Metropolitan Council Environmental Services

INFLOW/INFILTRATION TASK FORCE REPORT

May 2004

Metropolitan Council
Environmental Services

230 East Fifth Street ■ St. Paul, Minnesota 55101-1626 ■ (651) 602-1005 ■ Fax 602-1138 ■ TTY 291-0904

Metropolitan Council Members

Chair:

Peter Bell

Council Members:

Roger Scherer	District 1	Natalie Steffen	District 9
Tony Pistilli	District 2	Vacant	District 10
Mary H. Smith	District 3	Georgeanne Hilker	District 11
Julius C. (Jules) Smith	District 4	Chris Georgacas	District 12
Russ Susag	District 5	Richard Aguilar	District 13
Peggy Leppik	District 6	Song Lo Fawcett	District 14
Annette Meeks	District 7	Thomas Egan	District 15
Lynette Wittsack	District 8	Brian McDaniel	District 16

Council Regional Administrator

Thomas Weaver

General Manager, Environmental Services Division

William G. Moore

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

Publication #32-04-020

Released May 2004

A. Table of Contents

Section One: Introduction 1
Background Information 2
Formation of I/I Task Force 3
Task Force Process 3

Section Two: Statement of I/I Problem 5
Characterization of I/I 5
Historical Perspective 6
Impact on MCES System 8
Current Allowance for I/I in MCES Facilities 8
Forecasting Additional Interceptor Capacity Locations 11
I/I Impacts at Treatment Plants 12
Impact on Local Systems 14
Potential Federal Regulations 14
Estimated Regional Capital Costs 16
Interceptor Relief Sewer Costs 16
Pump Station Costs 17
Treatment Plant Costs 19

Section Three: Measurement of Flow 21
Measurement of Excessive I/I 21
Dry Weather Flow 26
Communities with Excessive I/I 29

Section Four: Current Metropolitan Council I/I Policy 35

Section Five: Examples of I/I Control Programs 37
MCES Interceptor Facilities 37
Minnesota Community Programs 39
City of Maple Plain 39
City of Minneapolis 39
City of Plymouth 40
City of St. Anthony 40
City of Duluth 41
Other States' Community Programs 41
City of Ann Arbor, Michigan 41
Rock River Water Reclamation District: Rockford, Illinois 42
City of West Lafayette, Indiana 42

Section Six: Possible Control Strategies....43
I/I Goals....43
Modified Sewer Discharge Rules....43
Community Contracts....44
Joint NPDES Permit....44
Financial Assistance Surcharge Program....44
Excess Demand Charge....44
Options for Reduction of I/I in Local Collection Systems....45
New Facilities....45
Ordinances....45
I/I Reduction in Local Sewers....46
Flow Storage....46
Relief Sewers....46

Section Seven: Authority, Conclusions and Recommended Actions....47
Authority....47
Conclusions....48
Recommendations....48

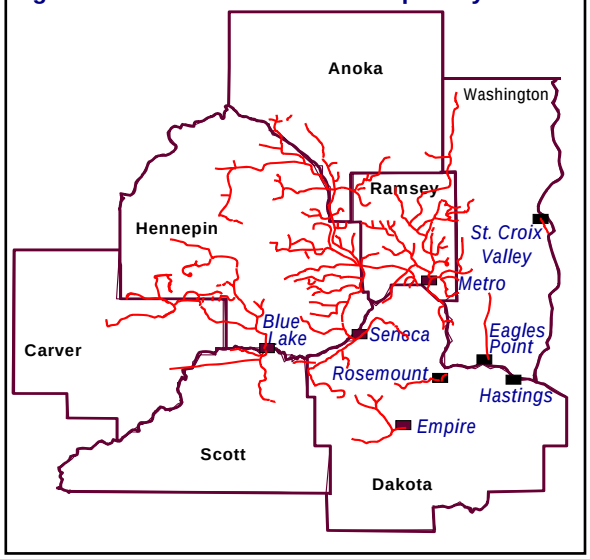
Appendix A: Definitions and Acronyms....51

Section One

Introduction

Metropolitan Council Environmental Services (MCES) owns and operates extensive interceptor systems, as shown in Figure 1. The largest system conveys wastewater flow to the Metro Wastewater Treatment Plant (WWTP) and serves 65 communities. Smaller systems convey flow to the Council's plants in Shakopee (Blue Lake), Eagan (Seneca), Empire, and Stillwater (St. Croix). There is no interceptor system for the Hastings plant and the interceptor system to the new Eagles Point WWTP is under construction.

Figure 1: MCES Plants and Interceptor System



More than 100 communities own and operate local sewer systems that are connected to the MCES regional interceptor system. Through these local systems, wastewater service is extended to residents, commercial establishments, industry, and public agencies. These end users are charged for this service by the local community who typically charges for wastewater on the basis of metered water use. MCES, as a wholesaler of the regional services, bills each community on the basis of its metered wastewater flow into the interceptor system. Only industries with high strength waste are billed individually by MCES.

Each community bills its customers to recapture the cost charged by MCES and the costs to maintain and operate the local sewers. Because MCES bases its charge for service on the volume of wastewater received, these charges reflect clear water entering the sewer system as well as the wastewater generated by the customers. This includes rain induced clear water that enters the local sewer system through leaks in the publicly owned sewer and manholes and the private property sources: rain leaders, sump pumps, foundation drains, and leaking house laterals. MCES flow records show a direct correlation between precipitation and the volume of clear water flow from many communities served by the regional wastewater system.

The addition of clear water into the local sewer systems creates two problems. First, the additional flow takes capacity that was originally designed for growth and, in some cases, the additional flow exceeds the available sewer system capacity. When the capacity of the sewer is exceeded, the wastewater backs up into basements or spills out of a manhole. These occurrences are not allowable under federal and state regulations. Second, once clear water enters the system there is no way to distinguish it from sewage, therefore MCES charges communities the same rate for its clear water as it does for the sewage. Communities have a fiscal as well as a public policy reason for assuring that the total system functions effectively and conforms to federal and state regulations.

Background Information

A comprehensive master plan for these interceptor systems was completed in December 2002. One of the more significant findings of the study was that uncontaminated groundwater and rainfall runoff were entering the local collection systems at rates that would overload the interceptor system. This uncontaminated clear water, called Infiltration/Inflow (I/I), is consuming interceptor and treatment plant capacity originally designed to serve future development. During significant rainfall events, portions of the interceptor system are at risk of causing a backup of wastewater into basements or spilling wastewater into the environment.

During the times that a sewer system is overloaded, the sewer becomes pressurized and the wastewater can flow back up a house lateral and into a basement. Even though the overloading may last only an hour or two, enough time has passed to cause damage and create a health hazard in the low-lying basements that essentially relieve the overloaded system. On occasion, the system becomes so pressurized, the wastewater rises up in manholes and flows out the top of the manhole. The overflow of untreated wastewater into the environment can cause a health hazard and, in some cases, adversely affect the aquatic environment.

The master planning study for the interceptor system provided an opportunity to examine the long-range implications of continuing to tolerate the current levels of I/I as development continues in the region. During that examination, improvements to the interceptor system were looked at in two scenarios. Under the first scenario, the level of I/I would be reduced to conform to the basis of the system's design. Under the second scenario, the I/I would remain at current levels. The cost to serve the regional growth under the latter scenario (based on 2030 ultimate development) would be a half billion dollars more than the first because of the need to construct relief sewers and expand pump stations.

However, the impact of I/I is also substantial at the treatment plants. Even if the interceptor system capacity were expanded, the hydraulic capacity of the Metro wastewater treatment plant could not be doubled to treat the resulting peak rate. Similarly, the hydraulic capacity of the Blue Lake plant may be constrained by the current site. Therefore, simply expanding the interceptor system (the second scenario) is not a feasible option.

Council staff assessed the problem and concluded that the only viable option for the long-term service of the region is to eliminate excessive I/I at its source. The practical limitations to expanding the system, the high cost of relief sewers, larger pump stations and larger treatment facilities, and the impending federal requirements (CMOM, etc.) on elimination of overflows supported this conclusion. Therefore, staff recommended the formation of an I/I Task Force, representing the communities served, to evaluate the problem and recommend a course of action.

Formation of I/I Task Force

The formation of an I/I Task Force started with information meetings for community representatives and a solicitation of volunteers to become members of the task force. These informational meetings were held in four locations around the metropolitan area in December of 2002. Community representatives were provided an opportunity to ask questions and to volunteer to participate on the Task Force.

Candidates for membership to the I/I Task Force were nominated by Council staff based on the interest expressed by community representatives and the concern for having members represent different technical backgrounds. In addition, the membership needed to be diverse enough to include some communities with high levels of I/I and some communities with low levels of I/I.

On April 8, 2003, the Metropolitan Council appointed the Infiltration and Inflow Task Force headed by Council Member Russ Susag, District 5. The Task Force included representatives from 15 communities from across the region as well as the Association of Metropolitan Municipalities. Individuals on the Task Force from the different communities serve "at large." The I/I Task Force chair and members are listed below.

TASK FORCE CHAIR

Russ Susag
Serves as a Metropolitan Council and Environment Committee member.

TASK FORCE MEMBERS

M. Drew Anderson
Utility Supervisor, Waconia

Deb Bloom
City Engineer, Roseville

Bonnie Burton
Finance Director, Shorewood

Jeannine Clancy
Public Works Director, Golden Valley

Robert Cockriel
Utility Superintendent, Bloomington

Tom Colbert
Public Works Director, Eagan

Gregory Gappa
Director of Public Services, Orono

Kelley Janes
Utilities Superintendent, Chanhassen

Mike Kassan
Civil Engineer III, St. Paul

Bruce Osborne
Public Works Superintendent, Victoria

Tom Ozzello
Utility Supervisor, Woodbury

Eugene Ranieri
Director, Association of Metropolitan Municipalities

Jim Sweeney
Utility Superintendent, Inver Grove Heights

Harlan Van Wyhe
Civil Engineer, Maple Grove

Pat Wrase
Storm Water/Wastewater Engineer, Minneapolis

Task Force Process

The Task Force was charged to review the I/I issues and then formulate and propose implementation strategies to reduce excessive infiltration and inflow in local and regional wastewater collection systems. Reporting back to the Environment Committee, the Task Force met monthly, reviewing information presented by the Environmental Services Division staff, who provided facilitation and administrative support. The recommendations and conclusions were arrived at by consensus of the members of the Task Force.

While the Task Force meetings were open to the public, the information presented and discussed was also available to all communities through a Web site established by Council staff. Meeting agendas and minutes were posted routinely. The notification of the creation and location of the Web site was sent to all the metropolitan communities.

Council staff provided information about the metropolitan disposal system and the procedure used to characterize the existing and projected effects of I/I on the system. After being grounded with an understanding of the problem, the Task Force reviewed the following key issues to formulate implementation strategies to be recommended to the Council.

- Regional versus local liability for Sanitary Sewer Overflows (SSO) resulting from excessive levels of I/I within the Metropolitan Disposal System (MDS).
- Appropriate level of service from regional government (should MCES design its facilities to handle large volumes of I/I?).
- Appropriate type and level of support from regional government to local communities to reduce I/I.
- I/I goals for communities with excessive I/I.
- What should be included in local I/I programs and when should I/I goals be met?
- Should there be a regional grant program?

Section Two

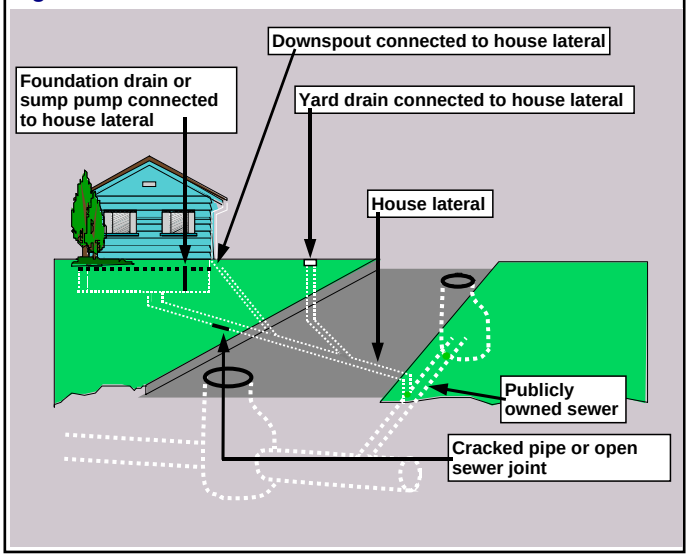
Statement of I/I Problem

Sewers, pump stations, and treatment plants are designed to convey and treat wastewater. The capacity or size of the facilities is dependent on the flow rate of the wastewater. For conveyance facilities, the flow rate is usually the maximum rate expected for a one-hour duration. For treatment plants, the structures must pass not only the maximum rate, but the processes are designed to meet permit limits, usually specified as a peak month condition. Consequently, the maximum 30 day average flow is important for sizing treatment plants. The introduction of non-contaminated, clear water (I/I) into the collection system increases the flow of the wastewater and consumes capacity of sewers, pump stations and treatment plants. Whenever the rate of I/I exceeds the initial basis of the design (some allowance of I/I is included in the design), the capacity allocated for growth is no longer available. Either larger facilities need to be constructed, excess I/I needs to be eliminated, or growth needs to be curtailed.

Characterization of I/I

The sewer system that conveys wastewater to the treatment plants can be characterized as the publicly owned system, typically located in public right-of-way (under streets or backyard easements), and the private system, typically the house lateral that extends from the building to the publicly owned sewer. As depicted in Figure 2, there are several ways for I/I to enter the collection system.

Figure 2: Sources of Infiltration/Inflow



Infiltration occurs when groundwater enters the sanitary sewer system through defects in the system. Inflow occurs when stormwater/rainwater enters the sanitary sewer system through defects and illegal connections in the system. Both infiltration and inflow are characterized as clear water that does not require treatment prior to discharge.

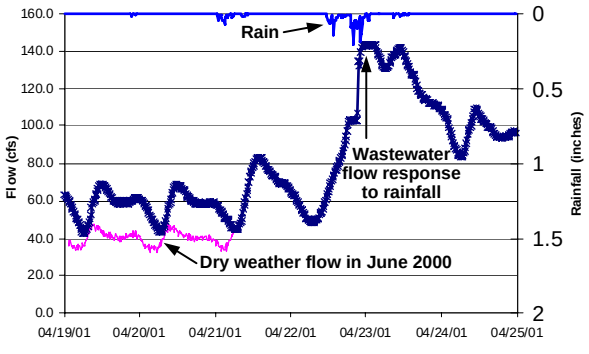
Sources of infiltration are typically cracks in pipes, leaky joints and deteriorated manholes. Groundwater can enter these defects whenever the collection system lies beneath the groundwater table or the soil above the sewer nears saturation. Typically, the rain infiltrating through the ground can cause an increase in wastewater flow if there are defects in the sewer.

Sources of inflow are typically direct connections to the sanitary sewer system such as cross connections with the storm sewer system, building rain leaders, building foundation drains, and sump pumps. These connections occur with both homes and businesses. Inflow typically occurs in direct proportion to rainfall. Soon after the rain stops, the inflow from most sources

stops also. The exception is the response of a foundation drain that can continue for extended periods of time as the water percolates through the overlying soil.

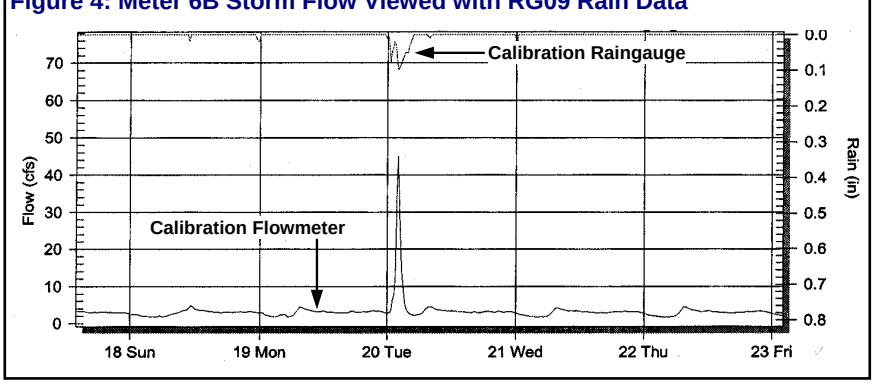
MCES measures wastewater flow at over 100 locations. A significant rain fell in April of 2001 and produced significant increases in wastewater flow in many communities. As shown in Figure 3, the peak flow increased to about 3.5 times the average of the typical dry weather days. This type of hydrograph indicates the influence of groundwater entering the upstream collection system and depicts the long period of time needed for infiltration flow to decrease. Foundation drains can cause this type of response as the water above the drain slowly percolates through the ground.

Figure 3: Meter 409 Flow April 2001



Inflow from direct connections exhibits a quick response and quick reduction when the rain stops. Figure 4 shows the results from Meter 6B (Figure 4) for a storm event on June 20, 2000 and depicts influence of inflow as well as some infiltration.

