	YEAR	POPL. SERVED	CONNECTS. *	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY** (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC. (gal)	NO. OF WELLS	WELL CAPAC. (gpm)
ANOKA	12	1988	6590	2189	DI***	0.45	0.01-0.15	0	130460	18	DI
CARVER	4	1988	1450	278	DI	DI	0.02-0.05	0.625	22600	6	DI
DAKOTA	6	1988	1870	690	DI	0.188	0.01-0.134	0.296	261500	9	DI
HENNEPIN	17	1987-1988	8598	1537	DI	DI	0.01-0.115	0.288	376860	29	DI
RAMSEY	10	1987-1988	3344	1338	DI	DI	0.015-0.13	0	138400	19	3034
SCOTT	6	1987-1988	1573	380	DI	DI	0.006-0.018	0	19220	9	DI
WASHINGTON	10	1987-1988	4036	967	DI	DI	0.0025-0.7	0	449619	13	DI
TOTAL	65		27461	7379					1398659	103	

* Data include institutional connections that serve many people
** Among those reporting highest use
*** Data incomplete

Source: Minnesota Department of Health, August 1989

SUMMARY

Because this is a working data report, conclusions and recommendations will not be drawn. Rather, the information and analysis contained herein will be used in subsequent reports on the needs of the Metropolitan Area relative to water supply. The following items summarize information contained in the body and appendices of this report.

1. There are 111 municipal water suppliers in the region, serving a combined population of 2,015,994 through 538,125 residential, commercial, industrial and institutional connections. A 112th system is currently being built by the city of Lakeland to serve itself, Lakeland Shores and Lake St. Croix Beach, raising the population served by 4,500 after September, 1991.

2. The average municipal water demand for all uses is about 277.5 million gallons per day (MGD) from a supply system with a total capacity of 904 MGD. Because of several years of dry weather, the average DNR-reported daily use rose to slightly over 300 MGD (see Working Paper No.1). The sum of the highest daily demand figures experienced by the municipal suppliers is 709 MGD, or 200 MGD less than the system capacity.

3. There are 490 municipal water wells in the region, with a combined capacity of 702 MGD. The Prairie du Chien-Jordan Aquifer supplies 66.5% of the capacity from these wells, with multi-aquifer wells, the surficial drift and the Mt. Simon-Hinckley Aquifer supplying an additional 13.2%, 9.8% and 7.1%, respectively. Small additional amounts come from the St. Lawrence-Franconia and Ironton-Galesville units. Less than one percent of the capacity of the system comes from unknown ground water units.

4. Projections for the Metropolitan Area show that a large portion of the future growth is likely to occur in communities that are located at the terminus or beyond the limits of the Prairie du Chien-Jordan Aquifer. Some communities in these locations have already experienced some symptoms of limited ground water availability.

5. About 87 MGD of the water supplied by municipal suppliers goes for industrial, commercial and institutional uses. This comprises about one-third (30.3%) of the total municipal water supplied. Although many suppliers stated that they would cut-off supply to these users in an emergency, many indicated an intention not to do so under any condition because of the disruption that would occur.

6. Mean per capita water use by municipal water consumers is 128 gallons when all uses are considered, or 102 gallons for just residential use. Peak per capita demand for all uses averaged 328 gallons. Peak per capita use for residential uses only is not available.

7. The average cost of water in the region for residential and industrial uses is between \$1.10 and \$1.20 per thousand gallons, or slightly over 0.1 cent/gallon. Most suppliers surveyed (54) price their water using a single block structure, followed by decreasing block (45). Five municipalities still charge a flat rate for all of the water a consumer can use. Only seven municipalities price water according to an increasing block rate structure that charges more per unit as use increases. These prices are substantially more than the \$0.56 per thousand gallon rate of 1979 in the region.

8. Only five municipal supply systems in the Metropolitan Area do not fully meter their customers.

The first step in assuring wise use of water in the region should be complete service area metering by suppliers.

9. With the current system of pricing water, there is no discernible relationship ($r^2 = -.05$) between cost and demand. This analysis, however, is confusing because of the starting base price from which a particular pricing method begins; that is, increasing block systems that use an extremely low base price charge far less for a given volume than a single or even a decreasing block system that uses higher base prices. The use of increasing block pricing to achieve demand reduction must incorporate a reasonable base price or the goal of reduction will not be achieved. The trend between pricing and demand could become better established if there was a more even mix of pricing methods and if there were not so many anomalies in the base prices.

10. Sixty-two municipal suppliers responded that they are interconnected in some fashion to another supplier; most of these are small emergency connections. Another 31 stated that they are not currently interconnected, but are interested in pursuing possibilities to do so. Only 23 suppliers indicated no interest in interconnecting, and most of these were because of the large distance to the closest possible connecting supplier.

11. A system of interconnection on a subregional basis is feasible. Several groupings of municipal suppliers could be instituted to share water on a permanent or emergency basis. The long-term option of routing excess surface water outward and ground water into the central part of the region is an option that merits further attention. Such an approach would assure adequate volumes of water to out-lying communities that are now, or might be in the future, experiencing water shortages. However, before pursuing a regional or subregional supply system, much additional work would need to be done to justify and design it.

12. Difficulties in putting together a subregional system of interconnected users include cost, differing system pressures, loss of system autonomy, altered revenue distribution, and varied treatment requirements.

13. Several communities experienced difficulties with lowered ground water during the recent drought. Typically, these problems occurred in rapidly growing communities or in communities on or beyond the outer edge of the Prairie du Chien-Jordan Aquifer. This may be symptomatic of problems that will plague communities expected to grow without this aquifer as a source of water.

14. The most common routine problem encountered by those suppliers identifying problems is the high level of iron and manganese in ground water. Other noted problems include "rotten egg" odors, an aging infrastructure, and radium.

15. 71 suppliers in the region use some method of sprinkling restriction when seasonal demand gets high. Public education and leak detection and repair are also commonly used to decrease demand. Most municipalities responding that they use pricing to control demand do not use a conservation-pricing approach, so the benefit of their efforts is questionable. Twenty-three of the surveyed municipalities do not have any type of conservation program in effect and 66 suppliers have no emergency plan in the event of shortage.

16. There are 65 permitted non-municipal, public supplies in the region, serving 27,461 people. Water for these supplies comes from 103 wells, with an estimated demand of 2.75 MGD.

APPENDIX A

MUNICIPAL WATER SUPPLY INVENTORY

APPENDIX A. MUNICIPAL WATER SUPPLY INVENTORY.

Source: Prepared by Metropolitan Council from Minnesota Department of Health data, August 1989; updated by Met. Council through Oct.1990

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
ANDOVER	Dec89	3809	1138	2.4	0.49	-	0	1-0.0075T	1	81	601	368	850P	MTS-H
								1-0.5E	2	86	525	387	850P	MTS-H
								1-1.0E	3	87	547	447	850P	MTS-H
ANOKA	Nov88	15950	5000	9.2	2.6	7.8	1.44	2-0.5E	1	20	400	250	500E	F-D
								1-0.4E	2	42	170	170	500E	DRIFT
									3	52	452	71	1000P	S-G
									4	59	660	522	1200P	D-H
									5	65	444	238	1500P	F-I
									6	76	640	387	1700P	I-MTS
									7	89	450	370	1700P	MTS
APPLE VALLEY	Mar88	30000	10248	17	5	14.3	3.3	1-4.0G	1	63	520	445	450P	J
								1-3.2G	2	64	529	431	950P	J
								1-2.0G	3	59	584	476	1000P	J
									4	71	497	400	1100P	J
									5	75	487	425	1200P	J
									6	76	507	426	1300P	J
									7	77	494	405	1200P	J
									8	79	506	432	1200P	J
									9	81	515	428	1200P	J
									10	82	502	426	1200P	J
									11	86	493	408	1400P	J
									12	89	494	418	1600P	J
									13	89	516	420	1600P	J
									14	90	1120	510(est.)	1000P	MTS-H
ARDEN HILLS (ST.PAUL)	May88	9100	2304	1.99	0.86	-	See St. Paul							
BAYPORT	Nov87	2000	600	3	0.3	0.7	0.6	1-0.13G	2	47	315	193	620P	STL-F
									3	52	299	118	500P	STL-F
									4	64	260	136	1000P	F
BELLE PLAINE	Mar89	3010	825	1.4	0.4	1	0	1-0.075E	E	50	287	257	425P	U
								1-0.4E	W	55	287	257	425P	U

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
BLAINE	Nov88	35560	10000	22.5	5	14.4	2	3-1.0E	1	59	675	224	650P	F-MTS
								1-5.0G	2	60	665	229	585P	F-MTS
									3	60	681	221	750P	J-MTS
									4	65	524	227	650P	J-EC
									5	66	686	323	700P	F-MTS
									6	68	741	300	500P	F-MTS
									7	69	487	213	1500P	F-EC
									8	71	500	222	1600P	I-G
									9	72	480	300	800P	I-G
									10	71	480	257	400P	F
									11	74	735	245	1050P	F-MTS
									12	76	228	188	1500P	DRIFT
									13	77	355	308	1600P	F-MTS
									14	78	736	414	1600P	F-MTS
									16	87	505	298	1500P	F-G
									17	90s	-	-	-	-
BLOOMINGTON	May89	83870	24057	38.6	12.55	39.6	30	2-10.0G	1	73	440	345	1750P	J
				(MAX.30 MGD			6.33P	2-1.5E	2	73	392	315	2400P	S-J
				FROM MPLS.)				1-3.0G	3	74	963	450	2000P	F-MTS
								1-4.0G	4	78	376	282	1800P	S-J
BROOKLYN CENTER	Oct87	31500	8800	15.5	4.5	12.6	0	1-1.0E	2	59	340	255	1130S	J
								1-0.5E	3	61	319	248	1175P	J
								1-1.5E	4	61	316	245	1320S	J
									5	66	317	242	1400P	J
									6	66	316	247	1440P	J
									7	71	317	248	1450P	J
									8	77	316	241	1400P	J
									9	83	320	244	1560P	J
BROOKLYN PARK	Oct87	45000	13500	20	6	17.6	2.5	2-1.0E	1	61	736	563	650P	D-MTS
								1-2.0G	2	61	595	330	580P	F-MTS
								1-6.0G	3	72	234	163	660P	J
									4	67	655	236	575P	F-MTS
									5	70	182	149	295P	J
									6	66	672	253	810P	F-MTS
									7	70	241	151	690P	J
									8	75	171	120	1250P	DRIFT
									9	76	274	210	1750P	DRIFT
									10	81	271	201	2610P	DRIFT
									11	81	213	134	2800P	DRIFT
									12	82	276	202	1210P	S-J
									13	87	280	240	2500P	DRIFT
									14	87	280	240	2500P	DRIFT
									15	89	550?	450?	725	MTS-H

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
BURNSVILLE	Sep87	44353	12058	23	5.5	21	11	1-1.8G	1	64	298	218	1200P	J
				(30.0P)				1-1.1E	2	66	306	225	1200P	J
								1-7.0E	3	69	420	338	1300P	J
								1-7.0G	4	69	314	234	1200P	J
								1-1.6E	5	70	335	260	1500P	J
								1-0.5G	6	70	264	187	1200P	J
									7	72	356	282	1200P	J
									8	72	357	272	1500P	J
									9	75	957	428	1500P	STL-H
									10	75	386	299	1200P	J
									11	81	984	728	1500P	MTS-H
									12	88	465	341	1200P	J
									13	78	407	324	1200P	J
									14	90	-	-	-	-
									15	90	-	-	-	-
CARVER	Dec87	523	177	0.29	0.035	0.075	-	1-0.4E	1	86	738	600	200P	MTS
CENTERVILLE	Feb89	450	175	0.1	0.034 (estimated)	-	-	1-0.1E	1	88	267	202	400P	J
CHAMPLIN	Mar90	15000	5050	7.9	1.5	7.5	2	2-1.0E	1	74	700	235	1200P	F-H
								1-0.006T	2	74	620	195	1200P	F-MTS
									3	77	602	201	500P	F-MTS
									4	84	505	153	500P	F-MTS
									5	84	550	381	1000P	MTS
									6	87	301	190	550P	J
									7	87	450	430	1000P	MTS
									8	90s			750	
									9	90s			750	
									10	90s			1000	
									11	90s			1000	
									12	90s			1000	
									13	90s			1000	
CHANHASSEN	Nov88	10000	3000	3.2	1.2	2.3	0	1-0.1E	2	69	471	325	1000P	S
								1-0.2E	3	73	500	317	1000P	S
								1-3.5G	4	81	665	289	1000P	PDC-J
									JH	63	501	419	150E	S-J
									5	90	215	185	700P	DRIFT
CHASKA	May90	11000	2454	7.6	3.18	4	0	1-0.35G	4	73	813	448	1750P	F-H
								1-0.3E	5	76	773	494	1750P	F-H
								1-1.5E	6	84	817	687	1800P	MTS-H
CIRCLE PINES	Nov88	4800	1611	2.6	0.5	1.5	2.6	1-0.5E	2	61	321	302	1000P	DRIFT
									3	67	270	181	1100P	J

