



Infiltration and Inflow Reduction Program Plan

Prepared for
Madison Metropolitan Sewerage District
Madison, WI
March 8, 2021





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Table of Contents

List of Figures	iv
List of Tables	iv
List of Abbreviations	v
Executive Brief by District Staff	vi
Executive Summary	viii
PURPOSE OF REGIONAL I/I REDUCTION PROGRAM	viii
OVERVIEW OF REGIONAL I/I REDUCTION PROGRAM	ix
OVERVIEW OF IMPLEMENTATION STRATEGY	ix
1. Purpose of I/I Reduction Program	1-1
1.1 District Service Area Overview	1-2
1.2 Concerns Related to Current I/I Conditions	1-4
1.2.1 I/I Conditions of Interest	1-4
1.2.2 Peak Flow Concerns (Design Curve)	1-4
1.2.3 Treatment Plant Capacity Conditions	1-7
1.3 Future I/I Concerns	1-10
1.4 Recommended Metrics for the I/I Reduction Program	1-12
2. I/I Program Description	2-1
2.1 I/I Program Development Process	2-1
2.2 Sewer Use Ordinance Considerations	2-2
2.3 Excessive I/I Standards	2-2
2.4 Customer Community Work Plans	2-4
2.5 District Approval and Oversight of Work Plans	2-7
2.6 Flow Assessments After Completion of Work Plans	2-9
3. Incorporation Into District CMOM	3-1
3.1 Chapter 2 – Management Plan	3-1
3.2 Chapter 3 – Operation and Maintenance Plan	3-2
3.3 Chapter 4 – Asset Management Plan	3-2
3.4 Chapter 5 – Capacity Plan	3-3
3.5 Chapter 6 – Emergency Overflow Response Plan	3-3
3.6 Chapter 7 – Communication Plan	3-3
4. District Support for Municipal Programs	4-1
4.1 Technical Support	4-1
4.2 Funding of Private Property Pilot Projects	4-1
4.3 PPII Policy and Program Advising	4-1
4.4 Public and Customer Education	4-2

5.	Changes to District Sewer Use Ordinance	5-1
5.1	Excessive I/I Standards.....	5-1
5.2	Establish the Regional I/I Reduction Program.....	5-1
5.3	Additional Modifications in Support of the I/I Program.....	5-1
6.	Flow Monitoring and Analysis Processes.....	6-1
6.1	Flow Monitoring.....	6-1
6.2	Flow Data Analysis.....	6-2
7.	Program Implementation.....	7-1
8.	Limitations	8-1

List of Figures

Figure 1.	Common sources of I/I	1-1
Figure 2.	Components of sewer flow	1-2
Figure 3.	District service area and facilities.....	1-3
Figure 4.	System schematic with monitoring locations.....	1-5
Figure 5.	Peaking Factor vs. Average Flow Curve – October 2019	1-7
Figure 6.	NSWWTP process schematic and capacity limits	1-8
Figure 7.	Maximum day volume ratio	1-10
Figure 8.	Forecasted lateral age in Dane County based on year of development.....	1-11
Figure 9.	Peak Flow Standard for I/I Program.....	2-3
Figure 10.	Example application of Peak Flow and Volume Excessive I/I Standards.....	2-4
Figure 11.	I/I Reduction unit costs achieved on previous projects	2-6
Figure 12.	Work Plan development and approval process	2-8
Figure 13.	Flow data collection and analysis process for Regional I/I Reduction Program.....	6-1
Figure 14.	Percent of annual average 1-inch rainfall days each month at Dane County Airport	6-2
Figure 15.	Schedule for I/I Reduction Program Implementation	7-4

List of Tables

Table 1.	Peaking Factor Summary.....	1-6
Table 2.	Maximum Daily Volume Summary.....	1-9
Table 3.	I/I Reduction Program Costs.....	7-3



List of Abbreviations

ADDWF	average daily dry weather flow
CMAR	Compliance Maintenance Annual Report
CMOM	Capacity, Management, Operation, and Maintenance
cfs	cubic feet per second
DCRA	Dane County Regional Airport
District	Madison Metropolitan Sewerage District
EORP	Emergency Overflow Response Plan
gpd	gallons per day
gpm	gallons per minute
I/I	Infiltration and Inflow
MG	million gallons
mgd	million gallons per day
NSWWTP	Nine Springs Wastewater Treatment Plan
PF	peaking factor
PPII	Private Property I/I
Q_{avg}	average dry weather flow
RCFA	root cause failure analysis
SSO	sanitary sewer overflow
SUO	sewer use ordinance
WDNR	Wisconsin Department of Natural Resources