Figure 4: Meter 6B Storm Flow Viewed with RG09 Rain Data



Historical Perspective

The significance of I/I was brought into focus when Congress passed the Clean Water Act (PL92-500 in 1972) and initiated the Construction Grant Program. Any community seeking grant money for wastewater conveyance or treatment was required to prove that the I/I in their system was less expensive to convey and treat than to remove. As a consequence, many communities across the country determined that I/I in their systems was excessive. Over the last 30 years all 103 of MCES's customer communities have done some maintenance involving I/I work. Eighty percent of the communities awarded I/I contracts or completed specific I/I work, and 27 communities received grants for I/I projects. Although the grant program stopped in the early 1980s, the requirement to evaluate I/I remains as a part of the application for a low interest loan from the Public Facilities Administration. Federal monies cannot be spent to convey and treat I/I that is judged to be more cost effective to remove.

In the 1970s, during the time of the Construction Grant Program, the importance of I/I sources on private property was well understood. Many studies concluded that disconnection of a sump pump was cost effective as it usually involved an expenditure of $200 to $500 for the new piping. House to house surveys were conducted in communities showing significant

I/I rates, and ordinances regarding sump pumps were enforced. Disconnection of gravity foundation drains was generally considered not cost effective to undertake so it was generally concluded that a house to house survey was not a worthwhile undertaking. A common reason for avoiding I/I reduction from private property sources was the perceived political consequence of “invading the privacy of the home.” As a result, many sources of I/I on private property remain today.

Today, most communities have ongoing programs to clean and inspect (televise) their local sewer system. If defects are found that could affect the structural integrity of the system, most communities correct the problem. If the defects cause infiltration but do not seem to be a structural problem, some communities do nothing. The additional volume results in an increase to the sewer bill from MCES.

Some communities in the region are investigating how to reduce the I/I from private property sources: the foundation drain, sump pump, or house lateral. Reasons to disconnect foundation drains and sump pumps range from financial (less volume and a smaller bill from MCES) to reducing the risk of basement backups during significant rainfall events.

The importance of disconnecting a foundation drain (or sump pump) can be better understood by comparing the flow generated from a drain versus the normal wastewater generated from within the home. Typically, residential wastewater generation is about 70 gallons per person per day. Residential density in the region is about 2.7 people per household. Thus, one could expect each home to generate about 190 gallons of wastewater per day. If the foundation drain or sump pump is connected to the house lateral and contributes just 0.5 gallons per minute of flow, there will be an additional 720 gallons per day of wastewater from the home, about four times the amount of wastewater generated within the home. Disconnecting the drain or sump pump is equivalent to about three new homes.

The annual volume of clear water discharged from a foundation drain can exceed 500,000 gallons if it pumps just four minutes every hour at a rate of 15 gallons per minute. During some very wet months, the flow to the Blue Lake treatment plant has been nearly 1/2 clear water for 30 continuous days. This would indicate that the wastewater flow from some communities more than doubles because of I/I.

Infiltration and inflow are, by definition, not found in combined sewers because combined sewers were designed to accept both sewage and storm water. Minneapolis, South St. Paul and St. Paul had combined sewers, which overflowed many times each year directly to the Mississippi River. All three communities agreed to separate their collection systems into a storm sewer system and a separate sanitary sewer system. The projects to separate the sewers were focused on constructing new public sewers. Consequently, continued efforts to disconnect the sources of clear water on private property are now required to conform with the requirements of a separated system.

Prior to the late 1960s, the Minnesota Building and Plumbing Codes allowed (and in some communities local code required) foundation drain tiles and sump pumps to be connected to the sanitary or combined sewer systems. In addition, roof leaders were allowed to discharge to combined sewers. After these codes were changed in the late 1960s, these sources of I/I became illegal for new construction. For buildings constructed prior to the late 1960s,

disconnection of these I/I sources is not required under the plumbing codes, however MCES's Wastewater Discharge Rules prohibit these types of connections.

In some areas the illegal connection is made because the drainage system is inadequate to handle the sump pump discharge in all seasons. Where this is the case, it will usually be necessary for the community to improve the local drainage system as part of a program to have sump pumps and foundation drains disconnected from the sanitary sewer system. The need for additional drainage facilities adds to the program cost and complexity of implementation.

It is estimated that 60 to 80 percent of the I/I flows that exist today originate on private property.

Impact on MCES System

Infiltration/Inflow consumes capacity in the interceptor system and at the treatment plants. If the I/I exceeds the rate that the facilities were designed to accommodate, additional capacity must be added or growth must be curtailed. The consequence of too much I/I is an overflow of wastewater, either to the environment or into a basement.

Current Allowance for I/I in MCES Facilities

MCES has established a basis for designing conveyance facilities based on the projected peak hour flow. The peak flow is calculated as the average flow times a factor, called the peak to average ratio. As shown in Figure 5 on the right and Table 1 on the following page, the MCES peak to average (P/A) ratio decreases as the average flow increases. These ratios used by MCES are slightly higher than those calculated by the formula published in Ten States Standards for Wastewater Facilities. Dry weather periods produce smaller peak flows, as shown in Figure 6 on the following page. The difference between the peaking factors for design versus dry weather is the allowance MCES provides for I/I.

Figure 5: MCES's Peak to Average Flow Ratio

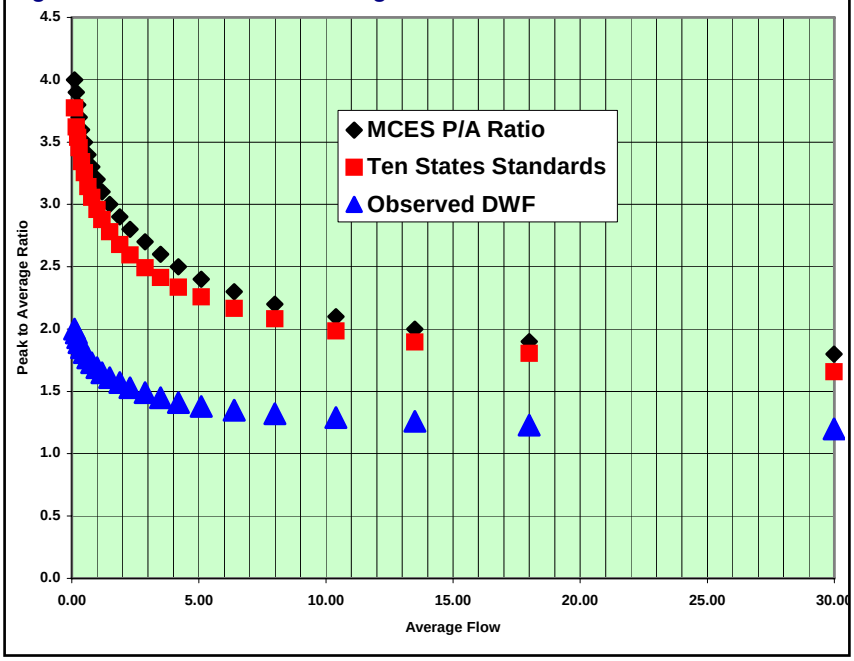
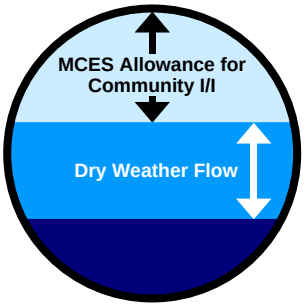


Table 1: MCES Peak to Average Ratios								
Average Flow (mgd)			**Peak Flow (mgd)**			**Peak to Average Ratios**
0.00	to	0.11	0.00	to	0.44	4.0
0.12	to	0.18	0.45	to	0.70	3.9
0.19	to	0.23	0.71	to	0.87	3.8
0.24	to	0.29	0.88	to	1.07	3.7
0.30	to	0.39	1.08	to	1.40	3.6
0.40	to	0.49	1.41	to	1.70	3.5
0.50	to	0.64	1.71	to	2.16	3.4
0.65	to	0.79	2.17	to	2.58	3.3
0.80	to	0.99	2.59	to	3.13	3.2
1.00	to	1.19	3.14	to	3.64	3.1
1.20	to	1.49	3.65	to	4.41	3.0
1.50	to	1.89	4.42	to	5.39	2.9
1.90	to	2.29	5.40	to	6.30	2.8
2.30	to	2.89	6.31	to	7.66	2.7
2.90	to	3.49	7.67	to	8.91	2.6
3.50	to	4.19	8.92	to	10.27	2.5
4.20	to	5.09	10.28	to	11.97	2.4
5.10	to	6.39	11.98	to	14.38	2.3
6.40	to	7.99	14.39	to	17.18	2.2
8.00	to	10.39	17.19	to	21.30	2.1
10.40	to	13.49	21.31	to	26.31	2.0
13.50	to	17.99	26.32	to	33.28	1.9
18.00	to	29.99	33.29	to	52.49	1.8
30.00	or more		52.50	or more		1.7

The capacity of the interceptors is designed to accept peak hour I/I that ranges from 1.0 to 1.2 million gallons per day per 1,000 acres of developed area for most tributary areas.

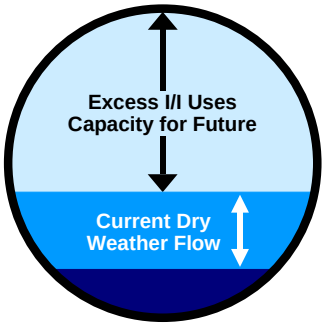
Figure 6: MCES Standards Allow for I/I



This rate of peak hour I/I accounts for about 1/3 of the sewer capacity as shown in Figure 6 on the left. In the early years of installation, the area is not fully developed and the dry weather flow is less than the basis of design.

Problems of overloading from too much I/I are avoided initially if the excessive I/I plus the dry weather flow is less than the sewer capacity (Figure 7).

Figure 7: I/I Contained with Excess System Capacity



The rate of I/I is typically dependent on rainfall. More intense rains mean higher rates of inflow. These higher intensity rain events occur less frequently than smaller intensity rain events. Frequent but lower intense rainfalls generally increase the rate of infiltration. Consequently, the intense, less frequent rains tend to generate higher rates of overall I/I. For sewer systems subject to high I/I levels, the risk or probability of being overloaded is related to the probability of high intensity rainfall.

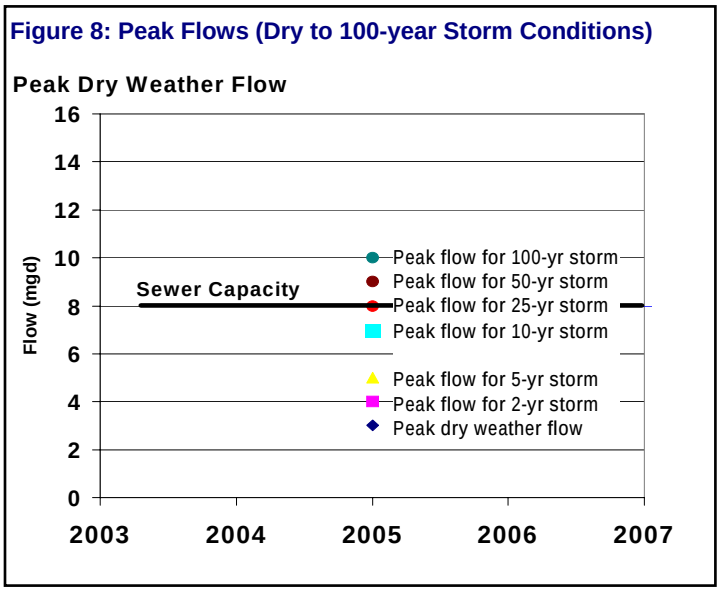
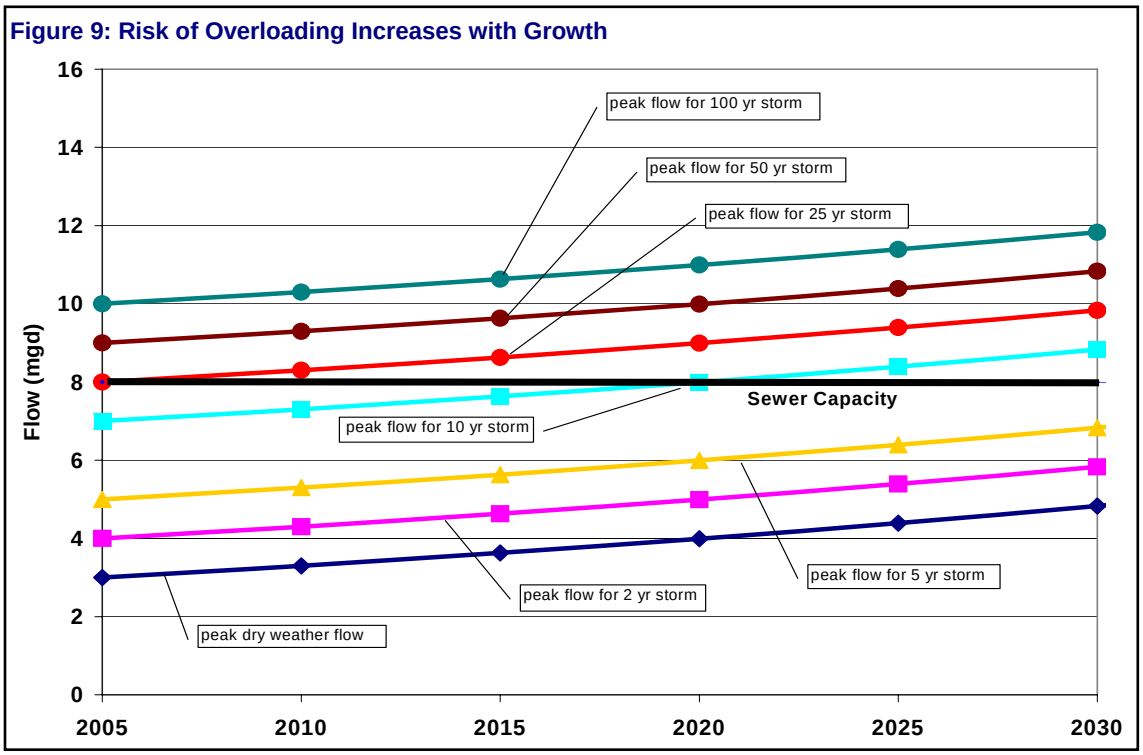


Figure 8 shows peak flow from a tributary area for various probabilities, each relating to a rain event. The risk of a ten-year peak flow is about ten percent each year. In this example, the peak flow will equal the sewer capacity during a 25-year rainfall. Thus, the risk of overloading the sewer is less than four percent each year.

As the dry weather flow increases with development, the capacity available for I/I decreases, therefore, the probability of rain that causes the sewer to become overloaded with I/I is greater. As shown in Figure 9, the peak flow for the various rain events increases as the dry weather flow increases with growth in the tributary area. By 2020 the dry weather flow will have increased sufficiently allowing a less frequent rain event to cause the sewer to be overloaded. The risk of overloading changed from less than four percent in 2005 to nearly ten percent in 2020.



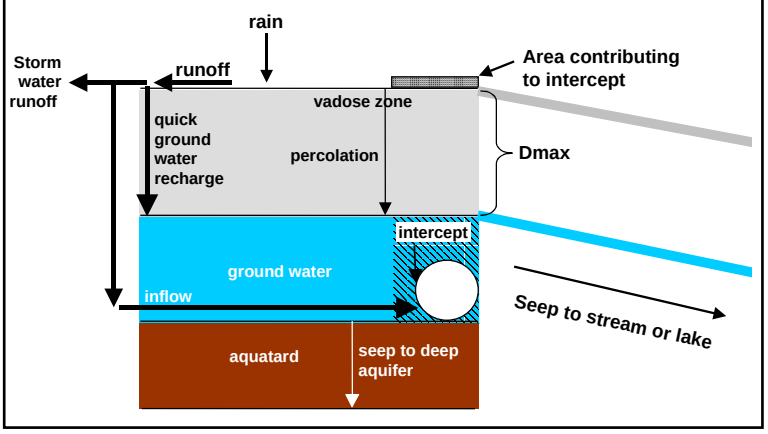
If the I/I is not eliminated, additional capacity—reflected in larger and more relief sewers, larger pump stations, and larger treatment plants—must be provided.

Forecasting Additional Interceptor Capacity Locations

The Metropolitan Council has projected significant growth in the metropolitan area by 2030. These projections for population and employment were used to project wastewater flows throughout the interceptor system and at each treatment plant. For the interceptor system, peak hour flows were projected; for the treatment plants, annual average, peak month, and peak hour flows were projected. The infiltration/inflow component of peak hour flow rates was estimated based on a computer model simulation of how rainfall generates infiltration/inflow in areas tributary to the interceptor system.

As shown in Figure 10, the rainfall simulation model accounts for rainfall seeping through the ground and for runoff as well. The seepage rate through the ground varies with the soil type so in sandier soils the seepage rate is relatively high and water moves rapidly toward the ground water table. As the ground water level rises, the rate of infiltration into a sewer defect or foundation drain increases. In tighter soils the water moves slower and contributes clear water to a drain over a longer period of time. The model also allows the user to characterize the percent of the area that contributes inflow through direct connections of surface runoff to the sewer system.

Figure 10: Infiltration/Inflow Model



Up to three storm events were used to calibrate this model, and routed peak flows were compared to the meter data. Generally, the model was considered calibrated if the simulated peak flow was within ten percent of the metered flow. In addition, the shape of the hydrograph for each event was closely matched to the measured flow. Consequently, different storms can be modeled to predict the peak I/I from a specific tributary area. For the treatment plants, the amount of I/I was calculated based on the difference between measured flows into each plant and the estimated wastewater generation rate.