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
COLOGNE	Sep88	610	215	0.43	0.075	0.16	0	1-0.75E	1	34	344	160	120P	U
									2	11	725	550	225P	U
COLUMBIA HTS.	Jun90	20000	8300	6.8	1.85	5	20	1-0.25E						
(MINNEAPOLIS)								1-6.75G						
								(20.25 in emergency)						
COON RAPIDS	Sep89	45700	14000	22	3.92	13.2	5.8	1-1.0E	2	59	685	220	400E	F-MTS
								1-0.5E	4	60	602	233	1000P	F-D
								2-5.8G	5	61	695	265	500P	F-MTS
									6	61	158	118	250E	J
									7	64	632	189	1300P	F-D
									8	65	702	283	1000P	F-MTS
									9	69	500	294	1000P	F-D
									10	71	684	272	1000P	F-MTS
									11	73	627	157	1100P	F-MTS
									12	75	604	209	900P	F-MTS
									13	77	693	395	900P	F-MTS
									14	77	613	328	1200P	F-MTS
									15	77	615	225	1200P	F-MTS
									16	81	653	395	1200P	F-MTS
									17	81	121	81	1300P	DRIFT
									18	87	600	575	1000P	MTS
									19	89	135	115	1200P	DRIFT
									20	89	135	95	1100P	DRIFT
									21	90	-	-	1200est.	DRIFT
									22	90	-	-	900est.	DRIFT
COTTAGE GROVE	Oct87	21000	5700	14.8	2.3	8.5	2	1-0.15E	1	58	325	238	670P	J
								1-1.5E	2	58	350	248	420P	J
								1-1.0G	3	60	388	312	780P	J
								1-3.0G	4	62	418	340	880P	J
								1-0.5E	5	67	358	283	1120P	J
									6	74	427	344	1090P	J
									7	76	370	281	490P	J
									8	77	400	313	1230P	J
									9	79	380	321	1530P	J
									10	85	284	220	1800P	J
CRYSTAL	Mar90	23000	7514	6.0	5.0	18.7	20	See						
(MINNEAPOLIS)								New Hope						
(SEE NOTE #1)														

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
EAGAN	Jul88	42000	10000	15.26	6.1	17.3	2.9	1-0.5E	1	68	402	346	1400P	J
				(12.0P)				1-2.0G	2	71	435	358	1200P	J
								1-5.0G	3	73	394	336	1250P	J
								1-4.0G	4	76	392	348	1300P	J
								1-0.6G	5	78	500	406	1200P	J
									6	80	420	356	1300P	J
									7	82	475	393	1400P	J
									TL	61	498	394	500E	J
									CG	59	450	348	500P	J
									CG	64	444	349	500P	J
									8	82	1075	850	1350P	MTS
									9	87	483	403	1350P	J
									10	87	535	495	1350P	J
									11	88	1048	758	1200P	MTS
									12	89	472	385	1200P	J
									13	89	492	382	1200P	J
									14	90	-	-	-	J
									15	90	-	-	-	J
EDEN PRAIRIE	Feb89	34000	11000	18	3.4	15.8	2	2-1.0G	1	71	405	227	1400P	S
								1-1.0E	2	71	394	210	1400P	S
								1-2.2G	3	78	392	207	1400P	S
									4	82	379	207	1400P	S
									5	81	393	219	1400P	S
									6	81	388	230	1400P	S
									7	87	383	306	2100P	PDC-J
									8	88	391	316	2100P	PDC-J
									9	88	405	319	2100P	PDC-J
									10	88	401	308	2100P	PDC-J
EDINA	Dec88	46000	13360	21.8	7.4	21	0	1-4.0G	2	35	460	250	1000P	S
								2-1.0E	3	49	496	265	800P	S
								2-0.5E	4	50	495	265	650P	S
									5	54	443	257	850P	S
									6	54	505	316	1090P	S
									7	55	547	350	900P	S
									8	53	472	232	900P	S
									9	57	1130	563	650P	F
									10	63	1001	881	850P	H
									11	63	321	321	1200P	J
									12	64	1081	995	850P	H
									13	64	496	427	1000P	J
									14	64	420	325	900P	J
									15	67	405	275	600P	S
									16	67	280	265	1200P	S
									17	70	461	373	1050P	J
									18	73	446	365	650P	J
									19	90	540	-	1000P	J

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
ELKO	May88	125	35	0.33	0.009	0.035	0	1-0.0026T	1	70	487	320	150P	U
EMPIRE	Mar89	450	193	1.8	0.055	0.21	0	2-0.007T	1	73	410	340	750P	J
									2	81	457	355	500P	J
EXCELSIOR	Apr88	2860	1300	2.3 (1.0P)	0.434	0.775	0.3	1-0.3G	1	57	465	303	350P	S-J
								1-0.25E	2	59	448	290	500P	S-J
									3	73	465	302	750P	S-J
FALCON HTS. (ST.PAUL)	Feb90	5386	2084	-	0.7	-	See St. Paul							
FARMINGTON	Aug89	5650	1650	3.4	0.8	2.8	0.65	1-0.675G	1	38	402	284	800E	S-ON
									2	52	402	284	450E	ON
									3	60	430	130	1000P	J
									4	73	477	392	1000P	J
FOREST LAKE	Dec89	5400	1600	2.1	0.69	2.15	0	1-0.1E	1	24	678	143	500P	F-H
								1-0.5E	3	65	630	310	890P	I-H
									4	92	-	-	700-1000	
FRIDLEY	Nov88	29423	7884	20	6.5	15.7	5	1-0.5E	1	57	925	389	670P	J-H
								1-1.5G	2	61	842	675	820P	MTS-H
								1-3.0G	3	61	840	752	870P	MTS-H
									4	61	830	663	750P	MTS-H
									5	61	845	656	780P	F-H
									6	64	250	153	1600P	S
									7	66	262	138	1060P	S
									8	66	265	138	1600P	S
									9	66	264	145	1600P	S
									10	69	199	128	1000P	DRIFT
									11	70	669	325	1000P	J-F
									12	70	276	233	1550P	J
									13	70	332	191	900P	S
GOLDEN VALLEY (MINNEAPOLIS) (SEE NOTE #1)	Nov88	24200	6915	-	3.7	7.8	0	See New Hope						
HAMBURG	Sep88	485	163	0.2	0.04	0.135	0	1-0.04E	1	43	745	180	80P	J-MTS
									2	41	838	381	125P	U
HAMPTON	Aug88	390	100	0.575	0.06	0.08	0	1-0.075E	2	65	302	248	440P	J

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
HASTINGS	Jan88	14432	4130	6.8	2.26	5.5	2.2	1-0.75E	1	29	575	275	465P	J
								1-0.15E	2	33	195	100	665P	J
								1-0.3E	3	56	300	211	720P	J
								1-0.75G	4	61	400	312	630P	J
									5	70	356	277	1225P	J
									6	72	328	240	1010P	J
									7	90	386	300	1200P	J
HILLTOP (MINNEAPOLIS)	Feb88	781	433	-	0.1	-	See Minneapolis							
HOPKINS	Dec88	16800	3000	12	2.1	7	5.76	1-1.7G	1	20	780	281	850P	S-D
								1-0.5G	3	48	475	289	9000S	S-J
								2-0.5E	4	54	548	352	2600P	S-J
									5	67	500	382	1700P	S-J
									6	77	545	354	2200P	S-J
HUGO	Feb89	1000	300	0.6	0.075	0.2	-	1-0.1E	1	62	320	242	430P	J
INVER GROVE HEIGHTS	Feb88	20000	4300	6.7	1.5	3.5	0	1-0.4E	1	-	431	288	500P	J
								1-2.0E	2	61	438	350	525P	J
								1-5.0G	3	72	407	310	1425P	J
								1-1.0E	4	72	360	280	1300P	J
									5	80	452	358	1450P	J
									6	87	1044	802	1000P	H
JORDAN	Nov88	2600	625	1.4	0.32	0.8	0	1-0.3E	3	50	563	221	600R	F-H
									4	54	560	370	300P	D-H
									5	90s	-	-	-	
									6	90s	-	-	-	
LAKE ELMO	Feb89	800	245	0.74	0.049	0.15	0	1-0.75E	1	61	805	277	550P	F-H
LAKELAND (see note #2)	Sep91	4500 (planned)	-	1.08	-	-	0	1-0.3E	1	90	380	210	1200P	MTS
LAKEVILLE	Feb88	15000	4800	8.15	2	5.1	0	2-0.6G	2	64	517	434	890P	J
								1-0.5G	3	68	460	363	1125P	J
								1-2.0G	4	69	505	434	1050P	J
								1-0.75E	6	80	682	591	1400P	J
									7	84	479	375	1200P	J
									8	89	-	-	1200P	J
LANDFALL	Feb89	702	373	0.432	0.078	-	0	1-0.005T	3	-	518	438	300P	U
LAUDERDALE (ST. PAUL)	Feb90	2307	1227	-	0.22	-	See St. Paul							

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
LEXINGTON	May88	2100	592	1.37	0.175	0.5	See	1-0.1E	1	66	306	275	950P	DRIFT
(Emergency interconnect							note	(1.0 MG						
w/ Blaine and Circle Pines)								AVAIL.						
								FR.BLAINE)						
LINO LAKES	Sep88	425	200	0.7	0.034	0.059	0	See Circle	1	72	306	152	500P	S-J
								Pines	2	87	250	163	600P	J
LITTLE CANADA	Jun88	8600	1350	3.7	0.8	2	See							
(ST.PAUL)							note							
(Emergency interconnect														
w/ Roseville)														
LONG LAKE	Mar88	1900	600	1.58	0.285	0.5	0	1-0.2E	1	48	340	188	550P	S-J
									2	66	448	366	550P	J
LORETTO	Sep87	310	117	0.5	0.045	0.22	0	1-0.05E	1	40	500	200	100S	F
									2	63	317	287	250P	F
MAHTOMEDI	Oct87	4300	1350	2.8	0.384	-	0.5	2-0.06E	2	40	440	250	350E	S-J
(ALSO SERVES									3	57	394	275	800P	J
WILLERNIE)									4	69	435	343	800P	J
									5	88	470	275	1500P	S-J
MAPLE GROVE	May90	36000	11000	16	4.2	15	3.5	1-1.5E	1	72	680	282	600P	MTS-H
								2-1.0E	2	73	230	170	2400P	DRIFT
									3	78	157	157	2300P	DRIFT
									4	81	197	118	2600P	DRIFT
									5	83	715	605	1000P	MTS-H
									6	85	197	197	2700P	DRIFT
									7	89	158	75	(capped)	DRIFT
									8	89	234	134	2200P	DRIFT
									9	90	-	-	-	DRIFT
									10	90	-	-	-	DRIFT
MAPLE PLAIN	Jun88	1550	540	1	0.26	0.425	0	1-0.4E	1	39	418	-	125E	F-D
									2	58	435	241	400P	F-D
									3	78	404	333	400P	F-D
MAPLEWOOD	Feb90	24615	9834	-	4.05	-	See St. Paul							
(ST. PAUL)														
MAYER	Jan89	420	155	0.25	0.033	0.055	0	1-0.5E	1	61	280	202	260P	STL

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
MEDINA	Jun88	1360	380	1.65	0.25	0.28	0	1-0.004T	H2	78	601	353	150P	F-D
(INCLUDES HAMEL								1-0.003T	H3	83	590	420	150P	I-G
MORNINGSIDE AND								1-0.475E	I1	76	240	200	600P	DRIFT
INDEPENDENCE)									I2	89	250	200	200P	DRIFT
									1M	61	205	187	100P	DRIFT
									2M	61	205	187	220P	DRIFT
MENDOTA HTS.	Feb90	7811	2939	-	1.48	-	See St. Paul							
(ST. PAUL)														
MINNEAPOLIS	Feb89	473073	103831	200	72.25	158.2	200	1-32.0G						
WATER WORKS		(381,592*)	(75,384*)	(120 to	(54.3*)			1-55.0G						
(see note #3)				170P)	(could supply			1-40.0G						
(* = Minneapolis only)					up to 30 mgd									
					to Bloomington)									
MINNETONKA	May88	41600	14100	22	6.24	15.8	-	2-0.5E	3	64	465	393	1000P	J
								1-0.1E	6	67	488	397	900P	J
								1-1.0E	7	67	486	397	800P	J
								1-2.0E	10	69	505	305	1000P	S
								1-3.0E	11	70	498	282	1200R	S-J
								1-0.05E	12	71	535	332	1100R	S-J
									13	72	475	292	1500P	S-J
									14	72	555	367	1000P	S-J
									15	75	450	235	1250P	S-J
									13A	78	464	274	1500P	S-J
									14A	78	575	395	1000P	S-J
									15A	78	444	238	1250P	S-J
									3A	81	458	254	1000P	S-J
									10A	81	486	302	1000P	S-J
									12A	85	506	340	1000P	S-J
									11A	89	492	292	1000P	S-J
MINNETONKA	Sep88	590	222	0.504	0.06	0.225	See	1-0.05E	1	58	403	385	400P	J
BEACH							note	1-0.125G	2	59	393	359	400P	J
(Emergency interconnect														
w/ Orono)														
MINNETRISTA	Aug89	320	118	2.2	0.045	0.18	0	1-0.01T	1	71	675	264	750P	F-G
								2-0.005T	2	60s	470	122	70E	J-F
									3	80	785	340	750P	F-MTS
MOUND	Jan89	9950	3150	4	0.65	5.8	0	2-0.3E	1	34	293	285	300R	DRIFT
								1-0.08E	3	50	296	163	450P	DRIFT
									4	62	729	600	750E	MTS
									6	76	175	141	600R	DRIFT
									7	77	194	133	800P	DRIFT