Executive Brief by District Staff

Recent years have seen intense storms with flooding that has resulted in stormwater (inflow) and groundwater (infiltration) getting into the sanitary sewer system. The August 20-21, 2018 storm event, while an extreme event, identified that the Madison Metropolitan Sewerage District (District) and its Community Customers are vulnerable to the impacts of inflow and infiltration (I/I) as basement backups and sanitary sewer overflows (SSOs) occurred in some areas where the sanitary sewers were inundated with excessive clear water.

The District's sewer use ordinance (SUO) requires all Community Customers to control excessive clear water from entering sanitary sewers. Excess inflow and infiltration is defined as any sewer having an hourly wet weather flow peak greater than four times the average daily dry weather flow (ADDWF) or hourly peaks greater than four times the typical daily wastewater-only flow anticipated for the served area based on water meter records.

The goal of Capacity, Management, Operation, and Maintenance (CMOM) Programs according to Wisconsin state statute NR210.23(3)(c) is to eliminate excessive I/I and cease SSOs. In their review of the District's CMOM program, the Wisconsin Department of Natural Resources (WDNR) identified that the District needed to develop a private property I/I control program to comply with CMOM requirements.

The District and Community Customers have been working on reducing I/I through periodic rehabilitation projects such as lining or replacing leaking public sewers. However, quantifying the benefits has been difficult due to limited flow monitoring, and these types of projects often have little to no impact on private property I/I.

Embarking on a Regional I/I Reduction Program allows the District the ability to get ahead of the looming problem related to the continued aging of private sewer laterals. Inspections are rare, and deteriorated private sewer laterals are significant sources of I/I. By year 2030, 25 percent of private sewer laterals in Dane County will be at least 70 years old. The expected increase in I/I from these laterals poses a threat to the capacity of the District's regional sewer system if their condition is not addressed.

Now is the time to be proactive and plan for these infrastructure improvements and I/I reduction projects. I/I reduction provides value to the District and Community Customers over time by increasing resilience to changing weather patterns, deferring needs for capacity increases, improving system performance, and meeting regulatory requirements.

What has been our process?

Customer community meetings held in 2019 identified I/I reduction as a top priority for the District. I/I reduction is included in the District strategic plan and aligns with the Commission outcome policies.

In 2020, the District hired Brown and Caldwell to begin work on an I/I reduction program plan and formed a technical advisory committee comprised of six representatives from the Community Customers to provide input on developing an overall I/I reduction program framework.

An important result of the technical advisory committee's work regards allocation of spending. Regional programs typically look to optimize solutions and target areas that will yield the greatest net benefit for the cost. However, the technical advisory committee raised concerns with money contributed by a community being used to fund work in another community. The program will need to

balance these issues to provide appropriate regional benefits while respecting local control of funds. The program will use compliance with the I/I standards in the District's sewer use ordinance to do this.

I/I Reduction Program Framework

The overall goal for the District's I/I reduction program is to maintain the flow standards defined by the District's sewer use ordinance. To accomplish this vision, the District will:

- Administer the regional I/I reduction program.
- Provide technical support and education resources to our Community Customers with an emphasis given to reducing private property I/I sources.
- Update the District's sewer use ordinance to refine program metrics.
- Monitor for compliance with the sewer use ordinance standards.
- Review and approve work plans for areas that are non-compliant.

How to meet compliance will be decided by the community in developing their work plan. A Work Plan Value will be calculated to provide an estimate for planning I/I reduction projects in a customer community's budget. It is in a customer community's best interest to determine the optimal solutions to reduce I/I to comply with the standards. If compliance is not achieved within a specified timeframe, a new work plan with additional spending requirements must be developed and approved.

Next Steps

It will take some time before the I/I program reaches the implementation stage and work plans are issued. In the next year or two, more work is needed to develop the work plan requirements and a Flow Monitoring Plan to measure compliance. These efforts will benefit from continuing work with the technical advisory committee. District staff, with help from consultants, will also begin developing education resources and plan for public outreach.