Results of simulating the projected conditions in 2030 with the current levels of I/I indicate a need for significant investment in relief sewers and pump stations. As shown in the following Figures 11, 12, 13 and 14, segments of the interceptor system will require extensive parallel sewers and many of the pumping stations will need to be expanded. Not all of the relief segments are future needs; some of these segments are needed today to convey current inflow and infiltration.

The simulation model was used to evaluate the 2030 conditions but with the assumption that all communities met the MCES standards regarding allowable I/I rates. As shown in Figure 15, which follows, most of the relief sewers are not needed.

I/I Impacts at Treatment Plants

I/I affects treatment plants in several ways. Peak hour flows must be hydraulically conveyed through each treatment plant to avoid a bypass or overflow. This provides a more accurate estimate of projected peak hour flows at each plant. In addition to the peak hour flow, the peak month flow is very important because of the way NPDES permits are written. For each of the MCES plants, there are limitations on the plant effluent that are based on a monthly average. Consequently, each plant must have capacity to meet the effluent conditions during the maximum month flow.

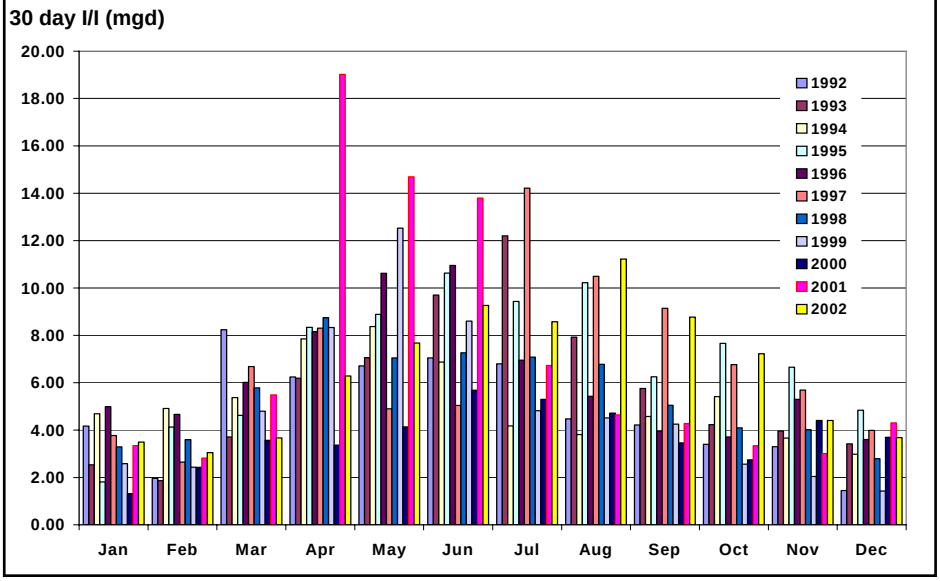
Wastewater generation was estimated for each treatment plant service area, based on the tributary population (residential and employment) and monitored industrial flow. Residential wastewater generation was assumed to be 70 gallons per capita per day (gpcd) and commercial wastewater generation was assumed to be 30 gpcd from the employment population. As indicated in Table 2, the amount of I/I as a percentage of the annual average flow in year 2000 varied among the MCES plants.

Table 2: Treatment Plant Annual Inflow and Infiltration

Treatment Plant	Annual Average Flow in 2000 (mgd)	Base Wastewater Flow Generation (mgd)	Annual I/I (mgd)	Annual I/I (% of Total Flow)
Metro	200	165	35	17.5%
Blue Lake	28.09	22.2	5.89	20.9%
Seneca	24.91	21.6	3.31	13.3%
Empire	8.94	7.9	1.04	11.3%
St. Croix	3.46	2.6	.86	24.8%
Hastings	1.63	1.6	.03	1.8%

Annual I/I is important only for billing purposes. The more important variable is the peak month I/I. Peak month I/I is highly dependent on rainfall and antecedent conditions at the plants. Flow records from 1992 to 2002 were evaluated to calculate the peak month I/I rates. Figure 16 illustrates peak monthly flow for the Blue Lake Plant from 1992 to 2002.

Figure 16: Blue Lake Plant Peak Month I/I (1992–2002)



In a similar manner, the peak month I/I for each plant was calculated and is listed in Table 3. Peak hour flows are based on historical peak flow minus dry weather peak hour flow.

Table 3: Treatment Plant Peak Inflow and Infiltration Rates

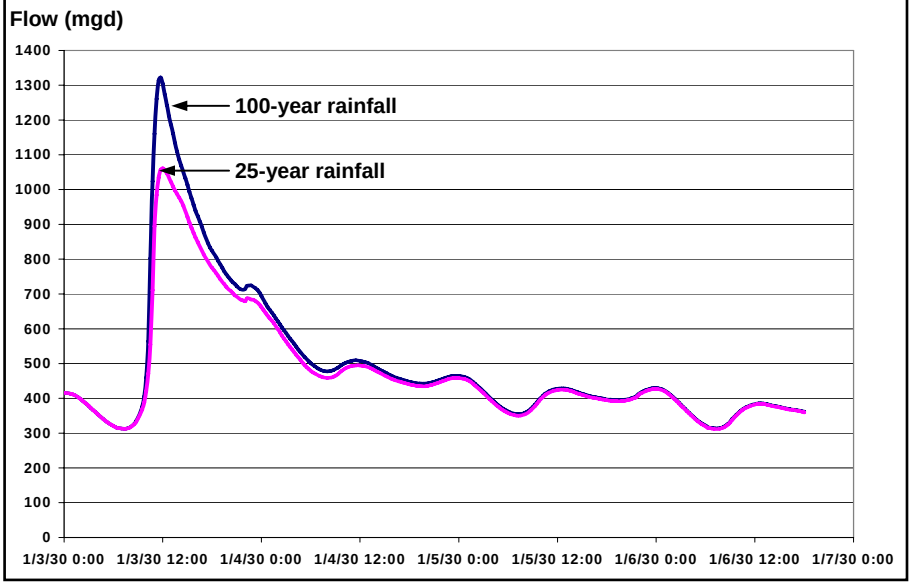
Treatment Plant	Peak Month I/I Flow (mgd)	Peak Month I/I (gpcd)	Peak Month I/I (% of Total Flow)	Peak Hour I/I (mgd)
Metro	150.0	88	48%	480*
Blue Lake	19.0	83	46%	60
Seneca	7.0	33	24%	17
Empire	3.0	31	27%	9
St. Croix	1.4	59	35%	6
Hastings	0.5	27	24%	2

*Peak hour flow at the plant is reduced by upstream overflows

The I/I tributary to the Metro, Blue Lake, and St. Croix plants is significantly higher than for the other plants. The older communities in the Metro service area are likely to have foundation drains and sump pumps connected to the sewer system because of the many homes constructed prior to the change in the plumbing code. In the Blue Lake and St. Croix service areas there is significant development in areas with high groundwater and many buildings in this service area are likely to have drains connected to the sanitary sewer system.

The wastewater flows from the service areas tributary to the Empire, Hastings, and Seneca plants do not respond to rainfall as severely as do flow to the other plants. These service areas offer a reasonable target for how the flows to the other plants could be if I/I were similarly controlled. Peak month I/I flows of 30 gpcd would reduce the peak month I/I rates at Metro, Blue Lake, and St. Croix plants by 99 mgd, 12 mgd, and 0.7 mgd, respectively.

Figure 17: Metro Plant Estimated Peak Flow (January 2030)



The peak hour flows to each plant in 2030 were projected with the interceptor model for 25-year and 100-year storm events. The peak flow to the Metro plant could reach over 1.3 billion gallons per day, as shown in Figure 17, if enough relief sewers were constructed. This is nearly twice the rate that the twin barrel joint interceptor can carry into the plant today. The feasibility of doubling the hydraulic capacity of the Metro plant is unlikely because of site constraints. MCES staff has concluded that simply adding more capacity to convey and treat I/I is not a feasible option.

Impact on Local Systems

I/I is currently causing backup problems in several communities. In these communities the peak I/I is so significant that local collection systems are overloaded and raw sewage is backing up into low-lying basements. Where the local collection system is overloaded by I/I the Minnesota Pollution Control Agency (MPCA) may not permit additional connections. This condition essentially stops growth or redevelopment that would increase wastewater flow.

In a few communities served by an MCES pump station, the peak flows during a significant rain exceed the firm capacity of the MCES pump station. These problems are severe and frequent enough for the Council to advise these communities that either I/I must be reduced or local sewer connections must be halted.

Excessive I/I rates can put the regional conveyance system at risk of being overloaded, consuming capacity that should be available for downstream communities. In some cases the excessive I/I from an upstream community can cause an overflow to occur in a downstream community. To reduce the risk of this occurring, MCES (as the regional wastewater agency) must advise the upstream community of its liability and work with the community to reduce the excessive I/I.

Excessive I/I entering the public sewer system creates voids around the pipes that could cause structural damage and leads to premature replacement of the system well before its normal life cycle replacement. When I/I enters the system from private sources it is not metered to the home or business. Therefore, all rate payers in the community share the conveyance and treatment costs instead of those private sources adding I/I to the system.

As stated earlier in this report, a normal residential connection discharges approximately 70 gallons per person per day. The average family size in the metropolitan area is 2.7 people per household equaling 190 gallons of wastewater per day. Foundation drains and sump pumps contributing 0.5 gallons per minute of flow create an additional 720 gallons of wastewater from the home. This is the equivalent of three new homes. Excessive I/I flow results in lost growth capability for the community and increased rates to the rate payers.

Potential Federal Regulations

On January 5, 2001, the United States Environmental Protection Agency (U.S. EPA) signed the long-awaited draft rule on sanitary sewer overflows. As with other regulations, the 120-day public comment period will not begin until the proposed rule is published in the Federal Register. That publication was delayed on January 24th when EPS withdrew the SSO regulations from the Office of the Federal Register to give the Bush Administration an opportunity to review it. Since January 2001, EPA has received hundreds of comments to the original draft, resulting in a directive to the Office of Water Management to do the following.

1. Propose regulations consistent with those originally recommended.
2. Summarize all comments received since and incorporate them into the preamble to the regulations.
3. Provide preamble discussion regarding the comments.

Publication in the Federal Register is still delayed. The draft rule has been removed from the U.S. EPA Web site as of March 1, 2004 and its status remains uncertain. Meanwhile, as

municipalities await formal regulations, the fact remains that roughly 22,000 cities in the U.S. experience SSO during wet weather conditions. Despite the lack of formal SSO regulations, these unpermitted/untreated discharges are still prohibited under the Clean Water Act and subject to enforcement action. This is a serious concern in areas where wastewater flow increases significantly because of rainfall. Even infrequent rain events will not be a valid excuse for an SSO.

At this time, MCES is the only National Pollution Discharge Elimination System (NPDES) permit holder for the regional wastewater system. The draft rule addressed the role of the "satellite" communities and their collection systems as well as the regional system. Satellite communities may well become joint permittees and subject to the same NPDES regulatory requirements.

If party to an enforcement action as a co-permittee, the community could be subject to administrative orders and required to be part of a Consent Decree, as is currently happening to Duluth, Minnesota. The city of Duluth is a co-permittee of the collection system with the Western Lake Superior Sanitary District. In 2002, the city and District negotiated with MPCA to finalize the terms of a new five-year permit to operate the collection system. As part of the permit conditions, Duluth agreed to a compliance schedule to control and eliminate SSOs where inflow and infiltration from the city's collection system was the primary cause. Unfortunately, SSOs actually increased in 2003 versus the prior two years, partly attributable to mechanical and operational failures on the District's system, and not just wet weather flow. This caught the attention of the U.S. EPA and on January 12, 2004, the city of Duluth and the Western Lake Superior Sanitary District received an Administrative Order requiring the city and the district to furnish information and develop a plan of action relative to eliminating SSOs. The city and the district must submit the plan of action to U.S. EPA by May 14, 2004, as the starting point for entering into a Consent Decree to eliminate SSOs.

While MCES is the only NPDES permit holder for the wastewater system,"satellite" communities and tributary communities may well become joint permittees and be held to the same Capacity, Management Operations, and Maintenance (CMOM) requirements as MCES. Every collection system owner will be required to submit a written CMOM program and an annual audit of its program to the EPA. Each CMOM program must address all aspects of the collection system including operation, maintenance, design, and financial and legal authority.

Specific requirements, listed below, include many provisions that are related to I/I.

1. Clear delineation of agency's goals, legal authorities, and organization, with unambiguous assignment of internal responsibilities for each part of the CMOM program.
2. Full documentation and measurement of activities for capacity management, such as
   — mapping and map maintenance,
   — facilities and equipment management,
   — trending and analysis of flow volumes and spill histories, and
   — routine O & M activities, including short-and long-term rehabilitation and replacement plans, training, and parts inventories.
3. Requirements, standards, procedures, and specifications involved in new installations and rehabilitation of pipes, pumps, and other system components.

4. An Overflow Emergency Response Plan that ensures the community staff is aware of spills, will react quickly, and protect the environment and public health.
5. A detailed "System Evaluation and Capacity Assurance Plan," analyzing the hydraulic capacities of the various parts of the system, and laying out the plans to resolve capacity bottlenecks that might cause spills.

Estimated Regional Capital Costs

Expanding the conveyance and treatment facilities enough to eliminate the risk of an overflow is not practical or feasible. The primary limitation is the need to double the capacity of the Metro Plant where peak flow rates could reach over 1.3 billion gallons per day. To understand the relative cost of conveying and treating excessive I/I, capital costs were estimated based on assuming a 25-year storm event occurred with the forecasted development of 2030. Technically, the interceptor system must not be overloaded for any rainfall condition so the use a 25-year event is for comparative purposes only. Capital cost for treatment plant capacity was also estimated, but at a very approximate level by assuming a unit cost of $1 per gallon per day of peak month capacity. The cost of increased hydraulic capacity at each plant was not estimated because of the limitations of space at each site.

Total capital costs, based on the 25-year I/I event, for MCES conveyance and treatment facilities needed for ultimate development would approach a half billion in 2002 dollars, not including a provision to increase the treatment plants' hydraulic capacities. If sized for the ultimate service area, the cost of these facilities would be even greater. The high cost of expansion to convey I/I only provides a measure of the importance of I/I reduction because it is not feasible to construct facilities large enough to prevent an SSO.

Interceptor Relief Sewer Costs

Relief sewers are required to convey the current levels of I/I (25-year rainfall) and the projected increase in tributary population, as was shown in Figures 11,12, and 13. As indicated in Table 4, the estimated capital cost of the relief sewers for the 2030 wastewater flows is over $270 million. Conveyance of the ultimate tributary population within the sewered area significantly increases this amount.

Table 4: Capital Cost of Relief Sewers to Convey I/I and 2030 Wastewater Flows

Interceptor	Capital Cost of Relief Sewer	Interceptor	Capital Cost of Relief Sewer	Interceptor	Capital Cost of Relief Sewer	Interceptor	Capital Cost of Relief Sewer
1-BC-453	$ 1,050,000	1-RF-491	$ 6,970,000	1-SP-200	$ 1,810,000	4-HT-100	$ 170,000
1-GV-460	$ 5,520,000	6901	$21,900,000	1-SP-214	$ 2,240,000	1-SP-224	$3,570,000
1-GV-461	$ 5,260,000	7029	$14,000,000	1-VH-422	$ 16,700,000	1-RV-432	$ 230,000
1-MN-310	$59,670,000	7122	$28,910,000	1-VH-423	$ 370,000	1-MN-303	$ 330,000
1-MN-312	$ 130,000	7332	$ 7,610,000	1-WL-416	$ 2,800,000	8851	$6,250,000
1-MN-313	$ 200,000	7651	$ 300,000	1-WO-500	$ 2,810,000	8451	$5,230,000
1-MN-320	$ 9,140,000	7705	$ 1,620,000	1-WO-500A	$ 620,000	6-MO-650	$1,020,000
1-MN-340	$14,380,000	8151	$ 6,300,000	1-WO-501	$ 7,220,000	6-MO-651	$1,050,000
1-MN-341	$ 2,100,000	1-LC-421	$ 2,870,000	8566-370	$ 5,400,000	6-OR-641	$ 240,000
1-MN-344	$ 60,000	1-MA-418	$ 2,440,000	Joint	$118,070,000	3-BV-35	$1,550,000
1-MN-345	$ 2,680,000	1-MW-411	$ 140,000	4-SL-534	$ 210,000	3-BV-39	$ 290,000
1-MN-346	$ 910,000	1-MW-413	$ 5,490,000				

Pump Station Costs

Pump stations would need to be expanded to convey the peak flows caused by excessive I/I. As indicated in Table 5, there are 26 pump stations that require expansion of the wet well and pumping capacity at an estimated capital cost of over $10 million. In addition, there are 17 pumping stations, listed in Table 6, currently overloaded by I/I and the estimated $31 million for expansion costs will need to be expended much earlier than if the I/I were reduced to non-excessive levels.