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
MOUNDS VIEW	Jul88	12550	2850	6.5	1.4	3.9	1.44	1-0.35E	1	61	855	497	1000P	F-H
								1-0.5E	2	62	835	648	900P	D-H
								1-2.0G	3	70	358	269	925P	J
									4	70	680	470	1000S	F-MTS
									5	70	350	190	1000P	S-J
									6	70	679	333	950P	F-MTS
NEW BRIGHTON	Jan89	23500	5225	7.7	2.5	7.4	0	2-0.75E	3	55	500	411	740C	J
								1-0.8E	4	55	495	410	900C	J
									5	63	501	430	850E	J
									6	63	521	445	1000E	J
									7	68	437	361	850S	J
									8	82	900	285	900S	MTS-H
									9	82	937	782	800S	MTS-H
									10	83	930	780	1100P	MTS-H
									11	83	800	775	700P	MTS-H
									12	84	790	730	1000P	MTS-H
NEW GERMANY	Sep88	370	140	0.165	0.03	0.064	0.165	1-0.05E	1	60	432	375	115P	F-D
NEW HOPE (MINNEAPOLIS) (see note #1)	Aug87	23500	5285	(NOTE #1)	7.3	18.2	(Note #1)	Joint Water Commission has 3 towers w/ 19 mill. gall. capacity						
NEW MARKET	Jul90	310	103	0.093	0.016	0.033	0.025	1-0.04E	1	13	410	-	50E	DRIFT
									2	88	465	-	90P	U
NEWPORT	Nov87	3600	950	2.6	0.34	0.882	0	1-0.25G	1	64	261	185	1000P	J
									2	73	285	195	900P	J
NEW TRIER	Mar89	140	35	0.1	0.023	-	0	1-0.03E	1	66	560	455	75P	J
									2	90	-	-	-	
NO.ST.PAUL (serves small area in Maplewood)	Mar88	14000	4000	7	1.5	3.38	1.5	1-0.3E	1	35	470	259	675P	S-J
								1-0.5E	2	42	473	259	600P	S-J
									3	57	470	375	1200P	J
									4	64	475	390	1100P	J
									5	77	531	457	1350P	J
NORWOOD (Emergency interconnect w/ Young America)	Sep88	1386	450	0.9	0.21	0.525	See note	1-0.07E	1	26	675	345	250P	J-G
								1-0.03G	2	50	448	425	4250S	J
									3	90	950	817	700P	MTS-H

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
OAK PARK HTS.	Mar89	3700	800	2.5	0.357	0.814	0	1-0.25E	1	68	310	230	850P	J
									2	75	291	230	850P	J
									3	91	-	-	-	
OAKDALE	Apr89	16500	4685	7.5	2	5.8	0	1-0.3E	1	58	581	501	975P	J
(serves areas in N.St.Paul and Lk.Elmo)								1-0.6E	2	64	542	464	950P	J
								1-1.0E	3	69	510	424	635P	J
									5	78	520	436	925P	J
									6	85	470	387	1650P	J
									7	91	-	-	-	
ORONO	Feb88	2150	710	1.8	0.248	0.397	0	1-0.2E	1	71	385	315	1000P	J
									2	71	390	380	275P	J
OSSEO	Apr88	3000	792	1.65	0.423	1.11	0	1-0.05E	1	60	197	177	550P	DRIFT
								1-0.25E	2	45	234	214	600P	DRIFT
PLYMOUTH	Nov88	47000	11000	17.9 (10.5P)	7.5	14.24	2.5	2-1.0E	1	65	505	442	800S	J
								2-0.5E	2	70	409	280	1800P	S
								1-2.0E	3	72	448	276	1500P	S
								1-3.0E	4	75	470	274	1800P	S
								1-0.5G	5	79	437	252	1800P	S
									6	80	415	260	2000P	S-J
									FS	66	390	301	1000E	J
									7	82	455	271	1700P	S-J
									8	87	416	192	1800P	S-J
									9	88	418	223	1800P	S-J
									10	89	353	198	1800P	S-J
									11	90	-	-	-	S-J
									12	90	-	-	-	S-J
									13	90s	-	-	-	
									14	90s	-	-	-	
PRIOR LAKE	Dec89	11320	3414	4.16	0.8	3.88	0	1-0.75E	3	70	364	268	1150P	J
								1-1.0E	4	75	345	264	1150P	J
									5	88	372	290	1450P	J
RAMSEY (NEW SYSTEM)	Feb88	500	150	-	0.05 (estimated)	-	-	1-0.008T	1	85	323	243	500P	I-G
								1-0.5E	2	87	320	240	300P	I-G
RANDOLPH	Jan89	250	92	0.8	0.025	0.104	0	1-0.1E	1	79	356	258	560P	J

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
RICHFIELD	Apr88	37800	11600	14.4	4.6	14.7	3	1-1.0E	1	62	435	343	1800P	J
								1-1.5E	2	62	435	343	2000P	J
								1-2.5G	3	63	425	226	2000P	S-J
									4	63	405	207	2000P	S-J
									5	63	408	225	2000P	S-J
									6	63	422	225	2000P	J
									7	77	1036	631	1500P	I-H
ROBBINSDALE	May88	14460	4960	6.8	1.51	2.13	1.3	1-0.125E	1	38	624	162	1000P	STP-F
								1-0.5E	2	44	600	269	750P	S-F
								1-0.75G	3	48	471	295	1000P	S-J
								1-0.5G	4	53	404	213	1000P	S-J
									5	56	467	280	1000P	S-J
ROCKFORD	Mar88	2800	400	2	0.26	1	0	1-0.075E	1	55	142	122	140P	DRIFT
(Note: only 18% of population in TCMA)								1-0.003T	2	71	130	105	260P	DRIFT
								1-0.4E	3	76	210	170	100P	F
									4	76	310	241	150P	F
									5	82	130	92	800P	DRIFT
ROGERS	Aug90	746	187	0.6	0.1	0.2	0	1-0.05E	1	55	360	223	330P	F-D
									2	66	356	210	330P	F-D
									3	84	370	319	500P	I-G
ROSEMOUNT	Jun88	5409	1479	3.3	0.567	1.6	0.72	1-0.5E	3	62	471	388	500P	J
								1-1.0E	6	65	485	398	575P	J
									7	76	490	400	1100P	J
									8	90	480	-	1000P	J
									9	90-91	-	-	-	J
ROSEVILLE (ST. PAUL)	Aug90	35800	9992	47.5	5	12.5	5	1-1.5E						
ST. ANTHONY	Mar88	7981	2200	4.75	0.974	2.9	1.4	1-0.25E	3	58	541	321	1200P	S-J
								1-2.2G	4	60	540	467	1200P	J
									5	61	475	387	1200P	J
ST. BONIFACIUS	Feb88	1070	355	0.9	0.12	0.34	0	1-0.3E	1	72	480	336	375P	F
									2	58	880	184	320P	J-H
ST. FRANCIS	Mar88	800	283	0.46	0.15	0.35	0.16	1-0.075E	1	74	416	168	320P	MTS
								1-0.25E	2	82	421	338	500P	H

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
ST. LOUIS PARK	Jan89	43463	13420	12.7	7	12.5	1	1-0.5E	3	38	286	103	900P	STP-S
								3-1.5G	4	46	503	415	900C	J
								2-1.0E	5	47	465	305	1200C	J
								1-2.0G	6	48	480	430	1000P	J
									7	52	446	247	1200P	S-J
									8	55	507	314	1000P	J
									9	55	473	289	1200P	S-J
									10	55	500	315	800P	J
									11	61	1095	880	1000P	MTS-H
									12	63	1095	900	1000P	MTS-H
									13	64	1050	891	1000P	MTS-H
									14	65	485	389	1000P	J
									15	69	503	398	1200P	J
									16	73	500	425	1000P	J
									17	83	1085	818	800P	S-MTS-H
ST. PAUL	Jan89	385000	100000	144	50.6	112.9	120	1-30.0G	B	77	438	170	2200P	S
WATER UTILITY		(273,160*)	(61,870*)		(35.8*)			1-20.0G	C	77	422	130	4000P	S
(see note #4)								1-18.0G	D	82	456	145	1100P	S
(* = St. Paul only)								2-10.0G	E	84	463	140	3600P	S
								1-6.0G						
								1-5.0G						
								2-2.0G						
								1-2.3E						
								4-1.5E						
								1-1.0E						
								2-0.2E						
ST. PAUL PARK	Oct87	4900	1296	1.9	0.5	1.6	1.3	1-0.75E	1	54	260	179	450P	J
								1-0.5E	2	57	322	239	425P	J
									3	63	338	258	475P	J
									4	88	360	261	900P	J
SAVAGE	Mar90	7897	2677	5.4	0.5	2.1	See	1-0.3E	1	61	225	150	600P	J
(Emergency interconnect							note	1-1.0E	2	69	846	660	1200P	MTS-H
w/ Burnsville)									3	85	393	302	1200P	J
									4	90	147	122	700P	DRIFT
									5	90	152	132	700P	DRIFT
									6	90	205	172	700P	DRIFT
SHAKOPEE	Jan89	10783	3081	9.2	2.2	6	1.1	1-0.25E	1	11	715	216	320P	F-D
								1-2.0E	2	45	730	287	500P	F-D
								1-1.5E	3	56	780	286	730P	F-D
									4	71	239	184	800P	J
									5	71	253	183	880P	J
									6	81	222	147	1130P	J
									7	86	215	145	1130P	J
									8	89	265	173	1050P	J

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
SHOREVIEW	Jun88	24500	6500	13	1.7	10.6	0	1-2.5E	2	69	395	251	1925P	ON-J
								1-1.0G	3	72	413	340	1650P	J
									4	74	439	332	1850P	ON-J
									5	81	468	336	2000P	J
									6	85	414	325	1650P	J
									7	87	442	325	1000P	J
SHOREWOOD	Sep89	1356	452	3.45	0.056	0.172	0	1-0.009T	1	73	528	244	500P	STP-J
(see note #5)								1-0.004T	2	79	480	296	300P	S-J
								1-0.005T	3	81	372	332	500P	S-J
								1-0.015E	4	81	640	398	500P	F-G
								1-0.4E	5	81	640	399	500P	F-G
									6	82	326	276	100P	S
SO. ST. PAUL	Jun89	23000	6625	14.7	2.8	5.5	3.5	2-1.0G	1	61	404	322	600P	J
								1-0.4E	2	73	436	352	900P	S-J
								1-0.75E	3	37	339	125	2100P	S-J
									4	46	342	240	1700P	J
									6	72	484	399	1900P	J
									7	71	255	175	1350P	J
									8	75	498	131	1000P	J
									9	79	360	110	1000OS	J
SPRING LAKE PK.	Sep88	6881	1872	4.5	1	2.5	0	1-0.25E	1	61	741	350	500P	F-H
								1-0.5E	2	65	690	329	950P	F-H
									3	70	729	299	800P	F-H
									4	82	726	533	900P	MTS-H
SPRING PARK	Jun88	1465	300	1.5	0.224	0.375	See	1-0.05E	1	64	567	418	215P	F-G
(Emergency interconnects							note	1-0.1E	2	64	391	341	250P	J
w/ Mound and Orono)									3	80	790	660	630P	MTS-H
STILLWATER	Mar89	12770	4000	6	1.8	3.3	2.5	1-0.5G	1	1888	83	45	855P	J
								1-0.75E	5	63	220	155	815P	J
								1-0.5E	6	67	271	202	465P	J
									7	72	236	166	1750R	J(capped)
									8	74	242	166	1110P	J
									9	78	305	224	1005P	J
									10	90s	300	-	1200P	J(test well)
TONKA BAY	Jul88	1453	595	1.58	0.2	0.523	0.9	1-0.3G	1	72	423	328	650P	J
				(0.8P)				1-0.015T	2	73	448	332	650P	J
								1-0.25E						

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
VADNAIS HTS.	Sep88	6785	2700	4.4	1.2	5.4	0	2-1.0E	1	77	490	307	650P	S-J
									2	77	470	382	1200P	J
									3	72	495	242	500P	S-J
									4	78	476	404	700P	J
VERMILLION (NEW SYSTEM)	Nov87	500	165	0.5	0.038 (estimated)	-	0	1-0.05E	1	87	816	658	350P	MTS
VICTORIA	Mar88	150	63	0.35	0.05	0.05	0	1-0.004T	1	75	640	298	225P	U
								1-0.1E	2	87	430	402	1000P	U
WACONIA	Oct88	3600	1200	2.8	0.7	1.3	1.2	1-0.075E	1	25	680	460	950P	J
								1-0.25E	2	48	847	460	325P	J
									3	71	250	Screened	350P	DRIFT
									4	71	254	Screened	520P	DRIFT
WATERTOWN	Jun87	2200	576	1.4	0.25	0.398	0	1-0.05E	1	25	164	U	200E	DRIFT
								1-0.3E	2	55	153	U	200P	DRIFT
									3	43	209	132	400P	DRIFT
WAYZATA	Sep88	3900	1090	4.3	0.854	1.625	3.5	1-0.5E	2	54	140	110	350P	DRIFT
									3	65	100	70	880P	DRIFT
									4	71	507	284	1600P	S-H
WEST ST. PAUL (ST. PAUL)	Feb90	18220	8400	-	2.18	-	See St. Paul							
WHITE BEAR LAKE (INCLUDES WILLERNIE)	Mar88	24000	8125	10.5 (7.2P)	2.4	8.1	2.2	1-3.0G	8	56	463	371	475E	J
								1-1.0G	1	59	490	400	1100P	J
								1-1.0E	2	62	963	700	1500P	D-H
									3	66	513	289	2300P	S-J
									4	69	476	267	2400P	S-J
WHITE BEAR TWSP	Sep88	8000	2529	3.6	0.689	-	0	1-0.1E	1	56	445	365	500P	J
								1-0.75E	2	60	430	375	225P	J
									3	76	372	200	1200P	S-J
									4	76	408	325	650P	S-J
									5	90	412	230	1700P	S-J