Once the program requirements are further defined, work will begin on updating the sewer use ordinance to establish the I/I reduction program. Up to five years may be required for program formation efforts to be completed, making the program effective by year 2027.



Executive Summary

As a regional sewerage district, the Madison Metropolitan Sewerage District (District) has responsibility for the collection, treatment, and disposal of wastewater generated within its service area. Similar to many other regional sewer entities, the District owns and operates sewer infrastructure downstream of other municipally-owned and privately-owned sewer infrastructure.

All buried sewer infrastructure can be the source of extraneous water from the ground surface runoff (inflow) and groundwater (infiltration). The amount of I/I present in the District system varies over time, but is significantly more in rain events than in dry weather. Over time, buried sewer infrastructure is prone to degrade, providing the opportunity for I/I to increase. During particularly significant storm events, saturated ground conditions, and high area lake levels, the amount of I/I conveyed for treatment by the District system can be in excess of its capacity to do so. Without a program to reduce current I/I and reduce the risk of future additional I/I, the problems associated with insufficient capacity in wet weather events will occur more frequently. It is both this existing amount of wet weather I/I and the potential for future additional I/I that is the context for the District considering the establishment of a regional I/I reduction program.

This Executive Summary document provides a high-level overview of the Regional I/I Reduction Program developed by District staff and consultants. The District received extensive input from an Advisory Committee comprised of six Community Customer organization representatives.

PURPOSE OF REGIONAL I/I REDUCTION PROGRAM

The District is establishing this Regional I/I Reduction Program to accomplish the following important purposes:

- **Protect Constructed Capacity of District Conveyance and Treatment Facilities:** District facilities currently convey and treat significant amounts of I/I which, at times, can exceed the constructed capacity. Implementing this program would eventually protect this infrastructure from capacity exceedances that may be a violation of state permits.
- **Provide Motivation for Targeting High I/I-Generating Areas with Investigations and Remediation:** The Program, as envisioned, would motivate Community Customers to pursue I/I reduction in areas that have been found to generate I/I in excess of design and operating standards for the District's system.
- **Provide a Mechanism for Evaluating Benefits of Pursuing Long Term I/I Reduction Activities:** With additional tools at the disposal of District engineering staff, it will be possible to evaluate how this program will derive benefits to the region over time in terms of reduced capital costs, improved system performance, and reduced regulatory risks.
- **Provide Opportunities for the District to Technically Support Efforts by Community Customers:** Aspects of complying with this I/I Reduction Program will pose challenges for some Community Customers with limited experience in reducing I/I. This Program would establish educational and technical support mechanisms for the District to help those seeking assistance with compliance activities.

OVERVIEW OF REGIONAL I/I REDUCTION PROGRAM

The Regional I/I Reduction Program will be based on core elements as articulated below:

- **Standard for Peak Flow and Volume:** Expressed limits on peak flow and volume will be used to determine if an area tributary to the District system requires I/I reduction actions by the Community Customer within that tributary area.
- **Work Plan Required:** The program would require Community Customers to develop and implement Work Plans for investigating and addressing I/I sources in tributary areas found to exceed one or both standards. The Work Plan would be reviewed and approved by the District. Each approved Work Plan would need to be completed within five years of approval.
- **Work Plan Value:** Each Work Plan will be designed to result in the Community Customer expending funds in proportion to how much measured I/I flows and volumes exceed the I/I standards. The value of the Work Plan may have both a peak flow and volume component.
- **Funds Expended on Work Plans Must Meet Specific Criteria:** Only qualifying activities would be eligible for satisfying the Work Plan Value. The District I/I reduction program manager will be responsible for maintaining the list of qualifying activities in the categories of inspection, engineering, and construction. If the tributary area regularly exceeds either peak flow or volume standards, only 10 percent of Work Plan Value can be satisfied with investigations and other non-construction cost.
- **Monitoring Program for Support of I/I Program:** The District will establish a flow monitoring program to identify non-compliant areas and determine progress toward compliance after Work Plans are completed by Community Customers. Flow monitors will need to be placed in community sewers in order to measure flows before entering the District's regional system. The program will prioritize the location of monitors based on an improved version of the District's collection system model that will help determine areas most likely to be exceeding the established peak flow and volume standards.
- **Timeline for Implementation:** This will be a long-term program and will not go into effect until the collection system model has been updated, flow monitoring locations and priorities have been established and monitors have been installed, the District's SUO has been updated to reflect existence of the Program, and necessary Program Guidelines have been established. Up to 5 years may be required for Program formation efforts to be completed, making the program effective by year 2027.