Table 5: Pump Stations Needing Expansion for I/I

Pump Station Name	Added Wetwell Cost for 25 yr Protection	Added Wetwell from 25 to 100 yr Protection	Added Mechanical & Etc for 25 yr Protection	Added mech & Etc from 25 yr to 100 yr Protection	Total Cost for 100 yr Protection
L-65 South St. Paul	$300,000	$159,000	$ 54,000	$ 60,000	$ 573,000
L-13 Burnsville	$405,000	$165,000	$112,500	$ 75,000	$ 757,500
L-41 New Hope	$975,000	$375,000	$300,000	$ 60,000	$1,710,000
L21 Lake Virginia	$333,000	$ 75,000	$143,141	$ 18,149	$ 569,289
L-11 Oakdale	$435,000	$277,500	$120,000	$ 97,500	$ 930,000
L-26 Wayzata	$423,000	$ 90,000	$225,938	$ 20,150	$ 759,088
L-23 Baycliff	$405,000	$ 75,000	$112,500	$ 30,000	$ 622,500
L-71 Chaska	$120,000	$135,000	$ 60,000	$ 60,000	$ 375,000
L-03 Lake Forest #3	$ 54,000	$ 30,000	$ 60,000	$ 30,000	$ 174,000
L-01 Forest Lake #1	$231,000	$120,000	$ 19,197	$ 9,657	$ 379,854
L-66 Savage	$112,500	$105,000	$ 60,000	$ 37,500	$ 315,000
L-02 Forest Lake #2	$205,500	$109,500	$ 39,896	$ 17,123	$ 372,019
L-38 Mound	$165,000	$ 37,500	$139,409	$ 11,301	$ 353,210
L-15 Lakeville	$ 45,000	0	$ 37,500	0	$ 82,500
L-27 Hopkins	$ 75,000	$ 63,000	$ 16,817	$ 14,081	$ 168,898
L-25 Mound	$150,000	$ 33,000	$ 79,500	$ 7,500	$ 270,000
L-16 Shakopee	$ 37,500	0	$ 30,000	0	$ 67,500
L-24 St.Bonifacius	$138,000	$ 67,500	$ 74,028	$ 23,657	$ 303,185
L-10 Little Canada	$138,000	$ 52,500	$ 60,000	$ 30,000	$ 280,500
L-59 Orono	$ 90,000	$ 52,500	$ 45,000	$ 22,500	$ 210,000
L-05 White Bear Lake #2	$ 57,000	$ 60,000	$ 23,604	$ 19,453	$ 160,057
L-46 Orono	0	$ 63,000	$ 3,000	$ 37,500	$ 103,500
L-39 Mound	$ 90,000	$ 22,500	$ 33,060	$ 2,702	$ 148,262
L-49 Orono	$105,000	$ 63,000	$490,236	$141,066	$ 799,302
L-18 Christmas Lake	$ 22,500	0	$ 22,500	$ 1,500	$ 46,500
L-40 Mound	$ 22,500	0	$ 33,290	$ 5,506	$ 61,297
				Total	**$10,591,961**

Table 6: Pump Stations Overloaded by I/I

Pump Station Name	Firm Capacity (mgd)	Ratio of yr 2000 with I/I to Firm Capacity	Pump Station Capital Cost ($million)
L-41 New Hope	9	136%	$3,760,000
L-21 Lake Virginia	15.1	121%	$1,960,000
L-26 Wayzata	6.9	181%	$1,600,000
L-23 Baycliff	5.9	220%	$1,110,000
L-71 Chaska	8.4	95%	0
L-03 Lake Forest #3	5.18	162%	$3,180,000
L-02 Forest Lake #2	4.61	153%	$1,170,000
L-38 Mound	6.1	127%	$1,460,000
L-25 Mound	4.0	146%	$2,290,000
L-16 Shakopee	5.6	100%	$3,300,000
L-24 St.Bonifacius	1.3	220%	$2,950,000
L-10 Little Canada	2.59	105%	$1,050,000
L-59 Orono	3.2	121%	$1,760,000
L-05 White Bear Lake #2	2.09	100%	$ 740,000
L-49 Orono	0.4	333%	$1,700,000
L-18 Christmas Lake	1.0	140%	$ 950,000
L-40 Mound	0.8	120%	$1,460,000
L-50 Minnetrista	0.5	134%	$1,200,000
Total Capital Cost Potentially Deferrable			**$31,640,000**

Treatment Plant Costs

Treatment plant capacity is usually cited on the basis of annual average flow but the NPDES permits are written for peak month conditions. Consequently, peak month conditions can govern the size of the various treatment facilities. The I/I tributary to the Metro and Blue Lake plants has the greater contribution to the peak month flow: generally more than twice the per capita contribution than at other plants. Capital cost estimates for handling the peak month I/I at the treatment plants is presented in Table 7.

There are additional costs associated with increasing the hydraulic conveyance capacity of each plant for handling the peak hour flow, but these costs have not been estimated as there may be no practical way to do it. For example, at the Metro plant upstream relief sewers could increase the peak hour to the plant to about twice the current hydraulic capacity of the plant. This would require adding 700 mgd of peak capacity at the plant or building facilities that could store the peak flows, which would allow the wastewater to be pumped back for treatment. However, expanding the Metro plant is not an option due to costs and lack of space. At the Blue Lake plant, the hydraulic capacity of the plant has already been reached by storms in 2001 and 2003. Flow equalization to dampen these peaks is a possibility for the present but may not be realistic for future flows as the service area expands and further development takes place.

Table 7: Estimated Capital Cost for I/I at Treatment Plants

Plant	Peak Month I/I Flow (mgd)	Excessive Peak Month Flow (mgd)	Estimated Capital Cost of Treatment Plant Expansion for Excessive I/I*
Metro	150	99	$99 million
Blue Lake	19	12	$12 million
Seneca	7	0	0
Empire	3	0	0
St. Croix	1.4	0.7	$1 million
Hastings	0.5	0	0

*Based on liquid treatment portion of plant expansion at $1 per gallon per day

Section Three

Measurement of Flow

MCES has designed interceptor sewers and pumping stations for the last three decades on the basis of a peak to average ratio. As discussed earlier, this calculation of a peak flow provides for some I/I from the tributary area. If the I/I from the area is greater than what the system is designed for, then the collection system is at risk of being overloaded and the extra I/I is deemed excessive. While this is relatively straightforward to determine for collection systems, I/I also affects the peak month flows at the treatment plants. Target levels of I/I from each community should be at 30 gpcd on a monthly basis to avoid building excessive capacity into the treatment plants.

Measurement of Excessive I/I

Peak flows generally constitute the greatest problem from I/I for MCES. Staff believe that many measures that reduce these peak flows will also reduce the peak month flow as well. This is based on the premise that foundation drains and sump pumps are the major sources of I/I affecting the peak flows. These sources are also responsible for sustained high flows on a monthly and even annual basis. Consequently, MCES identifies excessive I/I flow based only on the peak hour flow from an area connected to the interceptor system.

The operating definition of excessive I/I tributary to the MCES system is as follows:

> *Excessive I/I is that I/I that causes the peak hour flow to exceed the value calculated by multiplying the average flow times the appropriate MCES peak to average ratio. The average flow is the three year running average flow at the point of measurement and the appropriate MCES peak to average ratio.*

MCES measures wastewater flow at over 100 permanent locations throughout the metropolitan area. The flow from upstream and intervening areas can be determined as a direct measurement or by subtracting the upstream flows from the downstream flow. As shown in Figures 18 through 22 on the following pages, the existing flow metering system can monitor the flow from over 150 tributary areas (metersheds).

Figure 18: Metro WWTP Service Area (Meter Sheds)

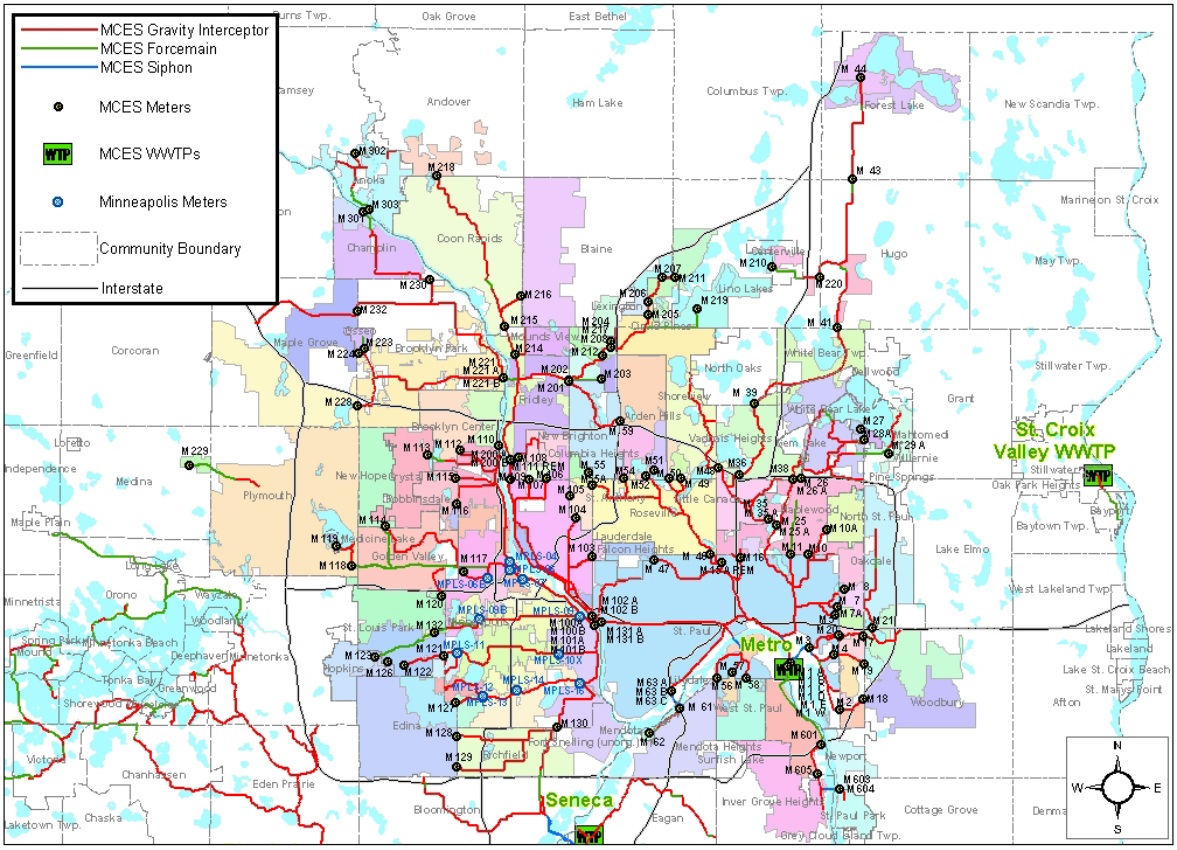


Figure 19: Blue Lake WWTP Service Area (Meter Sheds)

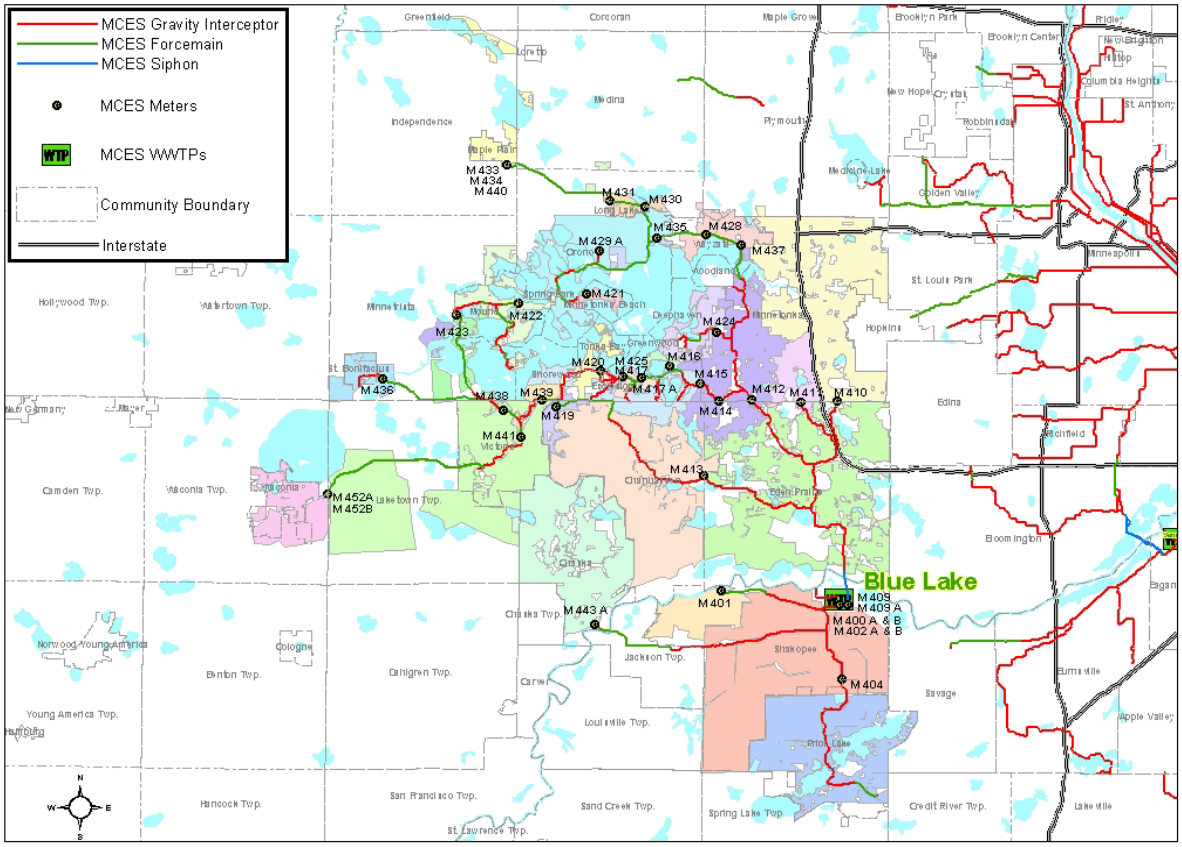


Figure 20: Seneca WWTP Service Area (Meter Sheds)

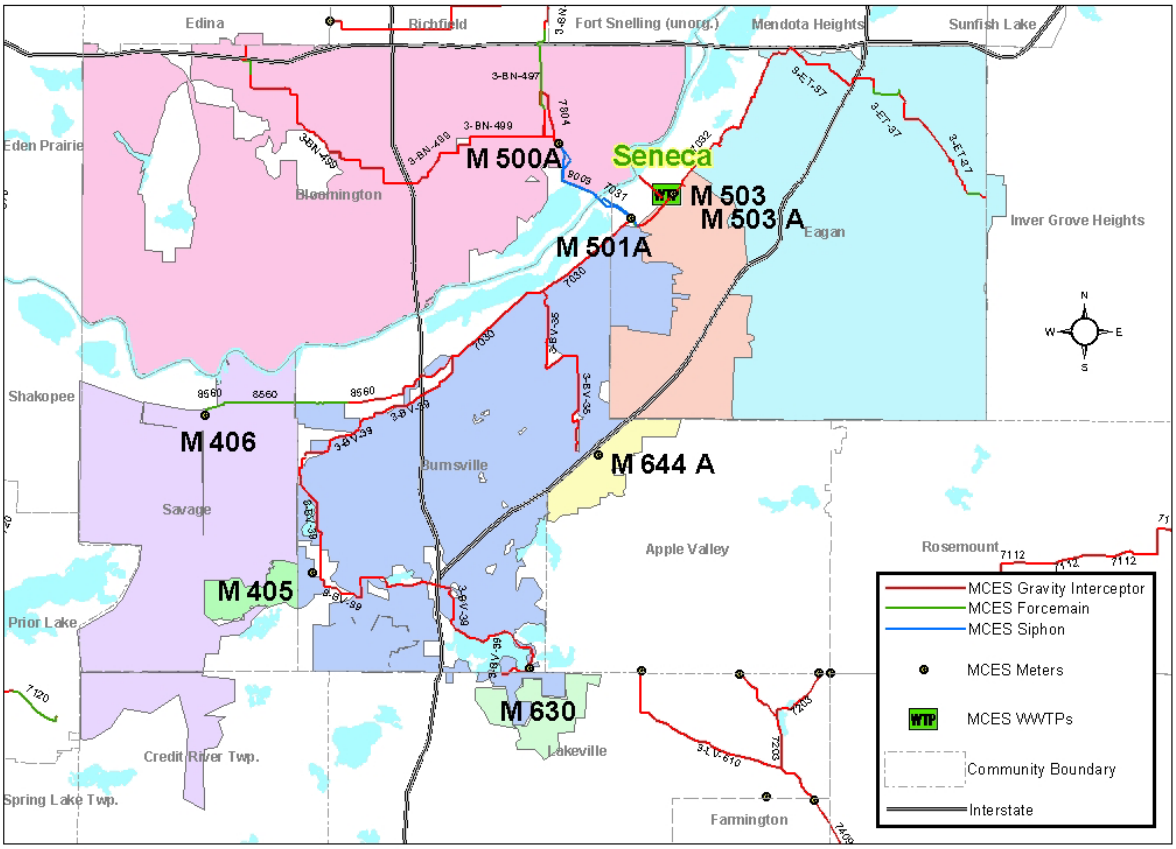


Figure 21: Empire WWTP Service Area (Meter Sheds)