CITY	MOYR	POPL. SERVED	CONNECTS.	DESIGN CAPAC. (mgd)	AVE. DAILY (mgd)	HIGHEST DAILY (mgd)	EMERG. CAPAC. (mgd)	STORAGE CAPAC.* (mg)	WELL #	YEAR INSTALLED	WELL DEPTH	CASING DEPTH	WELL CAPAC.** (gpm)	GEOLOGIC UNIT***
WOODBURY	Dec88	18500	5260	6	2.5	6.9	0	1-3.0G	1	56	517	444	800P	J
								1-1.0G	2	64	481	396	750P	J
								1-0.5E	3	69	512	425	1000P	J
									4	73	480	398	1000P	J
									5	79	480	405	1000P	J
									6	85	505	406	1200P	J
									7	89	495	404	1200P	J
									8	90	510	-	1200P	J
									9	91	-	-	-	-
YOUNG AMERICA (Emergency interconnect w/ Norwood)	Aug88	1300	425	0.432	0.109	0.2	See note	1-0.05E	2	78	943	666	300P	I-H
TOTALS (adjusted for M-SP suburban supplies)		2019894	539832	904.191	277.428	709.234 (few small systems missing)		494.8401	490 (additional 29 planned for 1990's)				487525 gpm (702 mgd)	

* E = elevated reservoir
G = ground reservoir
T = pressure tank

** P = permanent use
E = emergency use
S = seasonal use
C = contaminated
OS = out of service

*** Geologic Units
DRIFT = glacial drift
STP = St. Peter sandstone
PDC = Prairie du Chien Group
S = Shakopee dolomite (PDC)
ON = Oneota dolomite (PDC)
J = Jordan sandstone
STL = St. Lawrence sandstone
F = Franconia sandstone
I = Ironton sandstone
G = Galesville sandstone
EC = Eau Claire sandstone
MTS = Mt. Simon sandstone
D (Dresbach) = G, EC, MTS
H = Hinckley sandstone
U = unknown source

NOTES:

1) Crystal, Golden Valley and New Hope formed Joint Water Commission to buy water from the Minneapolis Water Works at a design capacity of 51.0 mgd.

2) Lakeland will begin service about Sept.1991 and will also serve Lakeland Shores and Lake St. Croix Beach

3) Minneapolis Water Works also supplies the cities of Columbia Hts., Hilltop, Golden Valley, New Hope, Crystal and portions of Edina and Bloomington.

4) St. Paul Water Utility also supplies the cities of Lauderdale, Falcon Hts., Roseville, Arden Hills, Little Canada, West St. Paul, Maplewood, Mendota Hts., and a portion of St. Anthony. The Water Utility withdraws approximately 70% of its water from the Mississippi River, 20% from groundwater, and 10% from the Centerville-Rice Creek reservoir system.

5) Shorewood supplies the Amesbury, Woodhaven, Badger and Boulder Branch systems.

APPENDIX B

MUNICIPALLY-SUPPLIED COMMERCIAL/INDUSTRIAL USE AND PER CAPITA USE

CITY	POPL. SERVED	AVG. DAILY (mgd)	% COMM.	% IND.	% Total C+I	AVG. DAILY C and I (mgd)	AVG.GALL. PER CAPITA PER DAY- ALL USES	PEAK GALL. PER CAPITA PER DAY- ALL USES	AVG.GALL. PER CAPITA PER DAY- RESIDENTIAL
EAGAN	42000	6.1	1.8	1.1	2.9	0.18	145	412	141
EDEN PRAIRIE	34000	3.4	35% C+I	-	35	1.19	100	465	65
EDINA	46000	7.4	25% C+I	-	25	1.85	161	456	121
ELKO	125	0.009	2% C+I	-	2	0.00	72	280	71
EMPIRE	450	0.055	0	0	0	0.00	122	467	122
EXCELSIOR	2860	0.434	39	0	39	0.17	152	271	93
FALCON HTS.* (ST.PAUL)	5386	0.7	N.R.	N.R.	5	0.04	130	-	123
FARMINGTON	5650	0.8	12%C+I	-	12	0.10	142	440	125
FOREST LAKE	5400	0.69	12% C+I	-	12	0.08	128	398	112
FRIDLEY	29423	6.5	50% C+I	-	50	3.25	221	534	110
GOLDEN VALLEY* (MINNEAPOLIS)	24200	3.7	N.A.	N.A.	23	0.85	153	-	118
HAMBURG	485	0.04	5	0	5	0.00	82	278	78
HAMPTON	390	0.06	40	0	40	0.02	154	205	92
HASTINGS*	14432	2.26	N.A.	N.A.	10	0.23	157	388	141
HILLTOP (MINNEAPOLIS)	781	0.1	25% C+I	-	25	0.03	128	-	96
HOPKINS	16800	2.1	35% C+I	-	35	0.74	125	417	81
HUGO*	1000	0.075	N.A.	N.A.	15	0.01	75	200	64
INVER GROVE HEIGHTS	20000	1.5	9.9	1.3	11.2	0.17	75	175	67
JORDAN	2600	0.32	10% C+I	-	10	0.03	123	308	111
LAKE ELMO	800	0.049	10	0	10	0.00	61	188	55
LAKEVILLE	15000	2	7	9	16	0.32	133	340	112
LANDFALL	702	0.078	10% C+I	-	10	0.01	111	-	100
LAUDERDALE* (ST. PAUL)	2307	0.22	N.R.	N.R.	20	0.04	95	-	76

CITY	POPL. SERVED	AVG. DAILY (mgd)	% COMM.	% IND.	% Total C+I	AVG. DAILY C and I (mgd)	AVG.GALL. PER CAPITA PER DAY-ALL USES	PEAK GALL. PER CAPITA PER DAY-ALL USES	AVG.GALL. PER CAPITA PER DAY-RESIDENTIAL
LEXINGTON	2100	0.175	3% C+I	-	3	0.01	83	238	81
LINO LAKES	425	0.034	1	0	1	0.00	80	139	79
LITTLE CANADA (ST.PAUL)	8600	0.8	20	5	25	0.20	93	-	70
LONG LAKE	1900	0.285	15	35	50	0.14	150	139	75
LORETTO	310	0.045	12	3	15	0.01	145	city wc	123
MAHTOMEDI	4300	0.384	10	1	11	0.04	89	-	79
MAPLE GROVE	36000	4.2	4	6	10	0.42	117	417	105
MAPLE PLAIN	1550	0.26	35% C+I	-	35	0.09	168	274	109
MAPLEWOOD (ST. PAUL)	24615	4.05	Est. 50%	-	50	2.03	165	-	82
MAYER	420	0.033	25	0	25	0.01	79	131	59
MEDINA	1360	0.25	7	10	17	0.04	184	206	153
MENDOTA HTS. (ST. PAUL)	7811	1.48	15	15	30	0.44	189	-	133
MINNEAPOLIS* (city only)	381592	54.3	45% C+I	-	45	24.44	142	334 (system)	78
MINNETONKA	41600	6.24	40% C+I	-	40	2.50	150	380	90
MINNETONKA BEACH	590	0.06	25	0	25	0.02	102	381	76
MINNETRISTA	320	0.045	10	0	10	0.01	234	562	211
MOUND*	9950	0.65	N.A.	N.A.	10	0.07	65	583	59
MOUNDS VIEW	12550	1.4	8	1	9	0.13	112	311	102
NEW BRIGHTON	23500	2.5	3	0	3	0.08	106	315	103
NEW GERMANY	370	0.03	10	29	39	0.01	81	173	49
NEW HOPE (MINNEAPOLIS)	23500	7.3	25% C+I	-	25	1.83	311	-	233
NEW MARKET	310	0.016	5	0	5	0.00	52	106	49
NEWPORT	3600	0.34	30	5	35	0.12	94	245	61

CITY	POPL. SERVED	AVG. DAILY (mgd)	% COMM.	% IND.	% Total C+I	AVG. DAILY C and I (mgd)	AVG.GALL. PER CAPITA PER DAY- ALL USES	PEAK GALL. PER CAPITA PER DAY- ALL USES	AVG.GALL. PER CAPITA PER DAY- RESIDENTIAL
NEW TRIER	140	0.023	10	0	10	0.00	164	-	148
NO.ST.PAUL	14000	1.5	25% C+I	-	25	0.38	107	241	80
NORWOOD	1386	0.21	25% C+I	-	25	0.05	152	379	114
OAK PARK HTS.	3700	0.357	19.4	0	19.4	0.07	96	220	78
OAKDALE	16500	2	7.2	0.1	7.3	0.15	121	352	112
ORONO	2150	0.248	5% C+I	-	5	0.01	115	185	110
OSSEO	3000	0.423	25% C+I	-	25	0.11	141	370	106
PLYMOUTH	47000	7.5	32% C+I	-	32	2.40	160	303	109
PRIOR LAKE	11320	0.8	7	0	7	0.06	71	299	66
RAMSEY (ESTIM.DAILY USE)	500	0.05	3.5	0	3.5	0.00	100	-	97
RANDOLPH	250	0.025	0	0	0	0.00	100	416	100
RICHFIELD	37800	4.6	5	1	6	0.28	122	389	114
ROBBINSDALE*	14460	1.51	N.A.	N.A.	5	0.08	104	147	99
ROCKFORD (only 18% in TCMA)	2800	0.26	20% C+I	-	20	0.05	93	-	74
ROGERS	746	0.1	50	15	65	0.07	134	268	47
ROSEMOUNT	5409	0.567	9	2	11	0.06	105	296	93
ROSEVILLE (ST. PAUL)	35800	5	35% C+I	-	35	1.75	140	-	91
ST. ANTHONY	7981	0.974	25% C+I	-	25	0.24	122	363	92
ST. BONIFACIUS	1070	0.12	9% C+I	-	9	0.01	112	318	102
ST. FRANCIS*	800	0.15	N.A.	N.A.	15	0.02	188	438	159
ST. LOUIS PARK	43463	7	51% C+I	-	51	3.57	161	288	79
ST. PAUL (city only)	273160	35.8	50% C+I	-	50	17.90	131	293 (system)	66
ST. PAUL PARK	4900	0.5	15	10		0.13	102	326	77
SAVAGE	7897	0.5	7	13	20	0.10	63	266	51

CITY	POPL. SERVED	AVG. DAILY (mgd)	% COMM.	% IND.	% Total C+I	AVG. DAILY C and I (mgd)	AVG.GALL. PER CAPITA PER DAY-ALL USES	PEAK GALL. PER CAPITA PER DAY-ALL USES	AVG.GALL. PER CAPITA PER DAY-RESIDENTIAL
SHAKOPEE	10783	2.2	14	40	54	1.19	204	556	94
SHOREVIEW	24500	1.7	2.8	6.8	9.6	0.16	69	433	63
SHOREWOOD	1356	0.056	9% C+I	-	9	0.01	41	302	38
SO. ST. PAUL	23000	2.8	25% C+I	-	25	0.70	122	239	91
SPRING LAKE PK.	6881	1	10.7	1.4	12.1	0.12	145	363	128
SPRING PARK	1465	0.224	32	0	32	0.07	153	256	104
STILLWATER	12770	1.8	8	4	12	0.22	141	258	124
TONKA BAY	1453	0.2	6	0	6	0.01	138	360	129
VADNAIS HTS.	6785	1.2	27% C+I	-	27	0.32	177	(peak assoc.w/ system malfunction)	129
VERMILLION (ESTIM. DAILY USE)	500	0.038	2	0	2	0.00	76	-	74
VICTORIA	150	0.05	1	0	1	0.00	333	333	330
WACONIA	3600	0.7	14	19	33	0.23	194	361	130
WATERTOWN	2200	0.25	0	0	0	0.00	114	181	114
WAYZATA*	3900	0.854	N.A.	N.A.	9	0.08	219	417	199
WEST ST. PAUL* (ST. PAUL)	18220	2.18	N.A.	N.A.	11	0.24	120	-	106
WHITE BEAR LAKE	24000	2.4	15	5	20	0.48	100	338	80
WHITE BEAR TWSP	8000	0.689	2.5	5	7.5	0.05	86	-	80
WOODBURY	18500	2.5	11	6	17	0.43	135	373	112
YOUNG AMERICA	1300	0.109	7	5	12	0.01	84	154	74
TOTAL	2019894	277.428				87.03 (30.3% of total)	128 (mean)	328 (mean)	102 (mean)

* No response from city or city does not know percentage so percentage C/I estimated from previous Minnesota Dept. of Health study or from city's comprehensive plan

** N.A. = data not available in city records
N.R. = no response received from city

APPENDIX C. PRICING METHODS AND PRICES FOR MUNICIPAL WATER
Compiled by Metropolitan Council (10/90)