OVERVIEW OF IMPLEMENTATION STRATEGY

The I/I Reduction Program Implementation Strategy describes the major steps to be taken by the District and the approximate Program timeline. An outline of these steps are:

- **Monitoring Program:** Starting in 2021, the District will develop and implement a flow monitoring plan to support the Program. This effort will begin with an upgrade to the District's collection system hydraulic model so that it better reflects dynamic I/I conditions and can be used to identify high priority flow monitoring of tributary areas suspected of exceeding the I/I Reduction Program standards. This effort will also result in a flow monitoring plan that recommends phased locations for installing and maintaining monitors.
- **Adopt Changes to SUO:** Implementation of the recommended I/I Reduction Program may require some modifications to the District's existing SUO. Changes include reference to the I/I Reduction Program, the requirement for Community Customer Work Plans, and an expressed limit on I/I daily volume. The timing of this effort would occur after District Commission approval of the

I/I Reduction Program Plan and several years in advance of when any Community Customer would need to begin development of a Work Plan.

- **Establish Technical Support Capabilities:** The District will establish technical support capabilities for Community Customers seeking to comply with the I/I standards or otherwise reduce I/I in their collection systems. Support could include providing general technical information useful to all communities, such as investigation and design guidelines, or specific to a single community that has requested assistance. In the case of an individual community request, the District would pass on the costs associated with that assistance to that community. The timing of this activity would be such that technical support would be available in time for assistance with developing a Customer Community's Work Plan, if so requested.
- **Establish Education Support Capabilities:** The District will develop and/or provide general and targeted educational materials concerning I/I reduction in the form of web page material, templates for direct contact mailers, and informational brochures. The District may also provide access to a regional contract for I/I public outreach, with any direct community engagements paid for by that community. The timing of this activity would be such that educational support would be available in time for assistance with developing a Customer Community's Work Plan, if so requested.
- **Begin Enforcement Process:** The commencement of enforcement would not occur until after data have been collected to confirm an area exceeds the I/I standards and any changes to the District's SUO have taken effect. It is likely that this would not occur until Year 2027, or the seventh year of the program.

Section 1

Purpose of I/I Reduction Program

This section presents an overview of the Madison Metropolitan Sewerage District (District) and its service area, details concerning the extent of existing Infiltration and Inflow (I/I) and its impact on District facilities, and the potential for future I/I to further increase risks to the District's operations and permit. There are several possible sources of I/I in a sanitary sewer system. Figure 1 below depicts the two main ways I/I can enter the sanitary sewer system. One way is through inflow, which is rainwater that enters the system at a direct connection, such as a downspout directly connected to a foundation drain that is directly connected to a lateral pipe. The other way is through infiltration, which occurs when a crack forms in a pipe, manhole, or connection that allows groundwater, runoff, or flow from a storm sewer to seep into the sanitary sewer. Tree roots are a common way for cracks to form in pipes and can also cause flow blockages. Figure 2 is a graphical depiction of I/I compared to other components of flow in a sewer.