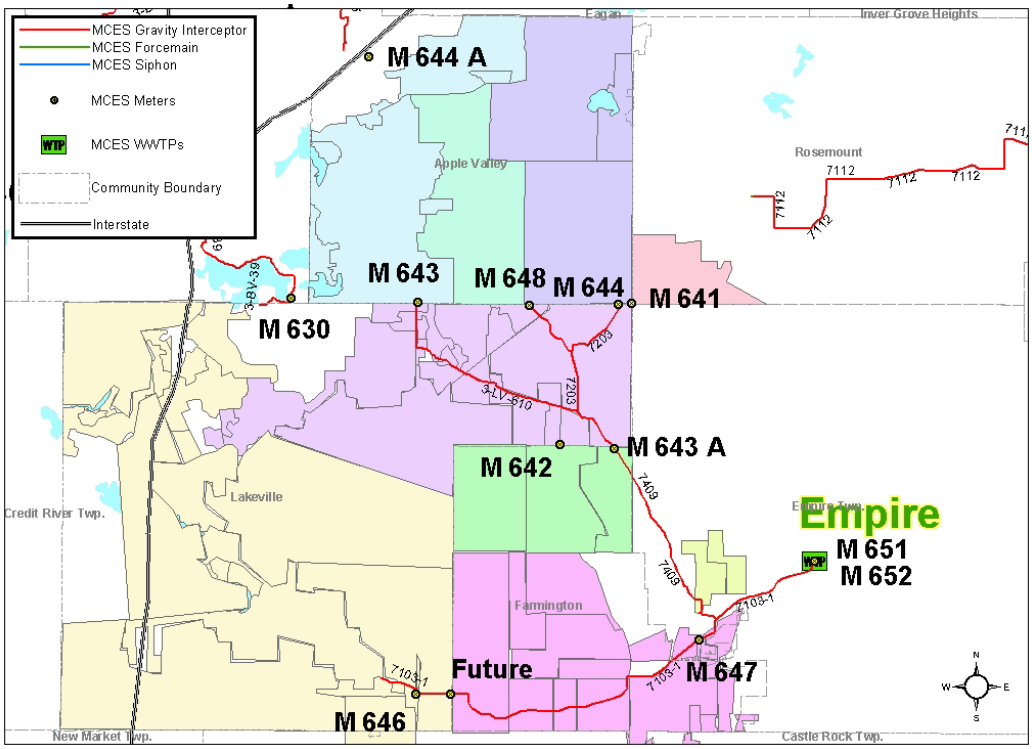
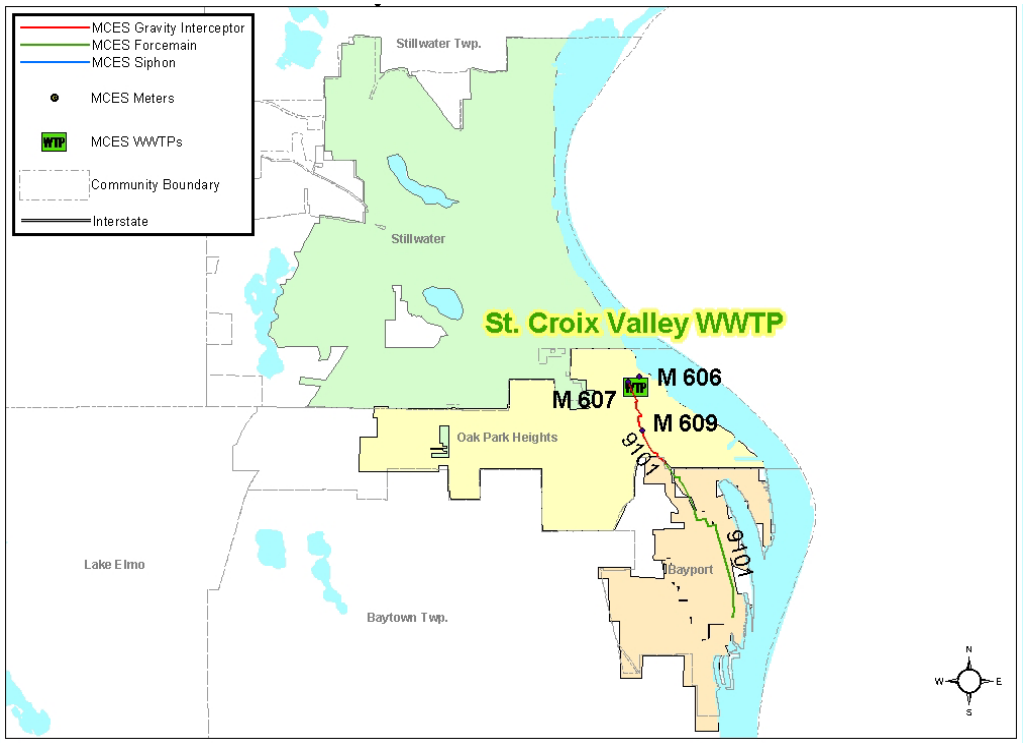


Figure 22: St. Croix Valley WWTP Service Area (Meter Sheds)

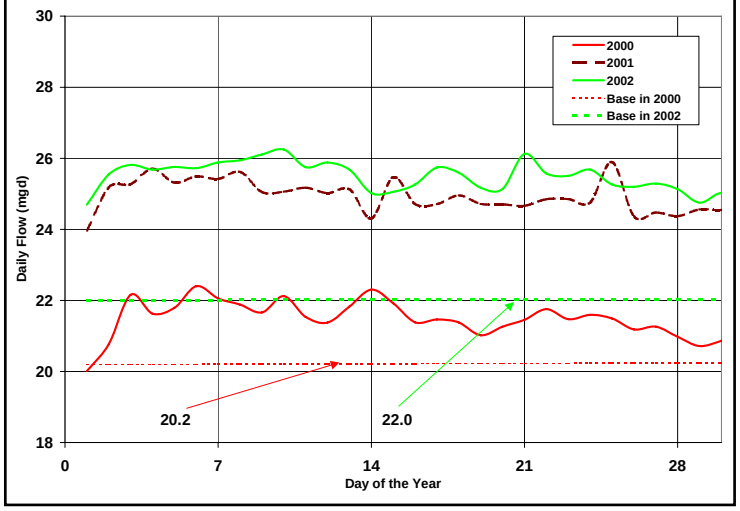


Each meter location continuously measures the flow rate. Flow data are recorded in three-second increments, from which 15 minute, hourly, daily, weekly, monthly and annual totals are derived. MCES is in the process of upgrading its meters to improve the recording of peak flows while maintaining the accuracy of the annual flow measurement. In addition, MCES is initiating a means of automating the processing of these data to generate hydrographs whenever a significant rain or the peak hour flow exceeds an anticipated value.

Dry Weather Flow

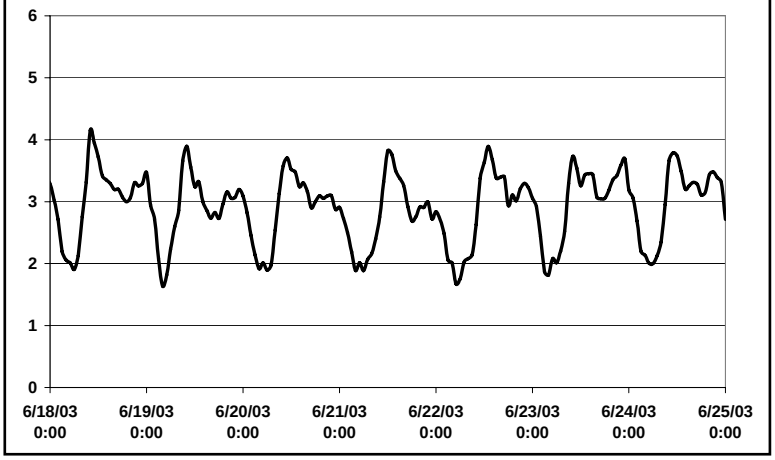
Dry weather flow is generally the wastewater flow occurring a week or two after a rain or snow melt. Even under such conditions, there will be some infiltration (groundwater) in the wastewater flow, reflecting that some foundation drains or sump pumps are connected or that some sections of the sewer are influenced by water moving through the ground. An assessment of the daily flows to the Blue Lake WWTP in January (when one would expect minimal I/I) indicates some very long-term affects of seasonal rainfall.

Figure 23: Blue Lake WWTP Daily Flows for January



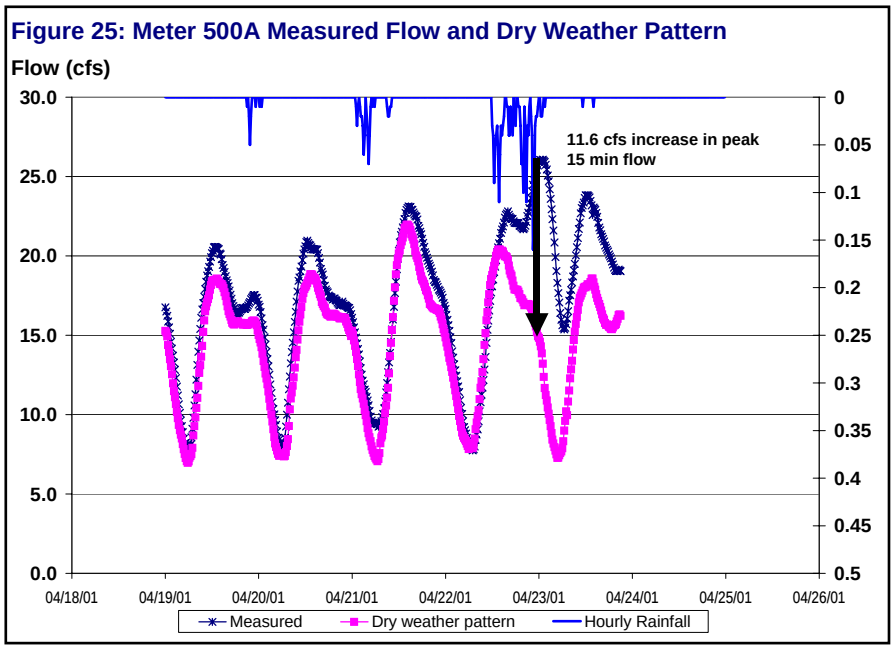
The base flow (wastewater generation rate) was estimated to increase from 20.2 mgd in year 2000 to 22.0 mgd in 2002. The actual flow to the plant in January of those years was slightly above these estimated generation rates but the difference was greater in 2002 than 2000, primarily because of the amount of rain in 2001. Where the base flow was estimated to increase 1.8 mgd, the monthly flow in January 2002 was nearly 4 mgd greater than for year 2000. This example illustrates that some discretion must be exercised when selecting periods as representative of dry weather flow.

Figure 24: Flow Pattern at Meter 120



Evaluation of flow records at many of the monitoring locations indicates that variable wastewater over the course of a week is a repeatable pattern if rain is not a factor. As shown in Figure 24, the diurnal flow patterns are very similar day to day, with some increases in flow variation on the weekends in some communities.

The rate of I/I can be determined by subtracting the dry weather flow pattern from the wet weather flow pattern if the dry weather flow pattern is consistent. Examination of the MCES meter data indicates this assumption is very good for almost all of the flow meters. An example of this approach to estimating I/I rate is presented in Figure 25, for Meter 500A.



The dry weather flow pattern is taken from the first week in April of 2001, a relatively dry period, and plotted to match the day and hour of the week of the wet weather event under analysis. Rainfall is plotted at the top of the graph to see the relationship of flow to rain. The rain-influenced flow is plotted and indicates how much the flow is increased each hour relative to the dry period.

This procedure allows for calculation of the peak hour I/I rate, even if the peak does not coincide with the peak during a dry weather event. In the above example the peak I/I rate occurs around 3 or 4 a.m., when flows are usually receding. The peak hour I/I increased the flow about 11 cubic feet per second (cfs).

If the peak had occurred during the usual dry weather peak hour, the total would have been closer to 32 cfs versus the recorded peak of 26 cfs as shown in Figure 25 above.

The procedure used by MCES to determine if the I/I from a tributary area is excessive is as follows.

1. The average flow for the city is based on an average of the past three years of historical flow records and it will be updated annually.
2. The acceptable peak hour flow is calculated using the MCES table that relates peak to average ratios to average flow. The appropriate peak to average ratio is multiplied times the three-year average flow to calculate the acceptable peak hour flow.
3. A representative dry weather flow pattern is selected from recent historical data. The average flow during this period is close to the average flow for the past three years.
4. The I/I component of the wet weather flow is determined by subtracting the dry weather flow for the corresponding hour and day of the week.
5. The I/I component of wet weather flow is added to the peak hour flow rate of the typical dry weather flow pattern to determine if the resulting peak flow is greater than the peak calculated in step 2. If the resulting peak flow is greater, the I/I is excessive.

The following three graphs in Figures 26, 27, and 28, illustrate the five steps used to determine excessive I/I.