CITY	QUARTERLY WATER PRICE PER 1000 GAL.	PRICING METHOD*	RESIDENTIAL PRICE FOR 30,000 Gall. ($)	COMMERCIAL PRICE FOR 30,000 GALL. ($ for 1.5" pipe)	COMMERCIAL PRICE FOR 100,000 GALL. ($ for 3" pipe)
ANDOVER	$0.94 plus $5 service charge; $7 minimum	single block	33.20	33.20	102.00
ANOKA	$0.53 plus $12 service charge	single block	27.90	27.90	65.00
APPLE VALLEY	$0.656 for 1-250 $0.606 over 250	decreasing block	19.68	19.68	65.60
ARDEN HILLS (ST.PAUL)	$1.27 all volumes	decreasing block	38.10	38.10	127.00
BAYPORT	$2 all volumes	single block	60.00	60.00	200.00
BELLE PLAINE	Resid.$8 per capita C+I $1 single block	flat	32.00	30.00	100.00
BLAINE	$0.35 for 0-50 $0.39 for 51-250 $0.43 over 250	increasing block	10.50	10.50	37.00
BLOOMINGTON (MAX.30 MGD FROM MPLS.)	$1.30 with min.charge and $4.88 service fee	single block with service and minimum charges	43.88	43.88	134.88
BROOKLYN CTR.	$0.47 all volumes	single block	14.10	14.10	47.00
BROOKLYN PK.	$1.29 for 0-6 $0.75 over 6	decreasing block	25.74	25.74	78.24
BURNSVILLE	$0.94 for 0-50 $1.20 over 50	increasing block	28.20	28.20	107.00
CARVER	$2.70 for 0-20 $1.70 over 20	decreasing block	71.00	71.00	190.00
CENTERVILLE	$1.50 plus $15 service charge	single block with service charge	60.00	NC***	NC
CHAMPLIN	$2.27 for 0-2 $0.71 over 2	decreasing block	24.42	24.42	74.12
CHANHASSEN	$8 for first 10 $0.85 over 10	increasing block after min. volume	25.00	25.00	84.50

CITY	QUARTERLY WATER PRICE PER 1000 GAL.	PRICING METHOD*	RESIDENTIAL PRICE FOR 30,000 Gall. ($)	COMMERCIAL PRICE FOR 30,000 GALL. ($ for 1.5" pipe)	COMMERCIAL PRICE FOR 100,000 GALL. ($ for 3" pipe)
CHASKA	$0.80 for 1-7 $0.65 over 7	decreasing block	20.55	20.55	66.05
CIRCLE PINES	Resid.$0.75 plus $3.50 Comm.$0.75 plus $5.50	single block with service charge	26.00	28.00	80.50
COLOGNE	$1.75 all volumes	single block	52.50	52.50	175.00
COLUMBIA HTS. (MINNEAPOLIS)	$24 for first 13.5 $0.85 over 13.5	decreasing block after min. volume	38.02	38.02	97.52
COON RAPIDS	$0.98 all volumes	single block	29.40	29.40	98.00
COTTAGE GROVE	$17.85 for first 15 $0.85 over 15	decreasing block after min. volume	30.60	30.60	90.10
CRYSTAL (MINNEAPOLIS)	$1.04 with minimum charge based on size	single block with minimum	31.20	39.50	118.85
EAGAN	$14.50 for first 10 $0.80 over 10	decreasing block after min. volume	30.50	30.50	86.50
EDEN PRAIRIE	$0.95 all volumes	single block	28.50	28.50	95.00
EDINA	$0.56 all volumes	single block	16.80	16.80	56.00
ELKO	$18 for first 9 $2 over 9	single block with min. volume	60.00	60.00	200.00
EMPIRE	$42 unlimited	flat	42.00	NC	NC
EXCELSIOR	$22.09 for first 13 $1.13 over 13	decreasing block after min. volume	41.30	41.30	120.40
FALCON HTS. (ST.PAUL)	$1.51 for 0-374 1.48 over 374	decreasing block	45.30	45.30	151.00
FARMINGTON	$0.65 for metered (C+I) $22 unmetered (resid.)	flat	22.00	19.50	65.00
FOREST LAKE	$2.00 for 0-5 $1.20 6-10 $1.00 11-20 $0.90 over 20	decreasing block	35.00	35.00	98.00

CITY	QUARTERLY WATER PRICE PER 1000 GAL.	PRICING METHOD*	RESIDENTIAL PRICE FOR 30,000 Gall. ($)	COMMERCIAL PRICE FOR 30,000 GALL. ($ for 1.5" pipe)	COMMERCIAL PRICE FOR 100,000 GALL. ($ for 3" pipe)
FRIDLEY	$0.69 for 1-10 $0.53 for 11-30 $0.47 for 31-50 $0.40 for 51-100 $0.38 for 101-200 $0.35 over 200	decreasing block	17.50	17.50	46.90
GOLDEN VALLEY (MINNEAPOLIS)	$0.98 all volumes	single block	29.40	29.40	98.00
HAMBURG	$9 for first 4 $1.50 over 4	decreasing block after min. volume	48.00	48.00	153.00
HAMPTON	Res.-$0.40 all vols. Comm.-$0.60 all vols.	single block	12.00	18.00	60.00
HASTINGS	$0.73 all volumes	single block	21.90	21.90	73.00
HILLTOP (MINNEAPOLIS)	$1.14 all volumes	single block	34.20	34.20	114.00
HOPKINS	$0.85 all volumes	single block	25.50	25.50	85.00
HUGO	$11.50 for first 15 $0.60 over 15	decreasing block after min. volume	20.50	20.50	62.50
INVER GROVE HEIGHTS	$1.20 all volumes	single block	36.00	36.00	120.00
JORDAN	$5 for first 5 $1.54 over 5	increasing block after min. volume	43.50	NC	NC
LAKE ELMO	$1.00 all volumes	single block	30.00	30.00	100.00
LAKEVILLE	$0.77 plus $2.50 service charge	single block with service charge	25.60	25.60	79.50
LANDFALL	Part of rental fee for trailer lot	flat			
LAUDERDALE (ST. PAUL)	$1.45 for 0-67 $1.42 over 67	decreasing block	43.50	43.50	90.36
LEXINGTON	$12.50 for first 10 $0.75 over 10	decreasing block after min. volume	27.50	27.50	80.00

CITY	QUARTERLY WATER PRICE PER 1000 GAL.	PRICING METHOD*	RESIDENTIAL PRICE FOR 30,000 Gall. ($)	COMMERCIAL PRICE FOR 30,000 GALL. ($ for 1.5" pipe)	COMMERCIAL PRICE FOR 100,000 GALL. ($ for 3" pipe)
LINO LAKES	a) Resid.$1.20 plus $20 user fee	single block with service charge	56.00		
	b) Comm. same plus 0.06% tax			59.36	148.40
	c) Sunset Road $0.77 plus $10 user fee in 1990		33.10		
LITTLE CANADA (ST.PAUL)	$1.50 all volumes	single block	45.00	45.00	150.00
LONG LAKE	$2.25 all volumes	single block	67.50	67.50	225.00
LORETTO	$1 for 0-4 $1.07 over 4	increasing block	28.82	28.82	106.72
MAHTOMEDI (ALSO SERVES WILLERNIE)	$1.30 all volumes	single block	39.00	39.00	130.00
MAPLE GROVE	$0.90 with $9 minimum	single block with minimum	27.00	27.00	90.00
MAPLE PLAIN	$5 service charge plus $1.75 for 1-8 $1.55 for 9-92 $1.35 for 92-900 $1.25 over 900	decreasing block with service charge	53.10	53.10	158.45
MAPLEWOOD (ST. PAUL)	$1.74 for 0-374 $1.70 over 374	decreasing block	52.20	52.20	174.00
MAYER	$5.75 for 0-4 $0.70 over 4	decreasing block after min. volume	23.95	23.95	72.95
MEDINA	$1.95 all volumes	single block	58.50	58.50	195.00
MENDOTA HTS. (ST. PAUL)	$1.60 0-374 $1.56 over 374	decreasing block	48.00	48.00	160.00
MINNEAPOLIS	$1.14 direct bill in city $1.34 other direct bill min. charge based on size	single block with min.charge	34.20	34.20	114.00
MINNETONKA	$0.80 all volumes	single block	24.00	24.00	80.00
MINNETONKA BEACH	$1.27 all volumes	single block	38.10	38.10	127.00

CITY	QUARTERLY WATER PRICE PER 1000 GAL.	PRICING METHOD*	RESIDENTIAL PRICE FOR 30,000 Gall. ($)	COMMERCIAL PRICE FOR 30,000 GALL. ($ for 1.5" pipe)	COMMERCIAL PRICE FOR 100,000 GALL. ($ for 3" pipe)
MINNETRISTA	$17 for first 10 $1.50 over 10	decreasing block after min. volume	47.00	47.00	152.00
MOUND	$1 all volumes	single block	30.00	30.00	100.00
MOUNDS VIEW	$0.90 all volumes	single block	27.00	27.00	90.00
NEW BRIGHTON	$0.55 all volumes	single block	16.50	16.50	55.00
NEW GERMANY	$5 for first 4 $1 for 5-15 $0.75 over 15	decreasing block after min. volume	26.25	26.25	78.75
NEW HOPE (MINNEAPOLIS)	$3.60 for first 1 $0.95 over 1	decreasing block after min. volume	31.15	31.15	97.65
NEW MARKET	$1 all volumes	single block	30.00	30.00	100.00
NEWPORT	$1.06 0-10 $1.31 11-15 $1.98 16-25 $3.20 26-42	increasing block	32.00	32.00	96.00
NEW TRIER	$45 for first 10 $1 over 10	decreasing block after min. volume	65.00	65.00	135.00
NO.ST.PAUL	$2.80 for first 4 $0.70 over 4	single block with min. volume	21.00	21.00	70.00
NORWOOD	$10 for first 5 $1.25 over 5	decreasing block after min. volume	41.25	41.25	128.75
OAK PARK HTS.	$0.93 0-15 $0.90 over 15	decreasing block	27.45	27.45	90.45
OAKDALE	$0.75 all volumes	single block	22.50	22.50	75.00
ORONO	Area 1- $1.17 plus $12.80/qtr. charge	single block plus service charge	47.90	47.90	129.80
	Area 2- $2.75 plus $6.70		89.20	89.20	281.70
	Area 3- $1.40 plus $5.35		47.35	47.35	145.35
OSSEO	$0.85 for 0-10 $0.75 for 10-100 $0.70 over 100	decreasing block	23.50	23.50	76.00

CITY	QUARTERLY WATER PRICE PER 1000 GAL.	PRICING METHOD*	RESIDENTIAL PRICE FOR 30,000 Gall. ($)	COMMERCIAL PRICE FOR 30,000 GALL. ($ for 1.5" pipe)	COMMERCIAL PRICE FOR 100,000 GALL. ($ for 3" pipe)
PLYMOUTH	Resid.$4.50 plus $0.75; large users flat fee from $72 - $720	single block plus service charge	27.00	72.00	225.00
PRIOR LAKE	$1.40 all volumes	single block	42.00	42.00	140.00
RAMSEY (NEW SYSTEM)	$1 all volumes	single block	30.00	30.00	100.00
RANDOLPH	$10 for first 10 $0.70 over 10	decreasing block after min. volume	24.00	NC	NC
RICHFIELD	$1.15 all volumes	single block	34.50	34.50	115.00
ROBBINSDALE	$0.95 for 0-8 $0.90 over 8	decreasing block	29.16	29.16	90.40
ROCKFORD	$1.15 with minimum charge $10.35	single block with minimum	34.50	34.50	115.00
ROGERS	Res.-$10 for first 10 $0.95 over 10 C/I-$25 for first 10 $0.95 over 10	decreasing block after min. volume	29.00	44.00	110.50
ROSEMOUNT	$1.10 all volumes	single block	33.00	33.00	110.00
ROSEVILLE (ST. PAUL)	$1.09 all volumes	single block	32.70	32.70	109.00
ST. ANTHONY	$0.80 all volumes	single block	24.00	24.00	80.00
ST. BONIFACIUS	$7.75 for 0-5 $1.05 over 5	decreasing block after min. volume	34.00	34.00	107.50
ST. FRANCIS	$1.30 with $6.80 base charge	single block with service charge	45.80	45.80	136.80
ST. LOUIS PARK	$0.72 for 1-22.5 $0.67 over 22.5	decreasing block	21.22	21.22	68.12

CITY	QUARTERLY WATER PRICE PER 1000 GAL.	PRICING METHOD*	RESIDENTIAL PRICE FOR 30,000 Gall. ($)	COMMERCIAL PRICE FOR 30,000 GALL. ($ for 1.5" pipe)	COMMERCIAL PRICE FOR 100,000 GALL. ($ for 3" pipe)
ST. PAUL (city only)	$1.27 for 0-200 includes surcharge; price decreases w/use plus demand charge of $3.20 resid. $16.20 for 1.5" $82.50 for 3"	decreasing block w/ service charge	41.30	54.30	209.50
ST. PAUL PARK	$11 for first 10 $1 over 10	decreasing block after min. volume	31.00	31.00	101.00
SAVAGE	$1 plus $10.50 residential $25.20 C+I	single block plus service charge	40.50	55.20	125.20
SHAKOPEE	$5 for first 6 $0.60 for 7-20 $0.55 for 21-40 $0.43 over 40	decreasing block after min. volume	18.90	18.90	50.20
SHOREVIEW	$13.50 for first 15 $0.90 over 15	single block with min. volume	27.00	27.00	90.00
SHOREWOOD	$22 for first 10 $1.40 over 10	decreasing block	50.00	50.00	148.00
SO. ST. PAUL	$0.62 for 1-30 $0.41 next 470 $0.23 over 500	decreasing block	18.60	18.60	47.30
SPRING LAKE PK.	$16.40 for first 18 $0.69 over 18	decreasing block after min. volume	24.68	24.68	72.98
SPRING PARK	$7.50 for first 5 $1 over 5	decreasing block after min. volume	32.50	32.50	102.50
STILLWATER	$10 for first 10 $1 over 10	single block with min. volume	30.00	30.00	100.00
TONKA BAY	$1.80 plus $5 service fee	single block with service charge	59.00	59.00	185.00
VADNAIS HTS.	$0.90 all volumes	single block	27.00	27.00	90.00
VERMILLION (NEW SYSTEM)	$0.25 plus $18 maint.fee	single block with service charge	25.50	25.50	43.00