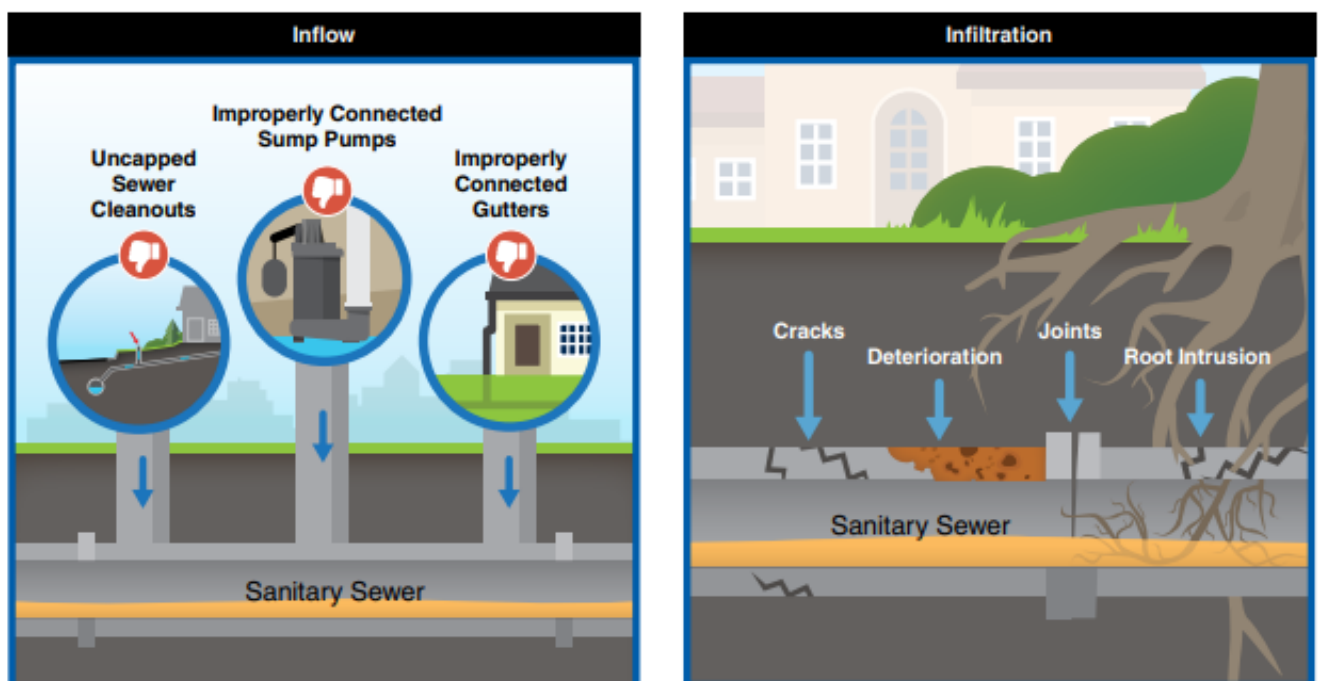


Figure 1. Common sources of I/I

source: Metropolitan Council, St. Paul, MN

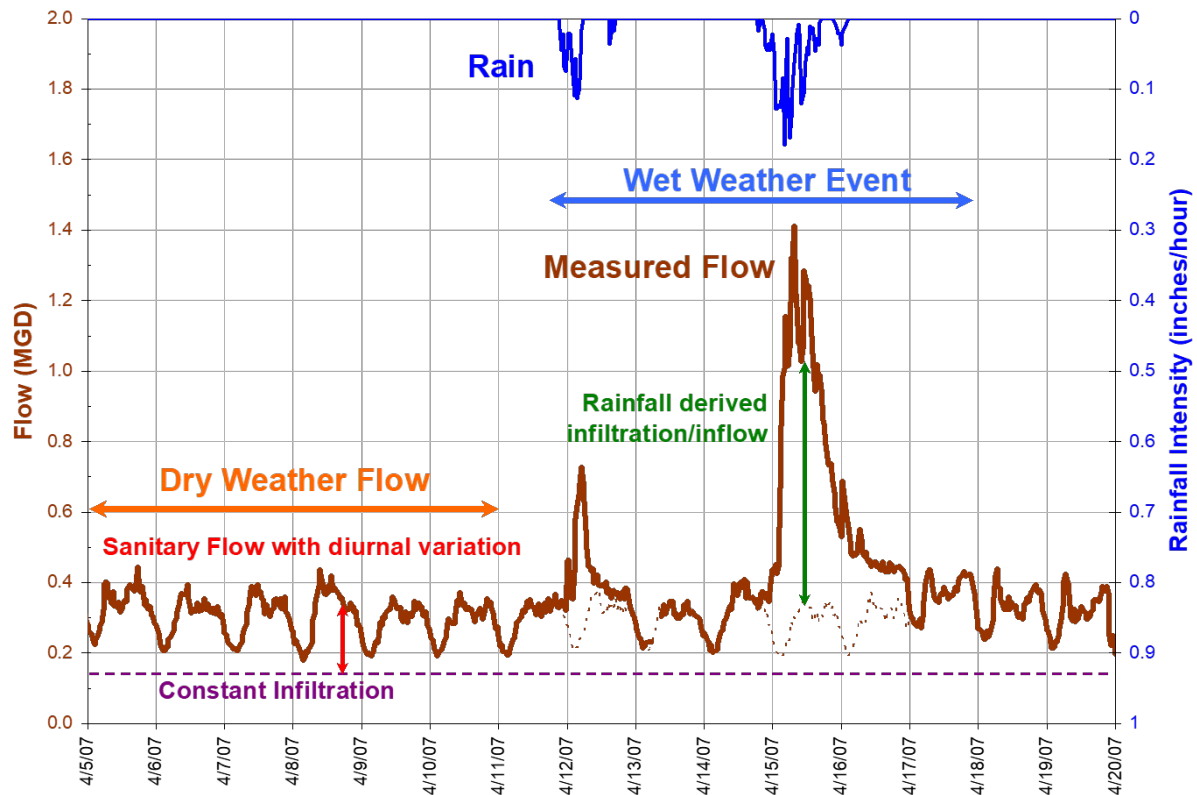


Figure 2. Components of sewer flow

1.1 District Service Area Overview

The Madison Metropolitan Sewerage District was formed in 1930 to provide area-wide wastewater collection and treatment for the communities around Lakes Mendota and Monona. Currently, the District's service area is 186 square miles, which the District serves through its network of 96 miles of gravity sewer interceptors, 18 regional pumping stations, and 47 miles of pressurized force mains.

Each dry weather day, the District receives and treats approximately 40 million gallons per day (mgd) of wastewater from the following "Community Customers": the Cities of Fitchburg, Madison, Middleton, Monona and Verona; the Villages of Cottage Grove, Dane, DeForest, Maple Bluff, McFarland, Shorewood Hills, Waunakee and Windsor; and from sanitary and utility districts and other areas in the Towns of Blooming Grove, Burke, Dunn, Madison, Middleton, Pleasant Springs, Verona, Vienna and Westport. A map of the current sewer service area that contributes to the District is shown in Figure 3.

All of the wastewater generated in the District service area is collected and transmitted to the Nine Springs Wastewater Treatment Plant (NSWWTP). Most of the treated effluent is discharged to Badfish Creek to avoid discharging treated wastewater directly to the Yahara River lakes. Some treated effluent is returned to Badger Mill Creek to offset the effects of inter-basin transfer on the base flow of Badger Mill Creek. The Badger Mill Creek outfall has a design capacity of 3.6 mgd. During wet weather, the diversion to Badger Mill Creek is not utilized and all treated effluent is either discharged to Badfish Creek or stored onsite if treated flows exceed the capacity of the effluent disposal system.