Figure 26: Steps 1, 2, and 3 in Determining Excessive I/I

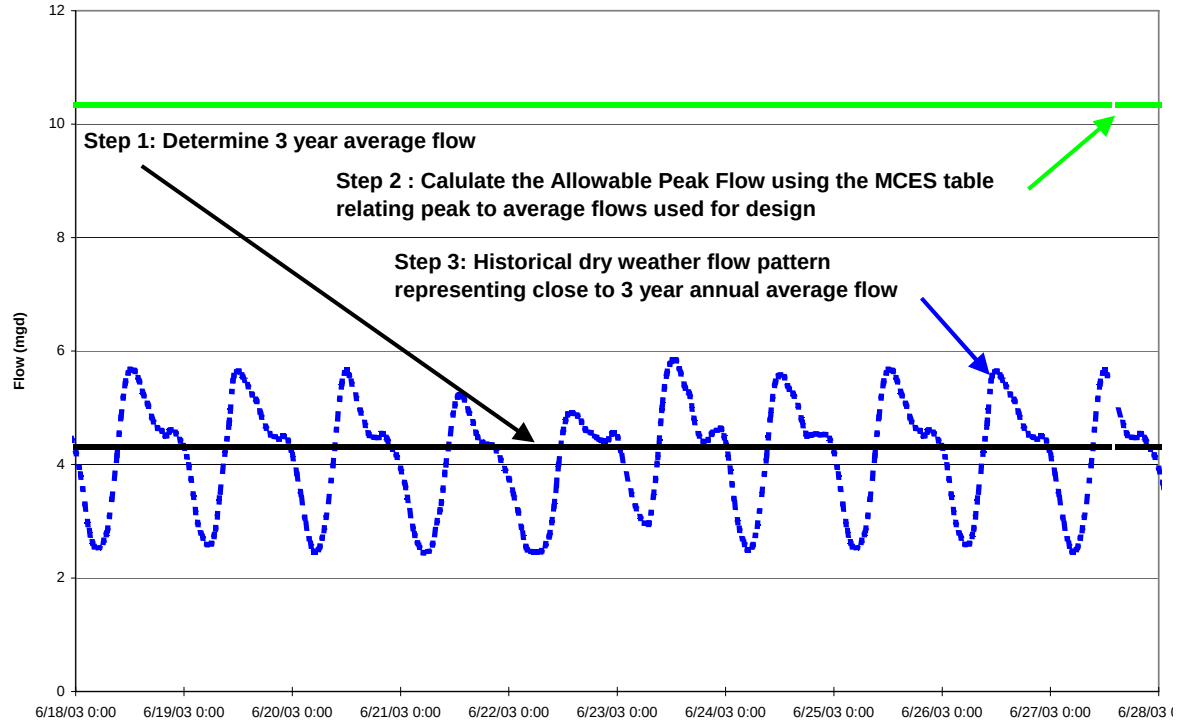


Figure 27: Step 4 in Determining Excessive I/I

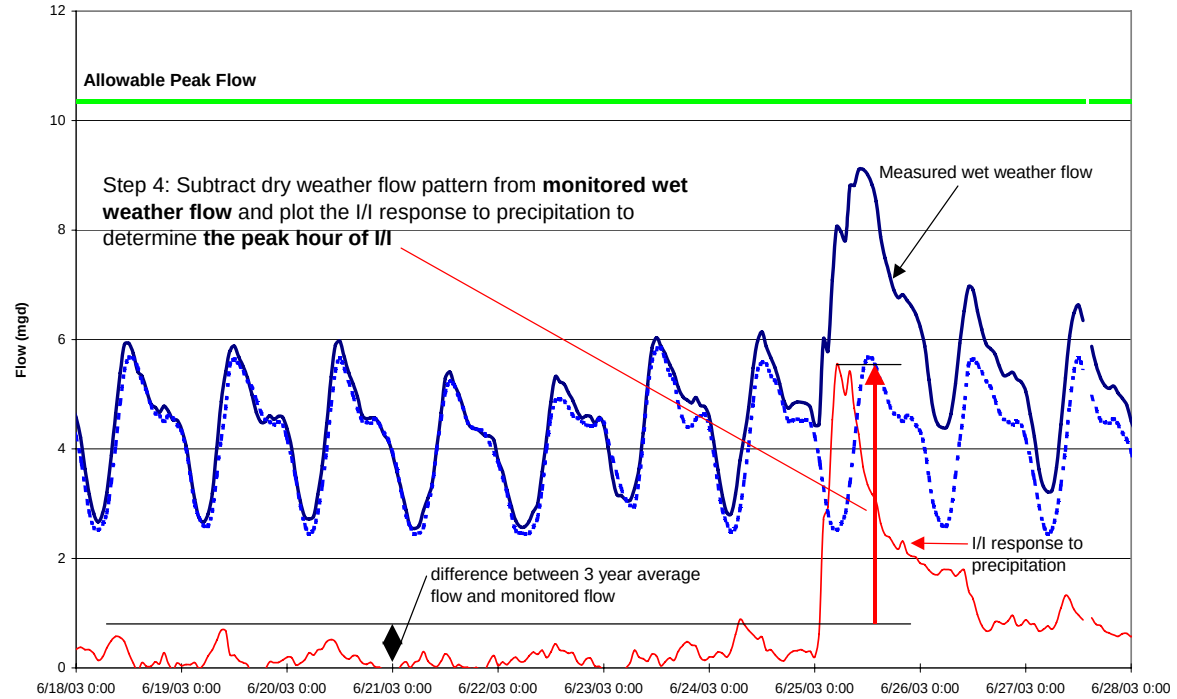
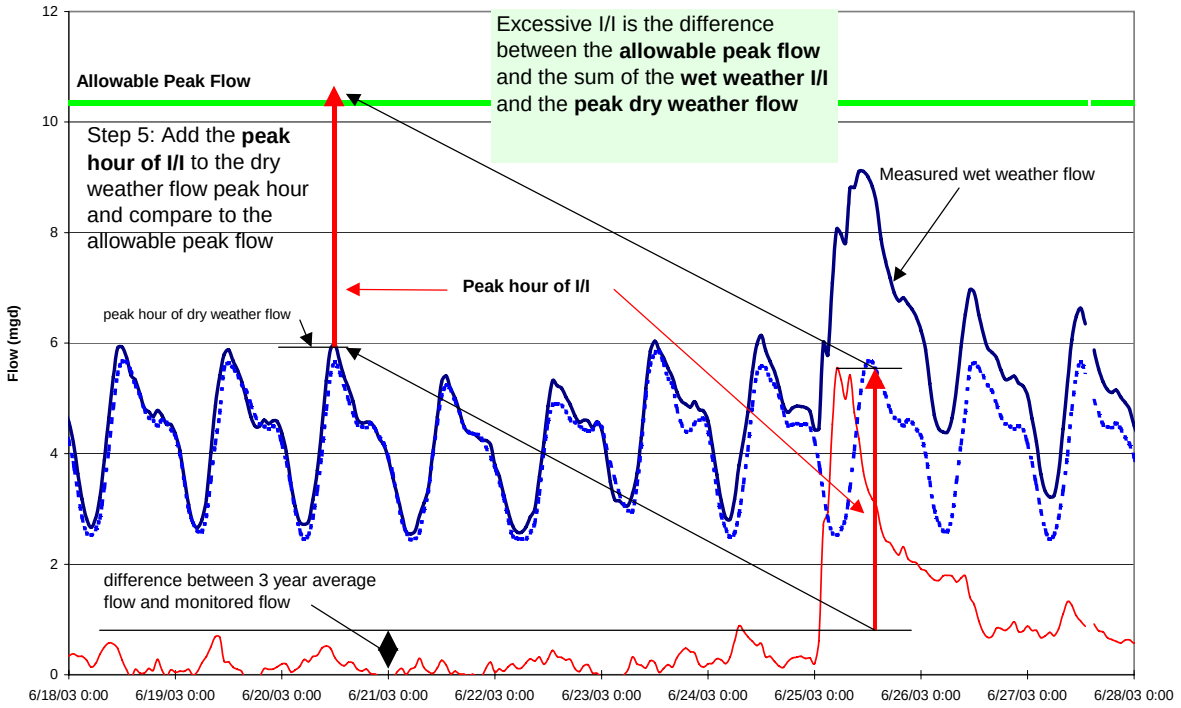


Figure 28: Step 5 in Determining Excessive I/I



Communities with Excessive I/I

MCES has analyzed the last three years of flow records for each community to identify tributary areas with excessive I/I. For each area, the average flow was determined and a representative dry weather period was selected. For most areas, the representative period selected is the first week of April in 2001. The allowable peak hour flow, based on the MCES peak to average ratio, was determined for each average flow. Peak I/I flow rates were identified by evaluating the flow records during and after significant rainfalls in the vicinity of the area under evaluation. The I/I component of flow was determined by subtracting the representative dry weather flow pattern from the wet weather flow pattern and the maximum I/I flow rate was established. Flow information for communities with peak I/I rates that could cause peak hour flow exceeding the acceptable value is listed in Table 8,on the following pages.

Added information, in the form of hydrographs by metered service area, can be found in the supplement to this document. Cities may request the information on the meters in their service areas.

Table 8: Community Flow Information (page 1 of 4)

NOTE: in the column headed Step 5, N.M = Not Meaningful: little discernible response to rainfall and M.D. = Missing Data: flow data during rain event are missing or data are suspect.

Step in I/I Determination Procedure		Step 1		Step 2	Step 3	Step 4	Step 5
Community	**Metershed**	**3yr Avg Flow (mgd)**	**Design P/A Ratio**	**Allowable Peak Hour Flow (mgd)**	**Dry Weather Peak Hour Flow (mgd)**	**Metered Peak Hour /I (mgd)**	**Resulting Peak Hour Flow (mgd)**
Andover	218	1.26	3	3.78	2.13	N.M.	N.M
Anoka	303-(302+304)	2.24	2.8	6.27	3.50	2.00	5.50
Apple Valley	643	1.66	2.9	4.80	2.46	N.M.	N.M.
Apple Valley	644	1.13	3.1	3.51	2.16	M.D.	N.M.
Apple Valley	644A	0.17	3.9	0.66	0.28	N.M.	N.M.
Apple Valley	648	0.69	3.3	2.28	1.19	N.M.	N.M.
Arden Hills	51+52	0.56	3.4	1.89	0.83	2.30	3.13
Arden Hills	54	0.22	3.8	0.84	0.40	0.95	1.35
Arden Hills	59	0.34	3.6	1.23	0.64	2.60	3.24
Bayport	609	0.56	3.4	1.91	0.88	1.40	2.28
Birchwood	028A	0.09	4	0.36	0.32	<.10	<.42
Blaine	207	0.32	3.6	1.16	0.60	0.45	1.05
Blaine	216	2.85	2.7	7.70	4.11	1.90	6.01
Bloomington	500A	9.69	2.1	20.34	14.10	6.50	20.60
Brooklyn Center	110	1.09	3.1	3.36	1.61	1.20	2.81
Brooklyn Center	112	1.61	2.9	4.66	2.30	1.75	4.05
Brooklyn Park	221-(223+224+228+230+232)	5.12	2.3	11.77	7.68	7.00	14.68
Burnsville	501A-(405+406+644+630)	5.81	2.3	13.36	7.66	N.M.	N.M.
Centerville	210	0.28	3.7	1.03	0.44	0.62	1.06
Champlin	230-303	1.74	2.9	5.05	2.67	2.50	5.17
Chanhassen	413-439	1.85	2.9	5.37	2.70	2.60	5.30
Chanhassen	419	0.17	3.9	0.68	0.27	0.15	0.42
Chaska	443A	2.20	2.8	6.15	3.30	>4	>7.3
Circle Pines	205-(206+207+211)	0.38	3.6	1.37	0.79	M.D.	N.M.
Columbia Heights	106	0.30	3.6	1.08	0.50	>2.0	>2.5
Columbia Heights	107	0.32	3.6	1.16	0.88	>2.0	>2.88
Columbia Heights	108	0.96	3.2	3.08	1.63	M.D.	N.M.
Coon Rapids	215-(216+218)	6.07	2.3	13.96	7.50	2.50	10.00
Cottage Grove	600A	1.96	2.8	5.49	3.39	1.10	4.49
Crystal	113	2.38	2.7	6.42	3.53	5.50	9.03
Deephaven	424	0.53	3.4	1.79	1.19	1.10	2.29
Eagan	503+503A	6.45	2.2	14.19	8.84	3.80	12.64
Eden Prairie	(409+409A+414) -(410+411+412+413)	4.94	2.4	11.84	7.40	7.00	14.40
Edina	127	1.55	2.9	4.51	1.85	>2.5	>4.35
Edina	129	4.31	2.4	10.34	5.84	5.00	10.84
Edina	128	0.37	3.6	1.33	0.58	M.D.	N.M.

Table 8: Community Flow Information (page 2 of 4)

Step in I/I Determination Procedure		Step 1		Step 2	Step 3	Step 4	Step 5
Community	Metershed	3yr Avg Flow (mgd)	Design P/A Ratio	Allowable Peak Hour Flow (mgd)	Dry Weather Peak Hour Flow (mgd)	Metered Peak Hour /I (mgd)	Resulting Peak Hour Flow (mgd)
Excelsior	417	0.24	3.8	0.90	0.33	1.00	1.33
Excelsior	417A	0.08	4	0.33	0.13	0.33	0.46
Falcon Heights	47	0.23	3.8	0.88	0.37	M.D.	N.M.
Farmington	647-646	0.88	3.2	2.83	1.20	N.M.	N.M.
Farmington	642	0.26	3.7	0.96	0.41	N.M.	N.M.
Forest Lake	43	1.66	2.9	4.80	2.32	5.00	7.32
Fridley	109-108	1.43	3	4.30	2.10	3.40	5.50
Fridley	SA2 formula	4.04	2.5	10.10	6.46	M.D.	N.M.
Golden Valley	117-120	3.22	2.6	8.38	4.32	>15	>19.32
Greenwood	416	0.07	4	0.27	0.10	0.18	0.28
Hastings	602	1.66	2.9	4.81	2.52	<.10	<2.62
Hopkins	123-126	1.77	2.9	5.12	2.43	3.10	5.53
Hopkins	122	0.09	4	0.35	0.17	0.55	0.72
Hugo	41-(43+220)	0.25	3.7	0.93	0.45	M.D.	N.M.
Inver Grove Hts	605-(603+604)	2.15	2.8	6.01	3.27	1.90	5.17
Lakeville	643-(641+642 +643+644+648)	1.98	2.8	5.54	3.20	N.M.	N.M.
Lakeville	646	1.76	2.9	5.09	2.71	N.M.	N.M.
Lauderdale	103	0.11	4	0.46	0.24	0.95	1.19
Lexington	206	0.30	3.7	1.10	0.50	2.00	2.50
Lilydale	61	0.07	4	0.28	0.15	0.40	0.55
Lino Lakes	211	0.44	3.5	1.53	0.75	0.80	1.55
Lino Lakes	219	0.46	3.5	1.62	0.71	0.40	1.11
Lino Lakes	220-210	0.12	4	0.46	0.31	0.20	0.51
Little Canada	(35+35A)-(36+48)	1.81	2.9	5.26	2.43	2.90	5.33
Long Lake	430-(431+434)	0.29	3.7	1.08	0.51	1.80	2.31
Mahtomedi	029A	0.57	3.4	1.95	0.82	0.80	1.62
Maplewood	(4)-(19)	0.21	3.8	0.78	0.38	0.20	0.58
Maplewood	5	0.25	3.7	0.93	0.46	>0.7	>1.16
Maplewood	7	0.15	3.9	0.57	0.23	0.40	0.63
Maplewood	7A	0.70	3.3	2.31	0.99	1.80	2.79
Maplewood	8	0.34	3.6	1.22	0.50	0.85	1.35
Maplewood	11	0.70	3.3	2.32	0.96	1.80	2.76
Maplewood	15A	0.21	3.8	0.80	0.47	M.D.	N.M.
Maplewood	16	0.34	3.6	1.22	0.49	1.00	1.49
Maplewood	25A-(26+38)	0.38	3.6	1.37	0.60	2.30	2.90
Maple Grove	224	1.19	3.1	3.68	1.92	>9.5	>11.42
Maple Grove	228	1.63	2.9	4.72	2.10	4.00	6.10
Maple Grove	232	2.76	2.7	7.46	4.03	7.00	11.03
Maple Plain	433	0.36	3.6	1.31	0.76	>.9	>1.66
Medicine Lake	119	0.04	4	0.18	0.08	0.50	0.58
Medina	229	0.24	3.7	0.90	0.32	0.90	1.22
Medina	434-433	0.10	4	0.41	0.34	0.35	0.69

Table 8: Community Flow Information (page 3 of 4)

Step in I/I Determination Procedure		Step 1		Step 2	Step 3	Step 4	Step 5
Community	Metershed	3yr Avg Flow (mgd)	Design P/A Ratio	Allowable Peak Hour Flow (mgd)	Dry Weather Peak Hour Flow (mgd)	Metered Peak Hour /I (mgd)	Resulting Peak Hour Flow (mgd)
Mendota	62	0.02	4	0.07	0.06	0.10	0.16
Mendota Hts	(63A+63B)-	1.62	2.9	4.69	2.26	3.00	5.26
Minneapolis-NW	(100A+100B) -(110+112+113 +114+115+116 +117+118+132)	33.00	1.8	59.40	42.80	>100.00	>142.8
Minneapolis-SW	(101A+101B)- (121+127+130)	18.60	1.8	33.48	23.40	45.00	68.40
Minneapolis-E	(102A+102B +131A+131B) -(103+104+105 +106+107 +109+111 +200A+200B)	15.00	1.9	28.50	23.10	25.00	48.10
Minnetonka	410	4.59	2.4	11.01	6.90	11.00	17.90
Minnetonka	411	0.49	3.5	1.71	1.25	0.90	2.15
Minnetonka	412-(414+415 +424+437)	1.84	2.9	5.33	3.69	>8.00	>11.69
Minnetonka Beach	421	0.07	4	0.28	0.25	0.55	0.80
Mound	423-422	1.24	3	3.73	1.87	3.40	5.27
Moundsview	202	0.16	3.9	0.64	0.30	0.10	0.40
Moundsview	203	0.72	3.3	2.38	0.86	1.50	2.36
Moundsview	208	0.34	3.6	1.22	0.58	0.55	1.13
Moundsview	212	0.20	3.8	0.75	0.39	0.25	0.64
New Brighton	201-59	2.27	2.8	6.34	2.92	>5.1	>8.02
New Hope	114	2.33	2.7	6.29	3.40	9.50	12.90
Newport	603	0.33	3.6	1.20	0.51	0.70	1.21
No. St. Paul	10	1.39	3	4.18	1.80	2.80	4.60
Oakdale	21	2.63	2.7	7.09	3.81	3.30	7.11
Oak Park Heights	607-609	0.53	3.4	1.80	0.74	0.70	1.44
Orono	435-(421+430)	0.56	3.4	1.92	0.90	2.00	2.90
Orono	431	0.08	4	0.31	0.12	>.50	>.62
Osseo	223	0.22	3.8	0.82	0.31	0.90	1.21
Plymouth	118-(119+229)	7.74	2.2	17.04	10.96	>14.00	>24.96
Prior Lake	404	1.82	2.9	5.26	2.88	2.00	4.88
Ramsey	302	0.39	3.6	1.40	0.71	0.35	1.06
Ramsey	304	(new					0.00
Richfield	130-(128+129)	3.63	2.5	9.08	5.19	1.50	6.69
Robbinsdale	116	0.30	3.7	1.09	0.47	0.35	0.82
Robbinsdale	115	1.11	3.1	3.45	1.67	1.10	2.77
Rosemount	641	0.32	3.6	1.16	0.62	<.10	<.72
Rosemount	645	0.73	3.3	2.41	1.23	<.10	<1.33
Roseville	46-(49+50+51 +52+54+55 +55A)	4.34	2.4	10.43	6.80	>11	>17.8

Table 8: Community Flow Information (page 4 of 4)

Step in I/I Determination Procedure		Step 1		Step 2	Step 3	Step 4	Step 5
Community	**Metershed**	**3yr Avg Flow (mgd)**	**Design P/A Ratio**	**Allowable Peak Hour Flow (mgd)**	**Dry Weather Peak Hour Flow (mgd)**	**Metered Peak Hour /I (mgd)**	**Resulting Peak Hour Flow (mgd)**
Savage	405	0.27	3.7	0.98	0.47	<.10	<.57
Savage	406	1.69	2.9	4.90	3.61	<.10	<3.71
Shakopee	(402A+402B) -(404+443A)	2.75	2.7	7.43	4.88	1.00	5.88
Shoreview	49	0.12	4	0.47	0.19	1.40	1.59
Shoreview	50	0.14	3.9	0.53	0.24	0.40	0.64
Shoreview	48	1.71	2.9	4.96	2.22	2.40	4.62
Shoreview	204 -(205+208+219)	1.05	3.1	3.26	1.80	0.80	2.60
Shorewood	415 -(416+417+417A +419+420)	0.91	3.2	2.90	1.31	>3.00	>4.31
So. St. Paul	601-605	3.78	2.5	9.44	5.94	10.50	16.44
Spring Lake Park	214	0.76	3.3	2.51	1.16	0.40	1.56
Spring Park	422	0.30	3.6	1.09	0.46	0.40	0.86
St. Anthony	55	0.33	3.6	1.19	0.50	0.90	1.40
St. Anthony	55A	0.08	4	0.33	0.075	>.90	>.97
St. Anthony	104	0.45	3.5	1.59	0.52	2.30	2.82
St. Anthony	105	0.03	4	0.12	0.038	0.17	0.21
St. Bonifacius	436	0.24	3.7	0.90	0.41	0.15	0.56
St. Louis Park	120	2.92	2.6	7.58	3.95	3.80	7.75
St. Louis Park	121-122	2.05	2.8	5.74	2.93	2.80	5.73
St. Louis Park	126	0.02	4	0.07	0.03	0.015	0.04
St. Louis Park	132-123	1.18	3.1	3.67	1.77	3.70	5.47
St Paul		33.00	1.8	59.40	45.00	165.00	210.00
St Paul Park	604	0.53	3.4	1.79	0.69	<.10	<.79
Stillwater	606	2.32	2.7	6.27	3.63	4.20	7.83
Tonka Bay	420	0.25	3.7	0.93	0.36	0.60	0.96
Vadniais Hghts	36-39	0.98	3.2	3.13	1.34	2.50	3.84
Vadniais Hghts	38	0.19	3.9	0.73	0.34	1.60	1.94
Waconia	452A+452B	0.75	3.3	2.47	1.25	2.10	3.35
Wayzata	437-435	0.67	3.3	2.21	1.06	2.00	3.06
West St. Paul	56	0.15	3.9	0.59	0.26	1.10	1.36
West St. Paul	57	0.35	3.6	1.26	0.56	1.20	1.76
West St. Paul	58	1.69	2.9	4.89	2.38	5.60	7.98
White Bear Lake	26 -(27+28A+29A)	2.87	2.7	7.75	3.95	3.00	6.95
White Bear	27	0.09	4	0.37	0.15	0.80	0.95
White Bear	39-41	0.90	3.2	2.89	1.40	2.30	3.70
Woodbury	17-21	2.28	2.8	6.38	3.18	2.00	5.18
Woodbury	18	2.16	2.8	6.04	3.22	2.00	5.22
Woodbury	19	0.17	3.9	0.64	0.24	<.10	<.34

If the community disagrees with MCES's determination that its I/I is excessive it may appeal the determination. The procedure for a community to appeal is as follows.