CITY	QUARTERLY WATER PRICE PER 1000 GAL.	PRICING METHOD*	RESIDENTIAL PRICE FOR 30,000 Gall. ($)	COMMERCIAL PRICE FOR 30,000 GALL. ($ for 1.5" pipe)	COMMERCIAL PRICE FOR 100,000 GALL. ($ for 3" pipe)
VICTORIA	$20 for first 15 $0.96 over 15	decreasing block after min. volume	34.40	34.40	101.60
WACONIA	$11 for first 4 $1.10 over 4	decreasing block after min. volume	39.60	39.60	116.60
WATERTOWN	$1.25 all volumes	single block	37.50	37.50	125.00
WAYZATA	Base charge $3.33 $0.70 for 0-35 $1.50 over 35	increasing block with service charge	24.33	24.33	125.33
WEST ST. PAUL (ST. PAUL)	$1.45 0-374 $1.42 375-3740 $1.38 over 3740	decreasing block	43.50	43.50	145.00
WHITE BEAR LK.	$1.13 all volumes	single block	33.90	33.90	113.00
WHITE BEAR TWNSHP.	$45 unlimited for resid. C/I being developed	flat	45.00		
WOODBURY	$8 for first 8 $0.55 over 8	decreasing block after min. volume	20.10	20.10	58.60
YOUNG AMERICA	$15 for 0-5 $1.40 over 5	decreasing block after min. volume	50.00	50.00	148.00
NUMBER			146	146	140
AVERAGE			34.75	35.35	110.38
MINIMUM COST			10.50	10.50	37.00
MAXIMUM COST			89.20	89.20	281.70

* Method summary: 45 decreasing block
7 increasing block
54 single block
5 flat

** NR = no response to survey

*** NC = no commercial accounts

APPENDIX D

METERING BY MUNICIPAL SUPPLIERS

Appendix D
CITY METERING LIST

CITY	COUNTY	YEAR METERED
Andover	Anoka	1981
Anoka		1928
Blaine		1962
Centerville		yes
Circle Pines		1964
Columbia Heights		1930s
Coon Rapids		1955
Fridley		1960
Hilltop		1950s
Lexington		1965
Lino Lakes		1974
Ramsey		1984
St. Francis		1975
Spring Lake Park		1964
Carver	Carver	1986
Chanhassen		1958
Chaska		1965
Cologne		1934
Hamburg		1960
Mayer		1971
New Germany		1960
Norwood		1926
Victoria		1976
Waconia		1958
Watertown		1955

Appendix D
CITY METERING LIST

CITY	COUNTY	YEAR METERED
Young America		1979
Apple Valley	Dakota	1964
Burnsville		1965
Eagan		1972
Empire		none
Farmington		none
Hampton		1954
Hastings		yes
Inver Grove Heights		1965
Lakeville		1970s
Mendota Heights		1985
New Trier		yes
Randolph		yes
Rosemount		1972
South St. Paul		1930s
Vermillion		1987
West St. Paul		1985
Bloomington	Hennepin	1960
Brooklyn Center		1960
Brooklyn Park		yes
Champlin		1974
Crystal		1970
Eden Prairie		1971
Edina		1924
Excelsior		1958

Appendix D
CITY METERING LIST

CITY	COUNTY	YEAR METERED
Golden Valley		1962
Hopkins		1960s
Long Lake		1948
Loretto		1989
Maple Grove		1972
Maple Plain		1939
Medina		1960s
Minneapolis		1950s
Minnetonka		1960
Minnetonka Beach		1932
Minnetrista		15% metered
Mound		1970s
New Hope		yes
Orono		1970
Osseo		1915
Plymouth		yes
Richfield		1962
Robbinsdale		1950s
Rockford		yes
Rogers		1960
St. Anthony		1940s
St. Bonifacius		1971
St. Louis Park		yes
Shorewood		yes
Spring Park		1963
Tonka Bay		1974

Appendix D
CITY METERING LIST

CITY	COUNTY	YEAR METERED
Wayzata		1929
Arden Hills	Ramsey	yes
Falcon Heights		1950s
Lauderdale		yes
Little Canada		1970
Maplewood		1985
Mounds View		1964
New Brighton		yes
North St. Paul		1930s
Roseville		1960s
St. Paul		1985
Shoreview		1969
Vadnais Heights		1978
White Bear Lake		1988
White Bear Twp.		no residential yes in commercial
Belle Plaine	Scott	1988
Elko		1987
Jordan		1940
New Market		1930s
Prior Lake		1970
Savage		1978
Shakopee		1930s
Bayport	Washington	1930s
Cottage Grove		1958
Forest Lake		1951

Appendix D
CITY METERING LIST

CITY	COUNTY	YEAR METERED
Hugo		1961
Lake Elmo		1962
Landfall		no
Mahtomedi		1940
Newport		1963
Oakdale		1959
Oak Park Heights		1967
St. Paul Park		1954
Stillwater		1927
Woodbury		1956

APPENDIX E

MUNICIPAL SEWER SERVICE CHARGES

APPENDIX E PRICING METHODS AND PRICES FOR MUNICIPAL SEWER
Compiled by Metropolitan Council (3/91)

CITY	QUARTERLY SEWER PRICE PER 1000 GAL.	PRICE FOR 20,000 Gall. ($)
ANDOVER	A. $4.50/month	13.50
	B. $8.50/month	25.50
ANOKA	$1.78 plus $4 service charge	39.60
APPLE VALLEY	$0.95/1000 $2.60 base	19.00
ARDEN HILLS	$31.23/qtr.	31.23
BAYPORT	$2/1000	40.00
BELLE PLAINE	$8/capita/qtr.	24.00
BLAINE	$21.90/qtr.	21.90
BLOOMINGTON	$7.50/month	22.50
BROOKLYN CTR.	N.R.	
BROOKLYN PK.	$32/qtr.	32.00
BURNSVILLE	$18.15/qtr. first 10,000 $1.04 over 10,000	28.55
CARVER	$3.57/1000	71.40
CENTERVILLE	$36/qtr.	36.00
CHAMPLIN	N.R.	
CHANHASSEN	$9.50 for first 5,000 $2.15 over 5,000	41.75
CHASKA	$1.70/1000	34.00
CIRCLE PINES	$1.10/1000 plus $4 service charge	27.50
COLOGNE	$1.50/1000	30.00

COLUMBIA HTS.	$1.13/1000	22.60
COON RAPIDS	$20/qtr.	20.00
COTTAGE GROVE	$28.50/qtr.	28.50
CRYSTAL	$26/qtr.	26.00
EAGAN	$15.45 for first 10,000 $1.35/1000 >10,000	28.95
EDEN PRAIRIE	$1.90/1000	38.00
EDINA	$1.73/1000	34.60
ELKO	$5.90/1000	118.00
EMPIRE	$25/qtr.	25.00
EXCELSIOR	N.R.	
FALCON HTS.	$27/qtr.	27.00
FARMINGTON	$47.75/qtr.	47.75
FOREST LAKE	$1.80/1000 for 0-10,000 $1.75 > 10,000	35.50
FRIDLEY	$24.65/qtr.	24.65
GOLDEN VALLEY	$0.82/1000	16.40
HAMBURG	$12/qtr.	12.00
HAMPTON	$1.00/1000	20.00
HASTINGS	$1.49/1000	29.80
HILLTOP	N.R.	
HOPKINS	$1.75/1000	35.00
HUGO	$32 for first 15,000 $0.60 > 15,000	35.00
INVER GROVE HEIGHTS	$15.45 for first 10,000 $1.25/1000 > 10,000	25.00

JORDAN	$1.02/1000	20.40
LAKEVILLE	$1.77/1000 plus $2.50 service charge	37.90
LAUDERDALE	$24/qtr.	24.00
LEXINGTON	$32/qtr.	32.00
LINO LAKES	$36/qtr.	36.00
LITTLE CANADA	$32.50/unit	32.50
LONG LAKE	$1.95/1000	39.00
LORETTO	N.R.	
MAHTOMEDI	$2.77/1000	55.40
MAPLE GROVE	$32/qtr.	32.00
MAPLE PLAIN	$1.88/1000 for 0-8,000 $2.75/1000 for >8,000	48.04
MAPLEWOOD	$31.20/qtr. plus $3.60 service charge	34.80
MAYER	$6.75 for first 4,000 $0.70/1000 >4,000	17.95
MEDINA	$3.35/1000	67.00
MENDOTA HTS.	$26 min. plus $1.10/1000 >15,000	31.50
MINNEAPOLIS	$1.89/1000	37.80
MINNETONKA	$1.10/1000 $16.50 min. charge	22.00
MINNETONKA BEACH	$42.50/qtr.	42.50
MINNETRISTA	$45/qtr.	45.00
MOUND	$25.4 for first 10,000 $1.67/1000 >10,000	42.10

M

MOUNDS VIEW	$36.75/qtr.	36.75
NEW BRIGHTON	$1.30/1000	26.00
NEW GERMANY	$5 for first 4,000 $1/1000 for 5-15,000 $0.75 >19,000	20.75
NEW HOPE	$4 for first 1000 $1.44/1000 >1000	31.36
NEW MARKET	$6.75/1000	135.00
NEWPORT	$33/qtr. if 0-10,000 $41/qtr. if 10-15,000 $62/qtr. if 15-25,000 Variable depending on volume	62.00
NEW TRIER	No sewers	
NO.ST.PAUL	$34.92/qtr.	34.92
NORWOOD	$2.20/1000	44.00
OAK PARK HTS.	$23/qtr. for 15,000 $1.33/1000 >15,000	29.65
OAKDALE	$1.63/1000	32.60
ORONO	Area 1- $51.15/qtr. Area 2- $1.90/1000 plus $2.90 service charge	51.15 40.90
OSSEO	$35.75/qtr.	35.75
PLYMOUTH	$1.56/1000	31.20
PRIOR LAKE	$1.40/1000	28.00
RAMSEY	$32/qtr.	32.00
RANDOLPH	No sewers	
RICHFIELD	$0.90/1000	18.00
ROBBINSDALE	$23.20/qtr.	23.60
ROCKFORD	$1.20/1000	24.00

ROGERS	$0.90/1000	18.00
ROSEMOUNT	$1.85/1000	37.00
ROSEVILLE	$25.48/qtr.	25.48
ST. ANTHONY	$1.32/1000	26.40
ST. BONIFACIUS	$12 for first 1000 $1/1000 >1000	31.00
ST. FRANCIS	$1.55/1000 plus $8.60 base charge	39.60
ST. LOUIS PARK	$1.30/1000	26.00
ST. PAUL	$2.19/1000 for 0-750,000 Variable by volume >750,000	43.80
ST. PAUL PARK	N.R.	
SAVAGE	$25.20/qtr.	25.20
SHAKOPEE	$1.22/1000 plus $3/month service charge	33.40
SHOREVIEW	$32.50/qtr.	32.50
SHOREWOOD	$49.75/qtr.	49.75
SO. ST. PAUL	$2.03/1000	40.60
SPRING LAKE PK.	N.R.	
SPRING PARK	$15 min. for 0-5000 $2.35/1000 >5000	50.25
STILLWATER	$39 min. for 0-10,000 $2.10/1000 >10,000	60.00
TONKA BAY	$38/qtr.	38.00
VADNAIS HTS.	N.R.	
VERMILLION	$24/qtr.	24.00
VICTORIA	$38/qtr.	38.00
WACONIA	$2.58/1000	51.60

WATERTOWN	$1.25/1000	25.00	
WAYZATA	$0.90/1000 for 0-35,000 $2.50/1000 >35,000	18.00	
WEST ST. PAUL	$27.60/qtr.	27.60	
WHITE BEAR LK.	$0.95/1000	19.00	
WHITE BEAR TWNSHP.	$45/qtr.	45.00	
WOODBURY	$34.20/qtr.	34.20	
YOUNG AMERICA	N.R.		
AVERAGE		34.83	($1.74/1000)
MINIMUM COST		12.00	
MAXIMUM COST		135.00	

N.R. = no response to this survey question

APPENDIX F

MUNICIPAL WATER SUPPLY INTERCONNECTION INVENTORY

ANALYSIS OF INTERCONNECTIONS OF MUNICIPAL WATER SUPPLIERS

I. SAMPLE DATA

- Data based on direct phone contact with suppliers.
- 111 communities responded to survey of existing municipal interconnections.
- 39/111 communities are interconnected; 35.1% of the sample; the new Lakeland system will add one more to this total since it also serves Lakeland Shores and Lake St. Croix Beach).
- 17/111 communities supply or receive water from another community; 15.3% of the sample.
- 48/111 communities are not interconnected; 43.2% of the sample.
- 7/111 communities could interconnect hydrant-to-hydrant; 6.3% of the sample.
- Reasons for no interconnections:
  a) distance
  b) funding
  c) neighboring supplier does/not soften
  d) St. Paul or Minneapolis supplies the water
  e) neighboring supply not adequate
  f) neighboring supplier does/not chlorinate
  g) topography - differing elevations, terrain, etc.
  h) politics
  i) no interest; would drill another well before interconnecting
  j) different pressure zones
  k) neighboring supplier has contaminated water related to landfills
  l) surrounding cities do not have municipal water systems
  **) denotes the community has thought about the possibility of interconnecting in the future.

II. DISCREPANCIES

- Many (20) discrepancies exist between suppliers. The reasons include:
  - Personnel familiar with interconnections might no longer be with supplier, particularly if the connection is old; documentation of old connections could be poor.
  - Interconnection lines could be considered abandoned by one community but not by the other, especially if the lines have not been used for long time.
  - Some communities consider hydrant-to-hydrant as "interconnection", while others do not.
  - City on contributing end of a one-way connection might not consider themselves as interconnected.

- Many of the sizes of the interconnecting lines are not consistent, probably because of the age of the lns and the respondents' personal unfamiliarity with them.

ANOKA COUNTY

CITY	INTERCONNECTION SPECIFICS
ANDOVER	- Coon Rapids, 8", 1981, emergency only - Anoka, 8", 1981, emergency only
ANOKA (note discrepancy w/Andover)	- None (i)
BLAINE	- Coon Rapids, 8", 1988, emergency only - Spring Lake Park, 6", 1971, emergency only - Circle Pines, 6", 1970s emergency only - Supplies part of Lexington via 6" main
CENTERVILLE	- None **; note no reference to Hugo connection
CIRCLE PINES	- Blaine, 1970, emergency only - Lexington, 1970, emergency only - Shoreview, 1988, emergency only - Lino Lakes, supplied by Circle Pines
COLUMBIA HEIGHTS	- Supplied by Minneapolis; no other connections (d) - Note lack of reference to New Brighton connection
COON RAPIDS	- Andover, 6", 1988 (note discrepancy with Andover), emergency only - Blaine, 6", 1986 (note date and size discrepancy with Blaine), emergency only
FRIDLEY	- Mounds View, 2 mgd capacity, 1960, emergency only
HILLTOP	- No response; served by Minneapolis
LEXINGTON	- Circle Pines, 1500 gpm, 1970, emergency only - Portion supplied by Blaine at 1000 gpm for part of year
LINO LAKES	- Circle Pines, 2000 gpm, 1987, emergency only (note discrepancy with Circle Pines response) - Lino Lakes purchases water from Shoreview via a 1200 gpm line built in 1987 (note discrepancy with Shoreview)
RAMSEY	- Anoka, hydrant-to-hydrant, emergency only
ST. FRANCIS	- None (l)
SPRING LAKE PARK	- Blaine, 6", 1970s emergency only

CARVER COUNTY

CITY	INTERCONNECTION SPECIFICS
CARVER	- None (a, g) **
CHANHASSEN	- Shorewood, 8", 1987, emergency only
CHASKA	- None (a) **
COLOGNE	- None (a)
HAMBURG	- None (a)
MAYER	- None (a) **
NEW GERMANY	- None (a)
NORWOOD	- Young America, 6", 1975, emergency only
VICTORIA	- None (a)
WACONIA	- None (a) **
WATERTOWN	- None (a)
YOUNG AMERICA	- Norwood, 6", 1975, emergency only

DAKOTA COUNTY

CITY	INTERCONNECTION SPECIFICS
APPLE VALLEY	- Rosemount, 6", 1982, emergency only
BURNSVILLE	- None (j), but supplies portions of Savage, Lakeville, and Eagan.
EAGAN	- None (j) ** (note discrepancy with Burnsville) - Sells some water to Inver Grove Heights
EMPIRE	- None **
FARMINGTON	- None (b) **
HAMPTON	- None (a) **
HASTINGS	- None (a)
INVER GROVE HEIGHTS	- So.St.Paul, 6", 1962, emergency only - Note no reference to water from Eagan
LAKEVILLE	- None (a, b) **
MENDOTA HEIGHTS	- Supplied by St.Paul via W. St. Paul
NEW TRIER	- None (a, l)
RANDOLPH	- None
ROSEMOUNT	- Apple Valley, 6", 1982, emergency only
SOUTH ST PAUL	- West St.Paul, 8", 1935, emergency only - St.Paul, 8", 1925, emergency only - Note no reference to Inver Grove Heights
VERMILLION	- None (a)
WEST ST PAUL	- None (g); note no reference to So. St. Paul

HENNEPIN COUNTY

CITY	INTERCONNECTION SPECIFICS
BLOOMINGTON	- None (e), although can receive up to 30 mgd from Minneapolis under current contract - Note no reference to Edina connection
BROOKLYN CENTER	- None (l) **
BROOKLYN PARK	- Connection with Maple Grove
CHAMPLIN	- Can connect hydrant-to-hydrant with Maple Grove in emergency
CRYSTAL	- Supplied by Minneapolis; in Joint Water Commission with Golden Valley and New Hope
EDEN PRAIRIE	- None (h); note discrepancy with Edina
EDINA	- Bloomington, 12", 1960s, emergency only - Eden Prairie, 12", 1960s, emergency only - Note no reference to Minneapolis supply of Morningside
EXCELSIOR	- None, but supplies part of Greenwood & Shorewood via 6" mains since 1980
GOLDEN VALLEY	- Supplied by Minneapolis; in Joint Water Commission with Crystal and New Hope - Note no reference to Plymouth connection
HOPKINS	- Minnetonka, 6", 1965, emergency only
LONG LAKE	- Can supply Orono via 8" main but flow cannot be reversed
LORETTO	- None (a) **
MAPLE GROVE	- Osseo, 8", 1973, emergency only - Brooklyn Park, 12", 1976, emergency only - Will connect with Plymouth in 1991-2
MAPLE PLAIN	- None (a) **
MEDINA	- None (a) **
MINNEAPOLIS	- Bloomington supplied up to 30 mgd via 36-42" main since 1960 - Golden Valley, Crystal, and New Hope supplied via 16-36" mains - Edina Morningside supplied via 12" main - Hilltop supplied via 6" main - Columbia Heights supplied via 24" main - Airport supplied by 12-18" mains - Note none of these are emergency connections that could supply adequate volume to Minneapolis

CITY	INTERCONNECTION SPECIFICS
MINNETONKA	- Hopkins, St.Louis Park, Plymouth, Wayzata, and Shorewood all connected via 8" pipes for emergency only
MINNETONKA BEACH	- Orono, 6-8", emergency only
MINNETRISTA	- None (a)
MOUND	- Spring Park, 10", 1982, emergency only (note size discrepancy with Spring Park response)
NEW HOPE	- Supplied by Minneapolis; in Joint Water Commission with Crystal and Golden Valley
ORONO	- Spring Park, 6-8", 1970s, emergency only - Minnetonka Beach, 6-8", 1970s, emergency only - Long Lake and Wayzata supply water to parts of Orono via 6-8" mains
OSSEO	- No response to survey; see Maple Grove response
PLYMOUTH	- Minnetonka, Wayzata, St.Louis Park, Golden Valley, and Maple Grove all connected via 6-12" pipes for emergency only
RICHFIELD	- None (i) **
ROBBINSDALE	- None (i) **
ROCKFORD	- None (l)
ROGERS	- None (e)
ST. BONIFACIUS	- None (a, e, i)
ST. LOUIS PARK	- Plymouth, 8", 1975, emergency only - Note no reference to Minnetonka connection
SHOREWOOD	- Chanhassen, 8", 1987, emergency only - Minnetonka, 8", 1970s, emergency only - 8" connection with Tonka Bay closed and unusable - Supplied in portions of city by Excelsior
SPRING PARK	- Mound, 6", 1986, emergency only - Orono, 6", 1970, emergency only
TONKA BAY	- 8" connection with Shorewood closed & unusable **
WAYZATA	- Plymouth, 12", 1920, emergency only - Minnetonka, 8", 1920, emergency only - Note no reference to supplying part of Orono - Note both connections currently closed

RAMSEY COUNTY

CITY	INTERCONNECTION SPECIFICS
ARDEN HILLS	- Supplied by St. Paul - No response to survey; see Shoreview
FALCON HEIGHTS	- Supplied by St. Paul - Roseville, 6", 1970s, emergency only
LANDFALL	- None; self-supplied trailer community
LAUDERDALE	- Supplied by St. Paul
LITTLE CANADA	- Supplied by St. Paul - Roseville, 6-24" (?), 1981, emergency only - Note lack of reference to Maplewood
MAPLEWOOD	- Supplied by St. Paul - Provides water to parts of North St. Paul via 6-24" (?) main, Little Canada via 12" main, and Woodbury via 8" main
MOUNDS VIEW	- Fridley, 12", 1970, emergency only - Spring Lake Park, 1000 gpm, 1970s, emergency only (note no reference to this by Spring Lake Park) - Note no reference to connections with New Brighton
NEW BRIGHTON	- Roseville, 6", 1980, emergency only - Columbia Heights, 6", 1982, emergency only - Mounds View, 6", 1980, emergency only (note discrepancy with Mounds View)
NORTH ST PAUL	- None (e) **; note lack of reference to Maplewood connection
ROSEVILLE	- Supplied by St. Paul - St. Anthony, 12", 1960, emergency only - Supplies water to Arden Hills routinely; could use Arden Hills tanks to reverse supply to Roseville; not emergency only supply - Note lack of reference to Falcon Heights, Little Canada, New Brighton, and Shoreview
ST. ANTHONY	- Roseville, 10", 1983, emergency only
ST. PAUL	- Supplies water to Roseville, Lauderdale, Little Canada, Falcon Heights, West St. Paul, Mendota Heights, Maplewood and a portion of St. Anthony - South St. Paul, 6-8", emergency only, could not supply needs of St. Paul

CITY	INTERCONNECTION SPECIFICS
SHOREVIEW	- Roseville, 8", 1976, emergency only - Arden Hills, 8", 1988, emergency only - Circle Pines, 8", 1986, emergency only - Lino Lakes, 8", 1976, emergency only
VADNAIS HEIGHTS	- None (h) **; can connect hydrant-to-hydrant if necessary
WHITE BEAR LAKE	- Supplies Birchwood and parts of White Bear Township **
WHITE BEAR TOWNSHIP	- Birchwood, 6", 1981, emergency only

SCOTT COUNTY

CITY	INTERCONNECTION SPECIFICS
BELLE PLAINE	- None (a)
ELKO	- None (b) **
JORDAN	- None (a, e)
NEW MARKET	- None (a, e)
PRIOR LAKE	- None
SAVAGE	- Burnsville, 8", 1984, emergency only
SHAKOPEE	- None (a)

WASHINGTON COUNTY

CITY	INTERCONNECTION SPECIFICS
BAYPORT	- None (b)
COTTAGE GROVE	- None (f) **
FOREST LAKE	- None (a)
HUGO	- Centerville (?); note no connection noted by Centerville
LAKE ELMO	- None (a, k)
LAKELAND (begins service Sept.1991)	- Will also serve Lakeland Shores and Lake St. Croix Beach
MAHTOMEDI	- None (c); could connect hydrant-to-hydrant if needed
NEWPORT	- None; could connect hydrant-to-hydrant with St Paul Park if needed
OAKDALE	- None (b) **; supplies portions of North St. Paul and Lake Elmo
OAK PARK HEIGHTS	- None (h) **; could connect hydrant-to-hydrant with Stillwater
ST. PAUL PARK	- None (f) **; could connect hydrant-to-hydrant if needed
STILLWATER	- None (h) **
WOODBURY	- None (k) **

APPENDIX G

MUNICIPAL WATER SUPPLY PROBLEMS

PROBLEMS ENCOUNTERED WITH EACH MUNICIPAL WATER SYSTEM

ANOKA COUNTY

CITY	PROBLEMS ENCOUNTERED
ANDOVER	None
ANOKA	None
BLAINE	Fe
CENTERVILLE	None
CIRCLE PINES	None
COLUMBIA HEIGHTS	See Minneapolis
COON RAPIDS	Fe, Mn; radium *
EAST BETHEL	Fe, Mn; nitrate and coliform in shallow wells too close to septic systems
FRIDLEY	None
HILLTOP	
LEXINGTON	None
LINO LAKES	None
RAMSEY	None
ST. FRANCIS	Fe **
SPRING LAKE PARK	None

* = filter water; ** = use polyphosphate

CARVER COUNTY

CITY	PROBLEMS ENCOUNTERED
CARVER	Fe, Mn
CHANHASSEN	Fe, Mn
CHASKA	Fe, Mn; rotten egg odor; age of system *
COLOGNE	Fe, Mn **
HAMBURG	Fe *
MAYER	Fe, Mn *
NEW GERMANY	None
NORWOOD	Fe, Mn
VICTORIA	Fe, Mn
WACONIA	Fe, Mn *
WATERTOWN	Fe; hardness *
YOUNG AMERICA	None

* = filter water; ** = use polyphosphates

DAKOTA COUNTY

CITY	PROBLEMS ENCOUNTERED
APPLE VALLEY	Fe *
BURNSVILLE	Fe, radium *
EAGAN	Fe, Mn *
EMPIRE	
FARMINGTON	Fe, Mn *
HAMPTON	None
HASTINGS	VOCs in 1989; TCE
INVER GROVE HEIGHTS	Fe, Mn, radium **
LAKEVILLE	Fe, Mn **
MENDOTA HEIGHTS	Water hammers; system not looped
NEW TRIER	Nitrates
RANDOLPH	
ROSEMOUNT	Sulfur smell
SOUTH ST. PAUL	Fe, Mn (use chlorine dioxide); occasional infrastructure problems (leaks, breaks...)
VERMILLION	None
WEST ST. PAUL	None