Appeal Procedure

If a community believes that the MCES staff has incorrectly made the determination that the community failed to meet it's I/I goals as established by the Metropolitan Council it will have the opportunity to appeal that determination to the Metropolitan Council for a final determination. The Appeal shall be set in writing and shall be sent by mail or delivered in person to the Metropolitan Council addressed as follows:

METROPOLITAN COUNCIL ENVIRONMENTAL SERVICES DIVISION
WASTEWATER SERVICES DEPARTMENT
c/o William Moore, General Manager
Mears Park Centre
230 East 5th Street
St. Paul, MN 55101

The community, along with Council staff, will be given the opportunity to first appear before the Metropolitan Council Environmental Committee during its regularly scheduled meeting to present their case. If an acceptable decision is not arrived at, the City could elect to appear before the Metropolitan Council in whole. The Metropolitan Council decision will be final.

Section Four

Current Metropolitan Council I/I Policy

Current Council Policy states that the Council will provide wastewater services that are efficient, cost-effective, and environmentally sound to areas that support the Council's Regional Growth Strategy. Council staff determined that it is not cost effective or efficient to construct larger facilities to convey and treat I/I.

Much of the Council's authority to direct communities to reduce I/I is derived from the Metropolitan Land Planning Act. This act allows the Metropolitan Council to provide regional review and comment authority over local plans regarding their compatibility and conformity with other local, regional, and system plans. Recognizing that I/I was a problem in the 1990s, the Council established I/I reduction goals for those communities that had relatively high I/I on a monthly basis. These communities, through the issuance of System Statements in 1996, were asked to adopt an I/I program to identify those problems that could be cost-effectively removed and then to remove the I/I to meet the established goal within five years after the adoption of their comprehensive plans. As an incentive for communities to eliminate excessive I/I from their sanitary sewer system, the Council provided I/I grants and loans from 1993 through 2000.

The program provided the communities with grants for studies to define the I/I problems within their communities as well as matching loans to remove the I/I from their systems. If the community provided the Council with a certification that the I/I removal project was effective and no longer a source of I/I, the loan repayment was forgiven. As a result of the program, many communities (30) passed local ordinances requiring the disconnection of sump pumps from the sanitary sewer system. These communities adopted sump pump inspection programs and inspected all the homes and businesses within their communities to locate and remove the sump pumps from the sanitary sewer system. However, based on current studies inflow is still identified as the major problem within the metropolitan disposal system.

Section Five

Examples of I/I Control Programs

There are many examples of successful I/I control programs across the United States. In the Twin Cities area, several local communities have ongoing or recently completed I/I control programs that were described to the I/I Task Force. In addition, information about programs outside the metropolitan area was obtained and presented to the I/I Task Force. Of particular interest was the protocol followed by MCES in evaluating its interceptor system.

MCES Interceptor Facilities

MCES checks its interceptor system daily for indications of I/I. One method is daily evaluation of flow data and identification of anomalies in that data. Flow data are screened to identify trends that could indicate I/I is entering a section of interceptor (or even a problem in a tributary community). When unusually high flows are noted, a field crew is dispatched to investigate. If the source of the high flow is found to be within the MCES system, a repair method is chosen. If no problems are found in MCES's system, the community tributary to the meter with the high flow is notified. Another method used is internal inspections of the interceptor system.

Initial inspections of the interceptor system began in the 1970s and a formalized, routine inspection program was initiated in the early 1980s with the goal of inspecting the entire system during a ten-year cycle. Today, some locations are inspected on a more frequent basis if previous inspections have indicated a closer "watch" is warranted and some locations are inspected less frequently if the section is particularly sound.

A number of I/I reduction measures have been implemented in the MCES system. Examples of I/I reduction measures are mastic sealing of adjusting rings, installing solid manhole (MH) covers with no pick holes, limiting the number of adjusting rings to one, and using internal and external "chimney seals." The use of urethane grout and sealers to plug MH leaks was pioneered by MCES.

MCES minimizes the opportunity for I/I to enter the interceptor system through the use of its design standards. MCES adopted an allowable I/I rate for new construction in the late 1970s and has revised it since then to reflect better construction materials. Today, the allowable I/I rate for new construction is 100 gpd/inch-diameter/mile. In addition, interceptors are now designed to avoid wetlands and other low-lying land as much as practical. MCES requires use of bolted, watertight castings in "off-road" installations.

MCES considers the level of I/I in the interceptor system to be acceptable if it is in accordance with the I/I rates found in the WEF Manual of Practice No. 9/ASCE Manual on Engineering practice No. 37. Tables 9 and 10 on the following page show these acceptable levels.

Table 9: Infiltration Specification Allowances (1986 Design & Construction of Sanitary & Storm Sewers, Manual of Practice No.9)		
	Infiltration Permitted	
Pipe Diam (in.)	(gpd/mile)	(gpd/in.diam/mile)
8	3,500 to 5,000	450 to 625
12	4,500 to 6,000	375 to 500
24	10,000 to 12,000	420 to 500

Note: In. x 2.54 = cm; gpd/in. diam/mile x 0.000925 = cu m/day/cm diam/km.

Table 10: Variation of Infiltration Allowances among Cities (1986 Design & Construction of Sanitary & Storm Sewers, Manual of Practice No.9)			
Number of Cities Reporting	Allowance (gpd/in. diam/mile)	Number of Cities Reporting	Allowance (gpd/in. diam/mile)
4	1,500	63	500
4	1,000	11	450 to 300
1	800	16	250 to 150
2	700	21	100
1	600	5	50

Note: Gpd/in. diam/mile x 0.000925 = cu m/day/cm diam/km.

When I/I greater than the above limits are found, MCES prioritizes its response according to the following.

1. **Severe:** If the interceptor has a known capacity problem, rehabilitation is performed immediately. When the I/I is severe the defect can be immediately repaired with either in-house or contracted services.
2. **Significant:** If I/I rates are above acceptable limits but there are no known capacity problems with the interceptor, I/I removal is scheduled. If individual leaks of one gallon per minute or greater are found, judgement similar to the above is applied.

The MCES I/I reduction program continues to evolve in conjunction with regulatory requirements. The goal of this program is to have I/I rates in all interceptor segments meet the allowable standards in effect at the time of construction. Consequently, the priority assigned for the rehabilitation of a sewer section will include I/I as a major factor.

Minnesota Community Programs

Several communities in Minnesota are addressing their I/I issues. Following are brief descriptions of identified issues and related actions.

City of Maple Plain

Maple Plain is tributary to a MCES pump station that does not have enough capacity to pump the peak I/I from the city. During significant rains, the overloaded sewers backup and sewage enters some basements in the city. The problem has been severe enough that the city decided to embark on a program to reduce the I/I. Initially the program involved flow monitoring and slip lining some of the publicly owned sewers. Because the problem continued, the city

decided to use closed circuit TV to identify house services that are connected to a foundation drain or sump pump.

In 2003 a schedule was set and the city was able to get approval from 25 home owners to inspect their homes for passive drain tile and sumps that flow into the sanitary system. The city chose 12 of those 25 homes, and were allowed into eight readily. Access to the other homes had not occurred by November, 2003.

The city reported that trying to find and fix the problem is time consuming, complex, and expensive.

City of Minneapolis

Minneapolis began sewer separation efforts in the 1960s as part of its street reconstruction program. Included in the construction projects were storm drains designed to either separate combined flow or to add sufficient capacity for future separation of upstream sewers. In 1986, the Metropolitan Council and the cities of Minneapolis and St. Paul were required to get a combined sewer overflow permit. By the late 1990s at least 95 percent of the sewers were separated.

In 2000, the Metropolitan Council and Minneapolis agreed to a joint study to determine causes of overflows. Based on the study, it was determined that inflow rather than infiltration was the main source of I/I. A program to eliminate I/I was developed with start up in 2002 and implementation from 2003–2007.

The program consists of the following three parts:

1. disconnection of rain leaders (voluntary),
2. capital improvements and maintenance to look for connections and catch basins that are connected, and
3. identification and implementation of storage or other improvements that increase conveyance and capacity to prevent overflows.

Attempts in the 1980s and 1990s to pass ordinances to force the disconnection of rain leaders did not have initial political backing, but the ordinance was passed and became effective August 2003. By November 2003, 14,000 inspections were completed. Four percent of the inspected homes/businesses had rain leaders connected to the city sanitary system.

The city hired staff and is inspecting all properties to identify illegal connections and get them removed. The estimated cost for the five-year program is over $18 million. The city has spent $1.2 million in a 21-month period.

There has not been much reaction from the public, but more is expected as the program continues and additional notices are sent out.

Minneapolis suggests being creative and working with the homeowners to help provide solutions, especially in areas where there are fewer storm drains or lawns. They believe political support early in the process is best because it allows multiple I/I projects to be conducted simultaneously.

City of Plymouth

The City of Plymouth's I/I program involved sump pump inspection. The program goal was to save money. The city looked at programs in Lakeville and Farmington and did a cost benefit analysis before embarking on their program.

The city Finance Office was responsible for the program, which was completed at the end of 1997. The Mayor endorsed a letter that was mailed to all Plymouth residents.

The city had an education campaign before and during the program. The education elements reached city residents via the city newsletter, cable TV announcements, articles and advertisements in the local newspaper, direct mail notices and neighborhood meetings. The city found that it was very helpful to get information out to the public in advance.

Residents were given the option to hire a certified plumber if they didn't want the city contractor to inspect their property. All existing properties were inspected and new construction had to be certified. A notice was given each homeowner two to three weeks before the inspection. Flyers were placed on a resident's door if they were not home. The flyer provided information for making an inspection appointment. In some instances, it took two to three months for fixes to be completed. If no action was taken by the homeowner after being contacted two to three times, the city then assessed individuals a $100 surcharge per month on their bills. A few residents were non-compliant and paid the monthly fee for a couple of years.

There were over 2,000 properties disconnected from the sanitary sewer system under this program at a cost of $357,000. The Metropolitan Council provided a grant of $40,000. Seven hundred and fifty sump pumps were removed due to education and 1,300 were removed as a direct result of inspection. In follow-up inspections after the disconnections were made (required by the MC grant), the city found some homes had reconnected their sump pump to the sanitary sewer system.

Lessons learned reported by the city included:

- Good inspection forms and records of inspections are essential.
- A good software program will help make the inspections flexible.
- Provide as much information as possible to include the benefits to individuals, city and region.
- Expect some complaining.

City of St. Anthony

St. Anthony's program requires inspection and removal of sump pumps and foundation drains upon the sale of each home. The program was initiated in 1999 and was initiated with public meetings and notices mailed to the homeowners.

To date 200 homes are inspected and 160 homes are converted to current standards each year. The program allows homeowners to hire a plumber or complete the project themselves, which usually results in an average cost to homeowners of $1,200 to $1,500. There is the general feeling that the program is not addressing the issue fast enough, but costs to upgrade the home are acceptable at the time of sale.

The process is effective and the impact to the homeowner is tolerable, especially in older communities like St. Anthony. However, the program may not reach all the homes. Future considerations to the program may include water and sewer rate reductions to homes that are certified to be in conformance with city code, door-to-door mandatory inspections, and a grant program to offset costs of conformance.

City of Duluth

The city of Duluth is served by the Western Lake Superior Sanitary District's (WLSSD) interceptor system. During significant rain events, the I/I in the Duluth sewer system increases the wastewater flow beyond the capacity of the interceptor system and overflows occur. This long-standing problem was recognized by the city staff to be attributable to I/I from private property. Consequently, the city developed a program to reimburse homeowners for voluntarily disconnecting the foundation drain or sump pump from the sanitary sewer system. Started in the mid 1990s, this program was funded to expend about $1 million per year. By 2001, the city had inspected more than 1,700 buildings and disconnections were made in 1,450 buildings.

This program has been coupled with inspection of the publicly owned sewers and rehabilitation projects to eliminate I/I sources. The voluntary nature of the program and limited funds for reimbursement affect the rate of I/I reduction. Ongoing discussions with the Minnesota Pollution Control Agency and WLSSD (the NPDES permit holder) have broadened to include the U.S. EPA as well. Because the overflows are not permitted, the city is now facing a negotiated Consent Degree that could establish a court-ordered schedule for implementation.

In 2003 the city revised its voluntary program to make it mandatory. The reimbursement is $1,200 per building.

Other States' Community Programs

Several communities in other states are addressing their I/I issues. Following are brief descriptions of identified issues and related actions.

City of Ann Arbor, Michigan

The city of Ann Arbor, Michigan decided to address the I/I issue by focusing on the private property sources: primarily foundation drains and sump pumps. The long-term (20-year) program is now in its third year. Once completed, the program is expected to have required the disconnection of 20,000 foundation drains or sump pumps from the sanitary sewer system at an average cost of $7,000 per home. This includes the cost of a curbside collector for sump pump discharges and 100 percent reimbursement to the building owner for the cost of the disconnection. If a foundation drain or sump pump is found to be connected to the sanitary sewer system, the building owner must accept the city offer in 90 days or get zero reimbursement.

The city maintains a web site, http://www.ci.ann-arbor.mi.us/Utilities/fddnews.html, which provides additional information.

Rock River Water Reclamation District: Rockford, Illinois

The Rock River Water Reclamation District serves Rockford, Illinois and several suburbs. I/I from private property sources is now being addressed through a program of mandatory inspection and disconnection of drains and sump pumps at the time of sale. The District requires a Certification of Compliance with Discharge Standards. These standards require that no person or entity shall sell, transfer or convey ownership of a building serviced by a District sewer until such time as a current certification of compliance has been obtained by the property owner and deposited with the District. The certification of compliance confirmation must be signed by a licensed plumber.

Information about this program and the certification forms can be found on the Web site maintained by the District: http://www.rrwrd.dst.il.us. Navigate to the Rules and Regulations section and select user connection inspection for the details of the program.

City of West Lafayette, Indiana

The city of West Lafayette, Indiana has successfully implemented a program to disconnect gravity foundation drains from the sanitary sewer system. One subdivision, Bar Barry Heights, had been plagued for years with basement backups during significant rainfall. Initially, the city focused on the publicly owned sewers, rehabilitating manholes, lining sewers, and grouting leaking sewer joints. In this subdivision with over 600 homes, the city spent over $1 million on rehabilitating the public sewers but the backup problem remained as bad as before. The conclusion by the city was that I/I from private property was the major problem in this subdivision.

In 1992, the city decided to implement a program to disconnect foundation drains and sump pumps from the sanitary sewer system. The alternatives of building relief sewers or underground storage facilities were likely to be less expensive but still subject to overloading during extreme rainfall events. In the final analysis the mayor decided on disconnection as the best long-term course for the city.

This program started with a pilot program in 1993 to make sure all key issues were addressed. The city inspected every building and dye tested the foundation to determine if the foundation drain was connected to the sanitary sewer system. If the connection was confirmed by the dye test, the owner was notified and provided a package of information explaining the city program. The owner could receive 100 percent reimbursement for the cost of the disconnection if they agreed to undertake the disconnection within 12 months of notice. The city provided guide specifications and a list of qualified contractors to the owner who then received quotes and hired a contractor. City inspectors checked for code compliance prior to the reimbursement payment by the city. The city reimbursement was reduced by 25 percent each year the owner waited, until the fourth year when it became mandatory without reimbursement. By 1998 the city had completed disconnection of foundation drains and installed the curbside collector sewers for the sump pump discharges. Only two owners waited until the very end to disconnect from the sewer system.

Public informational meetings were held several times during the program. Such communication was important as homes were sold and bought and new residents moved into the subdivision during the program. Public acceptance of the program was high, as evidenced by the re-election of the mayor during the five-year implementation period.

Section Six

Possible Control Strategies

The Metropolitan Council, as the NPDES permit holder, must take regional government action to reduce the risk of an overflow from its interceptor system. The two basic options considered by the Council were to increase the system capacity or require that tributary communities reduce the I/I rates entering their collection systems. Information presented to the I/I Task Force supported the Council staff position that increasing system capacity to handle I/I was not a viable option. The task force members agreed that reduction of I/I is the only long-term option that allows for efficient accommodation of regional growth and reduces risk of sanitary sewer overflow.

Several strategies of how to reduce I/I in the region were discussed by the task force. One of the key issues discussed was how prescriptive the Metropolitan Council should be regarding I/I reduction. The task force agreed that Council should simply set the I/I reduction goals and allow each community to select the measures it believed would best meet those goals. The role of Council in this approach is to provide technical assistance and serve as a focal point for communicating lessons gained from customer communities as they implement their programs to reduce I/I.

The implementation strategy discussion included ways to provide incentives and ways to enforce the goals. The incentive might be a financial assistance surcharge program. Enforcement might involve mandatory reimbursement to the Metropolitan Council for facilities the Council built to accommodate excessive I/I from a community.

I/I Goals

The Metropolitan Council had already established I/I Goal(s) for some communities on the basis of monthly flows, and a grant program is in place that was used by some communities to improve their systems.

Completion of the Interceptor Master Plan underscored the need to set I/I goals on the basis of the peak hour flow. The goal for each community is to maintain its peak hourly flow at each point of connection to the interceptor system at or below the value obtained by use of the Council's design standards. The time for meeting these goals was discussed and is influenced by the comprehensive planning process and the Council’s review of the local plans. The proposed schedule is 2012.

One alternative design standard was considered. For comparison, the concept to apply a more lenient standard to older communities was evaluated. This option was presented to the I/I Task Force and discussed. A major impediment to implementing such a change is the lack of justification on deciding which communities receive a more lenient standard.

Modified Waste Discharge Rules

MCES has adopted Sewer Discharge Rules for the Metropolitan Disposal System that establish guidelines for all discharged waste and address discharges from industries and other customers that adversely affect the collection system or treatment plants. Current rules prohibit unpolluted water, such as stormwater or water from rain leaders from tributary

communities, to enter the system. These rules will be modified to establish a cost recovery fee for collection and/or containment of excessive I/I, and it may be necessary to strengthen the tie between unpolluted water and excessive I/I entering the regional system.

Community Contracts

MCES could establish a contract with each community to establish the peak rate that can be discharged into the interceptor system at each point of connection. Other regional agencies have used these contracts to establish allocation of capacity in the system for each customer.

Joint NPDES Permit

The pending regulations for sanitary sewer overflows will likely establish the need for a joint permit, held by MCES and the customer community. Conditions of the permit would limit the I/I allowed from the permittee and require programs be implemented if the I/I exceeded the limit in the permit. I/I from a community that caused or aggravated an overflow would be subject to an enforcement action by the MPCA or the U.S. EPA.

Financial Assistance Surcharge Program

Metropolitan Council Environmental Services will establish an I/I Financial Assistance Surcharge Program for a five-year period starting in 2008 as an incentive for communities to remove peak wet weather I/I from their sanitary sewer systems. Under this program, starting in 2007, those communities whose peak I/I rates exceed the I/I goals established for their community will be assessed a uniform I/I surcharge on top of the regular MCES municipal wastewater (flow) rate that will fund the surcharge program for the five-year period. These monies will be set aside by MCES in an account, for each of the communities, to aid them in the implementation of their I/I reduction program. For example, the money could be used to disconnect roof leaders, sump pumps and drain tile from homes, or to construct peak storage facilities, or to hire consultants to study the problems.

One version of the surcharge program would require a local 50 percent match. The community would be eligible to receive sums of money that match the balance in its account based on the five-year I/I surcharge to do acceptable I/I projects. If the community is successful in reducing its peak wet weather flows so that they do not exceed their I/I goal for a consecutive 3-year period, any balance in their surcharge account will be returned to the community. If an eligible community does not apply for all the money in its I/I surcharge account and does not effectively reduce its peak I/I to meet its I/I goals, the remaining money in its account will be used by the Metropolitan Council to help fund needed improvements within the Metropolitan Disposal System to contain, transport and treat excessive I/I.

Members of the Task Force suggested a different version of the financial assistance surcharge program that would allow communities to avoid the uniform I/I surcharge. Under this version, communities that establish I/I reduction programs that are locally funded to at least the extent of the surcharge would avoid the surcharge. Essentially, this version would allow a community to raise local funds earmarked for I/I reduction without having the money go through MCES and back again.

Excess Demand Charge

If a community does not effectively reduce its I/I and meet its I/I goal(s), resulting in a need for improvements to the MDS, MCES will meet with the community. The community will be informed of the needed improvement(s), the schedule for the improvements, and the

community's share of the cost to recover the capacity lost to its excessive I/I. When the needed improvements are completed, the local share of the cost will be assigned to the community over 20 years in the form of an excess demand charge. The excess demand charge is not a penalty, but will be based on MCES's cost of providing the service. While details of the excess demand charge will be worked out in the future, it will be in addition to the actual MCES municipal wastewater flow rate.

Options for Reduction of I/I in Local Collection Systems

New Facilities

The design and construction of new sewers and the connection of new buildings to the sewer system should meet the industry standards for tightness and minimize the entry of I/I into the collection system.

The state of Minnesota requires that new sewers be designed and installed so leakage into the sewer is less than 100 gallons per day per inch-diameter per mile of sewer. For one mile of 12-inch diameter sewer, the leakage into the new sewer must be less than 1,200 gallons per day (less than 1 gallon per minute). Adherence to this standard depends on inspection during construction and verification testing prior to acceptance by the owner. The task force agreed that the Metropolitan Council should require certification by a professional engineer that new facilities are installed in accordance with all specifications. Each community must retain records of these certifications so that MCES can audit them.

The connection of a building lateral to the local sewer system is usually permitted by the local building department. The steps taken to confirm that the connection is done correctly vary among communities. Some communities require that a licensed plumber certify that the connection was made in accordance with the building code.

Ordinances

All communities must have adopted ordinances that prohibit the connection of roof leaders, foundation drain tile and sump pumps from new construction to the sanitary sewer system. If these sources of I/I are significant in the community, the ordinances should also require the disconnection of any roof leaders, foundation drain tile or sump pumps currently connected to the sanitary sewer system.

Disconnection of Foundation Drains and Sump Pumps

The disconnection of foundation drains and sump pumps from the sanitary sewer system is one of the most difficult I/I reduction measures for a community to undertake. The identification of the locations that should be disconnected is a major step and a difficult one for most communities. Generally, the house to house inspection of the plumbing in the basement does not cause much public concern if the program is well explained to the public and they understand the reason for the inspections. These inspection programs take time and a concerted communications effort. The inspection for connected gravity drains often requires some form of dye testing around the foundation of a building. Dye is sprinkled around a foundation and water is added to flush the dye down the wall of the foundation. Concurrently, a TV camera is placed to observe the building lateral to see if dye is discharged. The local ordinance must be written to allow for this type of testing.

There are a range of options to address this and examples from other communities to follow. Options to consider include the following.

- **Voluntary disconnection and reimbursement:** Building owner is notified of connection and offered some form of reimbursement for disconnection if performed within a specified time frame. No penalty for remaining connected.
- **Point of sale:** Seller must provide community proof that code is met prior to building sale.
- **Age of structure:** Some communities require new building lateral and confirmation of disconnection if building permit is issued for building that is a certain age (40 or 50 years old, for example).
- **Mandatory disconnection with reimbursement:** Building owner is notified of connection and offered some form of reimbursement for disconnection if performed within a specified time frame. Fined if remaining non-compliant after certain period.

In all cases the disconnnection should be certified by community staff or a licensed plumber. These certifications should be on file and accessible for audit by the Metropolitan Council.

I/I Reduction in Local Sewers

The investigation of I/I sources in publicly owned sewer systems is fairly well developed and the standard practices well documented on the basis of the sewer system evaluation surveys conducted under the Construction Grant Program. The basic steps included the following.

- **Flow monitoring and analysis:** Locate areas generating high I/I and estimate I/I rates.
- **Smoke testing:** Locate inflow sources.
- **Dye water flooding:** Locate cross connections between drainage system and sanitary sewer system.
- **Closed circuit TV inspection:** Often conducted during the dye water flooding tests, the TV inspection locates specific I/I sources and structural defects that should be rehabilitated or replaced. Manhole inspections done concurrently with sewer inspections.

Most communities have ongoing sewer cleaning and inspection programs as part of the routine maintenance of the collection system. I/I sources are often identified during inspection and include open and leaking sewer joints, cracked pipes, missing joint gaskets, broken house lateral connections, running services (problem likely on private property), pick holes in manhole covers, and offset manhole frames. Many communities address these I/I sources as part of their infrastructure rehabilitation program.

Flow storage

An alternative to I/I reduction is to provide either off-line peak flow storage basins or in-line storage in over-sized pipelines. This is a relatively expensive alternative and one subject to overloading under extreme conditions.

Because these storage facilities would be located in fully developed areas, siting would be economically, environmentally, and politically difficult. In-line or off-line storage may be feasible in some cases, but it is not a reliable solution to the overall infiltration/inflow problem. Additionally, the need to empty the storage basins shortly after a wet weather event could impact the capacity of the downstream wastewater treatment plant.

Relief Sewers

Relief Sewers to convey excessive I/I to the MCES interceptor system are not permitted.

Section Seven

Authority, Conclusions and Recommended Actions

Authority

The Metropolitan Council is directed by Minnesota Statutes, Section 473.145 to prepare a comprehensive development guide for the metropolitan area. The development guide, as currently implemented, consists of the *2030 Development Framework* and four "system plans" dealing with transportation, aviation, wastewater, and regional recreation open space. Minnesota Statutes, Section 473.146 provides direction to the Council to adopt these comprehensive policy plans for transportation, airports, parks and open space, and wastewater treatment as chapters of the development guide. The development guide legislation also allows for the Council's adoption of related policy statements, goals, standards, programs and maps describing how it will achieve its charge. It is within this context that the Council is preparing the update to its existing *Water Resources Management Policy Plan* that was adopted in December 1996. The revised Plan will contain the wastewater "system plan," plus policies in overall water quality, non-point source pollution control, and water supply.

Legislation related to metropolitan land-use planning (Minn. Stat. Sec 473.858) suggests that comprehensive plans of local governments cannot be in conflict with the metropolitan system plans for airports, transportation, wastewater, and regional recreation open space. The system plan for metropolitan wastewater service will occur within the updated *Water Resources Management Policy Plan.*

In a similar manner, the Council's *2030 Development Framework* establishes a growth management strategy that incorporates system plans into overall regional development. Both the update to the *Water Resources Management Policy Plan* and the *2030 Development Framework* will be used to determine consistency of local government plans with those of the Metropolitan Council. Material contained in the plans can be used to determine whether there is a substantial impact or a substantial departure from the metropolitan systems plans.

The Council intends to adopt its peak hourly design standards as part of the *Water Resources Management Policy Plan*. These standards are the basis for the design of the Metropolitan Disposal System and will be used to establish I/I goals for each of the communities served by the Metropolitan Disposal System (MDS). Communities will be asked to develop an I/I reduction plan to reduce their peak hourly flows to meet these design standards. Those communities that discharge flows into the MDS at rates higher than the design standards put the system at risk of overflows and, therefore, have a substantial impact on the MDS.

Conclusions

The Council staff and the I/I Task Force members conclude that:

- The capacity of regional wastewater conveyance and treatment facilities is being exceeded during significant rainfalls because of excessive infiltration/inflow (I/I).
- Excessive I/I has used up existing capacity for future growth.
- Overloaded wastewater conveyance and treatment facilities have resulted in unacceptable conditions such as private property damage, spills and sanitary sewer overflows (SSOs).
- MCES, as the regional wastewater utility and NPDES permittee, must take action now to reduce the risk of overloading the regional wastewater facilities.
- It is not feasible to enlarge MCES's facilities to accommodate all the I/I from tributary communities.
- MCES has a fiduciary responsibility to not expend funds to convey and treat clear water from illegal connections associated with private property sources such as sump pumps and rain leaders.
- The MCES design allowance for I/I in the interceptor system is reasonable as many local communities meet this standard.

Recommendations

The Task Force recommends that the Metropolitan Council adopt the following I/I policy statements and corresponding implementation strategies for inclusion in the next *Water Resources Management Policy Plan*.

I/I Policy Statements

The Metropolitan Council will establish I/I goals for all communities discharging wastewater to the Metropolitan Disposal System. Communities that have excessive I/I in their sanitary sewer systems will be required to eliminate the excessive I/I within a reasonable time period.

The Metropolitan Council will not provide additional capacity within its interceptor system to serve excessive I/I.

Implementation Strategies

The Metropolitan Council will:

1. Continue to use the current design standards for interceptors.
2. Require communities served by the MDS to include an I/I program within their next comprehensive plan.
3. Develop I/I goals for all communities as well as guidelines for the preparation of the local I/I programs.
4. Require the community to reduce its I/I to reach the design flow standard for each connection point to the MDS within a five-year period from the adoption of its comprehensive plan.

5. Measure peak inflow during wet weather conditions by either the MCES metering system or by temporary monitoring equipment installed in the sanitary sewer system.
6. A. Initiate an I/I financial assistance surcharge program, starting in 2008. This program will allow MCES to surcharge communities to collect revenue for the community to use for solving its I/I problem.

   B. Allow communities with I/I reduction in place to continue with their programs and not participate in MCES's surcharge program. This will allow communities to undertake activities for I/I reduction using local funds, as long as those funds are equal to or greater than the surcharge program funds.

   MCES will work with communities with either option (A or B) to help solve their I/I problem on a case by case basis.
7. Limit increases in service within those communities where excessive I/I jeopardizes MCES's ability to convey wastewater without an overflow occurring. MCES will work with those communities on a case by case basis.
8. Limit future increases in service within those communities that have not met their I/I goal(s), starting in 2015, until the problem is solved. MCES will work with communities not meeting goals on a case by case basis
9. Institute a wastewater rate demand charge program, starting in 2015, for those communities that have not met their I/I goal(s), and are not actively working to do so, to help defray the cost of providing attenuation within the MDS to recover the capacity lost to their excessive I/I. MCES will continue to review communities and work with them on a case by case basis.
10. Work with the Public Facilities Authority to make funds available for I/I improvements.

Appendix A

Definitions and Acronyms

CFS: Cubic Feet per Second

CSO: Combined Sewer Overflow

CMOM: Capacity, Management Operations, and Maintenance regulations. Regulates Sanitary Sewer Overflows (SSOs). Will become part of NPDES permit requirements. Will require creation and maintenance of a plan to show regulators your agency's ability to plan and manage your system effectively, and maintain its integrity so that it has adequate capacity and stays in good condition over the years.

CWA: Clean Water Act

Current Annual Average Flow: The current annual average flow from a sewershed is calculated as the last full calendar year of annual volume from a sewered area divided by 365.

Design to Average Flow Ratio: The design average flow is calculated as the product of the ultimate service area times 800 gallons per acre per day. This value represents an annual average flow from a service area at ultimate development.

Design Peak Average Flow: The design peak to average ratio is the ratio of the peak hour flow used for hydraulic design divided by the design average flow. MCES has adopted a table (Attachment No. 1) that identifies the design Peak to Average Ratio to be used for ranges of design average flows.

Design Peak Hour Flow: The design peak hour flow is calculated as the product of the design average flow times the MCES specified peak to average ratio.

EPA: Environmental Protection Agency

Excessive I/I:

- **a)** I/I that results in the communities wet weather flows to be violation of the Metropolitan Councils established I/I goals for the community.
- **b)** I/I that causes the peak hourly flow to exceed the value determined by multiplying the average flow by the value of the peak to average Ratio used by MCES to design interceptors and pump stations.
- **c)** I/I that exceeds 25 gallons per day per capita on an maximum monthly basis.

gpcd: Gallons per capita per day

GWI: Groundwater Infiltration

I/I: Infiltration and Inflow:

Infiltration: The seepage of groundwater into sewer pipes through cracks or joints in the pipes.

Inflow: Inflow is typically flow from a single point, such as discharge from sump pumps and foundation drains, or stormwater entering openings in the sewer access covers

MDS: Metropolitan Disposal System

MGD: Million Gallons per Day

MH: Manhole

MPCA: Minnesota Pollution Control Agency

Measured Wet Weather Peak to Average Ratio: The observed peak hour flow during wet weather divided by the target annual average flow.

NPDES: National Pollutant Discharge Elimination System

PFA: Public Facilities Administration

PMQ: Peak Monthly Flow (Q) is determined as the highest monthly flow.

Observed Peak Hour Flow: The observed peak hour flow is the highest flow rate over one hour duration during a 24-hour period that has been measured and reported.

Observed Peak to Average Ratio: The observed peak to average ratio is the observed peak hour flow divided by the annual average flow.

SSO: Sanitary Sewer Overflow

Sewershed: The area tributary to the MCES interceptor system at a single point is a sewershed.

Ten State Standard (Recommended Standards for Sewage Works): Joint standard for design criteria for conventional sewage collection and treatment systems.

WEF: Water Environment Federation

WLSSD: Western Lake Superior Sanitary District

WWPT: Wastewater Treatment Plant

WWPR: Wet Weather Peak Ratio. Average of three highest peak days/the average daily flow