* = filter water; ** = use polyphosphates

HENNEPIN COUNTY

CITY	PROBLEMS ENCOUNTERED
BLOOMINGTON	None
BROOKLYN CENTER	Fe, Mn
BROOKLYN PARK	Fe, Mn *
CHAMPLIN	Fe, Mn **
CRYSTAL	None
EDEN PRAIRIE	Fe, Mn *
EDINA	Fe *
EXCELSIOR	None
GOLDEN VALLEY	None
HOPKINS	Fe *
LONG LAKE	None *
LORETTO	Fe, Mn
MAPLE GROVE	Fe, Mn *
MAPLE PLAIN	Fe, Mn *
MEDINA	Fe, Mn
MINNEAPOLIS	None *
MINNETONKA **	Fe, Mn **
MINNETONKA BEACH **	Fe, Mn **
MINNETRISTA	Fe
MOUND	None
NEW HOPE	None
ORONO	Fe, Mn *
OSSEO	None
PLYMOUTH	Fe, Mn *

* = filter water; ** = use polyphosphates

HENNEPIN COUNTY (continued)

CITY	PROBLEMS ENCOUNTERED
RICHFIELD	Fe, Mn *
ROBBINSDALE	None
ROCKFORD	Fe, Mn; brown water **
ROGERS	Fe, Mn; age of system; residents soften water privately *
ST. BONIFACIUS	Fe
ST. LOUIS PARK	None
SHOREWOOD	Fe, Mn; brown water; power surges
SPRING PARK	Fe, Mn *
TONKA BAY	Fe, Mn
WAYZATA	None

* = filter water; ** = use polyphosphates

RAMSEY COUNTY

CITY	PROBLEMS ENCOUNTERED
ARDEN HILLS	No response
FALCON HEIGHTS	Fe; see also St. Paul
LAUDERDALE	No response
LITTLE CANADA	None
MAPLEWOOD	Bad taste & smell; see also St. Paul
MOUNDS VIEW	Fe, Mn *
NEW BRIGHTON	Fe, Mn; * deep wells; ** in other part of system
NORTH ST PAUL	None
ROSEVILLE	Taste and smell in the summer; see also St. Paul
SHOREVIEW	Fe, Mn
ST. ANTHONY	Fe, MN, TCE *
ST. PAUL	None; note communities supplied have observed problems
VADNAIS HEIGHTS	None
WHITE BEAR LAKE	None
WHITE BEAR TOWNSHIP	Distance between systems; i.e., two separate water systems separated by 3 miles

* = use polyphosphates; ** = filter water

SCOTT COUNTY

CITY	PROBLEMS ENCOUNTERED
BELLE PLAINE	Fe, Mn
ELKO	None
JORDAN	Radium; brown water
NEW MARKET	Leakage (serial lines no loops)
PRIOR LAKE	Brown water; Fe, Mn
SAVAGE	Fe
SHAKOPEE	Age of system

WASHINGTON COUNTY

CITY	PROBLEMS ENCOUNTERED
BAYPORT	Hardness; brown water
COTTAGE GROVE	None
FOREST LAKE	Fe, Mn *
HUGO	None
LAKE ELMO	Fe, Mn
MAHTOMEDI	Fe
NEWPORT	Deep wells; distance between wells
OAKDALE	None
OAK PARK HEIGHTS	None
ST. PAUL PARK	Frequent water main breaks
STILLWATER	None
WOODBURY	Age of parts of system

* = filter water

APPENDIX H

MISCELLANEOUS INFORMATION FROM SUPPLIER SURVEYS

APPENDIX H. MISCELLANEOUS INFORMATION FROM SUPPLIER SURVEYS.

CITY	COUNTY	CAR WASHES		PARKS			FIRE HYDRANTS		IRRIGATION SYSTEMS		SYSTEM LEAKAGE	
		Number	Water Use GPD	Number	Restrooms	Water Use GPD	Number	Water Flushed MGY	Number	Water Use GPD	Known	Water Lost
Andover	Anoka	1	3943	50	0	0	300	6	0	0	no	NR
Anoka	Anoka	1	NR	15	28	NR	682	3	yes	NR	yes	<5%
Blaine	Anoka	4	4196	38	16	60	1330	0.5	4	4500	NR	NR
Centerville	Anoka	1	NR	NR	NR	NR	20	0.1	0	0	yes	NR
Circle Pines	Anoka	0	0	13	8	5	163	9	4	130	no	NR
Columbia Heights	Anoka	2	7000	14	11	330	516	1.29	yes	450	no	NR
Coon Rapids	Anoka	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Fridley	Anoka	5	4881	40	8	NR	1050	26	yes	211	no	NR
Hilltop	Anoka	0	0	0	0	0	12	NR	NR	NR	NR	NR
Lexington	Anoka	1	NR	2	NR	NR	62	0.125	0	0	no	NR
Lino Lakes	Anoka	0	0	7	4	NR	140	0.5	2	50	NR	NR
Ramsey	Anoka	1	438	0	0	0	80	0.5	0	0	yes	NR
Spring Lake Park	Anoka	1	NR	5	2	NR	250	4	yes	200	no	NR
St. Francis	Anoka	1	NR	3	NR	NR	87	NR	0	0	NR	NR
Carver	Carver	0	0	2	2	100	39	0.9	0	0	no	NR
Chanhassen	Carver	1	NR	1	2	0	1000	NR	1	NR	NR	NR
Chaska	Carver	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cologne	Carver	1	400	2	1	NR	34	0.12	NR	NR	yes	NR
Hamburg	Carver	1	500	3	2	NR	20	0.02	0	0	no	NR
Mayer	Carver	1	68	1	2	NR	28	0.05	0	0	yes	0
New Germany	Carver	0	0	3	2	NR	18	0.025	0	0	no	NR
Norwood	Carver	2	NR	5	0	NR	67	0.07	5	NR	no	NR
Victoria	Carver	1	NR	5	1	100	80	0.2	0	0	no	NR
Waconia	Carver	3	NR	4	2	NR	164	NR	0	0	no	NR
Watertown	Carver	1	NR	5	NR	NR	NR	NR	0	0	yes	<5%
Young America	Carver	0	0	2	3	NR	77	0.03	0	0	no	NR
Apple Valley	Dakota	5	3500	42	14	800	1375	20	yes	60000	yes	48 MGY
Burnsville	Dakota	10	NR	71	6	NR	3900	NR	yes	NR	yes	<5%
Eagan	Dakota	10	NR	48	18	NR	2500	6	280	NR	no	NR
Empire	Dakota	0	0	0	0	0	32	0.2	yes	NR	yes	NR
Farmington	Dakota	2	NR	9	2	NR	252	6	0	0	no	NR
Hampton	Dakota	0	0	1	1	200	25	NR	0	0	no	NR
Hastings	Dakota	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Inver Grove Heights	Dakota	4	8160	12	8	NR	1200	3	3	3280	no	NR
Lakeville	Dakota	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Mendota Heights	Dakota	0	0	0	0	0	650	5	0	0	no	NR
New Trier	Dakota	0	0	1	0	NR	10	NR	NR	NR	yes	0
Randolph	Dakota	0	0	1	1	0	25	NR	NR	NR	NR	NR
Rosemount	Dakota	5	627	15	2	NR	278	1.4	6	12000	no	NR
South St. Paul	Dakota	2	NR	10	0	0	850	NR	0	0	yes	0
Vermillion	Dakota	0	0	1	0	0	26	0.5	0	0	yes	0
West St. Paul	Dakota	4	NR	4	4	NR	NR	NR	0	0	no	NR
Bloomington	Hennepin	5	45107	19	42	NR	3252	NR	yes	71534	yes	47 MGY

Brooklyn Center	Hennepin	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Brooklyn Park	Hennepin	7	NR	51	20	NR	1661	6.5	NR	NR	no	NR
Champlin	Hennepin	3	4000	3	3	200	1000	0.015	yes	16000	yes	1%
Crystal	Hennepin	3	NR	22	11	NR	1170	NR	4	NR	no	NR
Eden Prairie	Hennepin	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Edina	Hennepin	4	NR	34	31	NR	1750	NR	4	NR	no	NR
Excelsior	Hennepin	1	NR	2	2	NR	81	0.6	yes	NR	no	NR
Golden Valley	Hennepin	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Hopkins	Hennepin	6	19726	15	5	NR	525	5	yes	NR	no	NR
Long Lake	Hennepin	2	NR	4	2	20	115	0.2	0	0	no	NR
Loretto	Hennepin	0	0	2	3	1200	29	0.095	yes	800	no	NR
Maple Grove	Hennepin	1	2772	10	20	NR	2190	18	yes	27385	NR	NR
Maple Plain	Hennepin	1	NR	4	2	NR	98	NR	yes	NR	no	NR
Medina	Hennepin	0	0	1	6	4000	153	1.5	0	0	no	NR
Minneapolis	Hennepin	NR	NR	NR	NR	NR	8100	NR	NR	NR	yes	10%
Minnetonka	Hennepin	2	12000	33	5	70	1976	11	yes	986	no	NR
Minnetonka Beach	Hennepin	0	0	3	0	0	38	0.03	NR	NR	no	NR
Minnetrista	Hennepin	0	0	0	0	0	125	NR	0	0	yes	<2%
Mound	Hennepin	0	0	19	2	NR	363	1.8	0	0	yes	.2%
New Hope	Hennepin	7	15000	NR	NR	NR	405	NR	0	0	no	NR
Orono	Hennepin	2	NR	9	NR	NR	150	NR	1	NR	no	NR
Osseo	Hennepin	1	NR	3	2	NR	81	NR	NR	NR	NR	NR
Plymouth	Hennepin	NR	NR	NR	NR	NR	NR	NR	yes	NR	yes	<5%
Richfield	Hennepin	8	3491	25	21	72	1009	10	yes	1774	NR	NR
Robbinsdale	Hennepin	1	NR	15	12	NR	319	2.3	yes	NR	yes	10-15%
Rockford	Hennepin	1	NR	2	1	NR	100	NR	0	0	yes	3%
Rogers	Hennepin	2	10275	1	2	NR	88	NR	0	0	no	NR
St. Anthony	Hennepin	2	NR	1	6	NR	300	2	0	0	yes	NR
St. Bonifacius	Hennepin	1	605	3	1	NR	66	4.5	NR	NR	no	NR
St. Louis Park	Hennepin	4	10564	52	10	200	1550	6.3	yes	333	no	NR
Shorewood	Hennepin	1	NR	NR	NR	NR	250	NR	NR	NR	NR	NR
Spring Park	Hennepin	2	2388	2	0	0	54	0.5	0	0	no	NR
Tonka Bay	Hennepin	0	0	6	0	0	105	0.075	0	0	no	NR
Wayzata	Hennepin	3	2740	3	6	NR	195	NR	yes	4616	no	NR
Falcon Heights	Ramsey	1	NR	4	2	NR	125	NR	0	0	no	NR
Little Canada	Ramsey	3	NR	2	0	0	250	NR	0	0	no	NR
Maplewood	Ramsey	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Mounds View	Ramsey	4	2940	10	4	NR	400	7	yes	NR	no	NR
New Brighton	Ramsey	1	0	NR	8	NR	500	NR	NR	NR	no	NR
North St. Paul	Ramsey	2	8493	13	3	7	499	1.5	yes	68500	yes	NR
Roseville	Ramsey	NR	NR	21	26	NR	1650	20	3	NR	NR	NR
St. Paul	Ramsey	20	80	3	50	NR	6500	25	yes	NR	no	NR
Shoreview	Ramsey	2	NR	10	0	0	1560	3	3	6000	yes	22 MGY
Vadnais Heights	Ramsey	3	NR	8	3	NR	500	2	0	0	no	NR
White Bear Lake	Ramsey	2	NR	13	9	NR	1460	NR	NR	NR	NR	NR
White Bear Township	Ramsey	0	0	10	5	NR	502	10	0	0	no	NR
Belle Plaine	Scott	2	654	5	3	NR	NR	0.5	0	0	no	NR
Elko	Scott	0	0	2	2	NR	2	60	0	0	yes	NR
Jordan	Scott	2	3800	3	3	NR	160	0.2	yes	1000	no	15-25%

New Market	Scott	0	0	1	2	15	10	0.02	0	0	no	NR
Prior Lake	Scott	3	2134	18	6	80	574	25	yes	NR	no	NR
Savage	Scott	3	NR	13	0	0	456	4	0	0	no	NR
Shakopee	Scott	6	1800	11	14	1200	850	4	0	0	yes	52 MGY
Bayport	Washington	0	0	3	2	NR	105	0.1	0	0	yes	18%
Cottage Grove	Washington	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Forest Lake	Washington	2	NR	4	1	50	250	1	yes	NR	yes	0
Hugo	Washington	0	0	2	1	NR	58	0.1	0	0	no	NR
Lake Elmo	Washington	0	0	9	0	0	40	0.04	0	0	no	NR
Mahtomedi	Washington	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Newport	Washington	2	NR	4	3	NR	165	2	2	NR	no	NR
Oakdale	Washington	2	12000	1	2	NR	900	NR	0	0	yes	13%
Oak Park Heights	Washington	1	10000	3	6	NR	85	NR	yes	2000	no	NR
St. Paul Park	Washington	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Stillwater	Washington	2	5000	10	6	NR	627	0.1	yes	2400	yes	10%
Woodbury	Washington	2	14245	25	2	NR	600	NR	yes	NR	no	NR