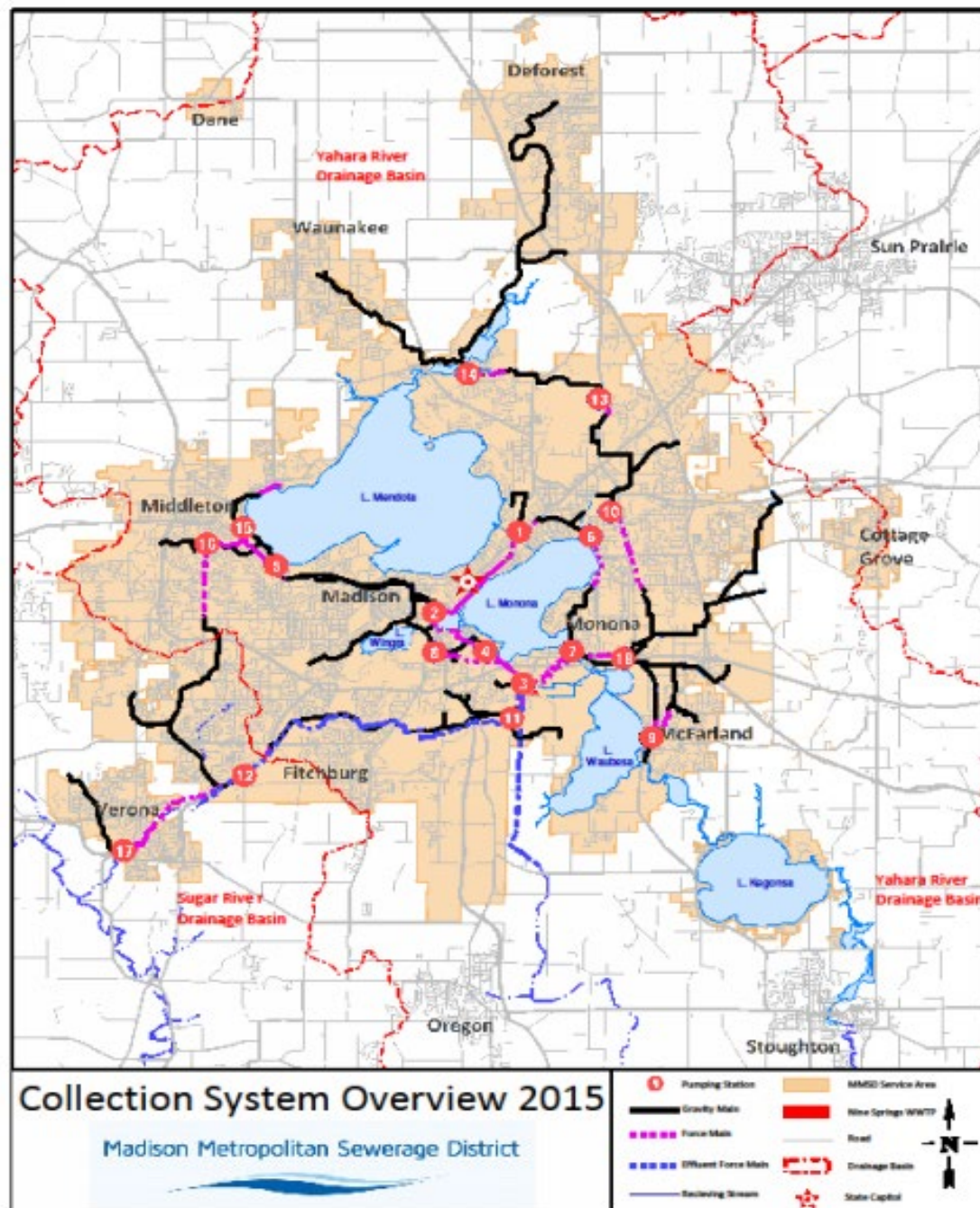


Figure 3. District service area and facilities

1.2 Concerns Related to Current I/I Conditions

The District is embarking on an effort to define a Regional I/I Reduction Program, through a planning process that considers the District's objectives and current and future I/I conditions. The plan resulting from this process will be informed by stakeholder input from Community Customers, District staff, and other interested parties.

Most I/I reduction programs are initiated because of a pressing issue like basement backups, sanitary sewer overflows (SSOs), or treatment plant compliance issues. While these circumstances can happen in the District service area, for the most part, they are rare and isolated to a few problem areas during extreme wet weather events.

District wet weather flows do certainly show an increase in significant storm events. The District's regional sewer use ordinance (SUO) provides performance objectives for community sewer flows, requiring peak hourly flows to not exceed four times the average daily flowrate. Exceeding this standard would trigger the requirement for an I/I plan to reduce flows in the affected community.

Another consideration for embarking on a regional I/I reduction program now is that it allows the District the ability to get ahead of the looming problem related to the continued aging of private sewer laterals. As most communities, and even fewer lateral owners, do little to address these sewer pipes this situation represents a significant future threat to the District's regional sewer system.

A high-level characterization of I/I conditions in the District service area provides an understanding of current conditions that can be compared to several different performance metrics. These comparisons may lead the District toward a particular vision for the I/I Reduction Program, particularly when the current conditions are extrapolated to future conditions that occur if a program were not implemented.

1.2.1 I/I Conditions of Interest

There are multiple ways to quantify I/I. One way is to evaluate the cumulative volume of flow over time. Another way is to identify the peak or maximum flow that occurred during a given event at a chosen time interval. This I/I assessment focuses on peak flow as the preferred metric for assessing the I/I impact on District conveyance facilities, but also considers total volume due to impacts on the downstream NSWWTP.

After considering several events and discussions with District staff, October 2019 was selected for evaluating I/I conditions across the service area. All flow monitoring sites had reasonable data for this event which made it an ideal event for calculating peaking factors. In addition, it showed a consistent flow response among the different sites and stressed the system enough to activate all pump stations.

1.2.2 Peak Flow Concerns (Design Curve)

Figure 4 presents a schematic of the pump stations showing how they interact. The arrows between pump stations indicate the flow path. Black arrows represent the flow path during normal operating conditions, red arrows represent the flow path during certain wet weather conditions, and gray arrows represent flow paths that are only used if the normal flow path is not available.

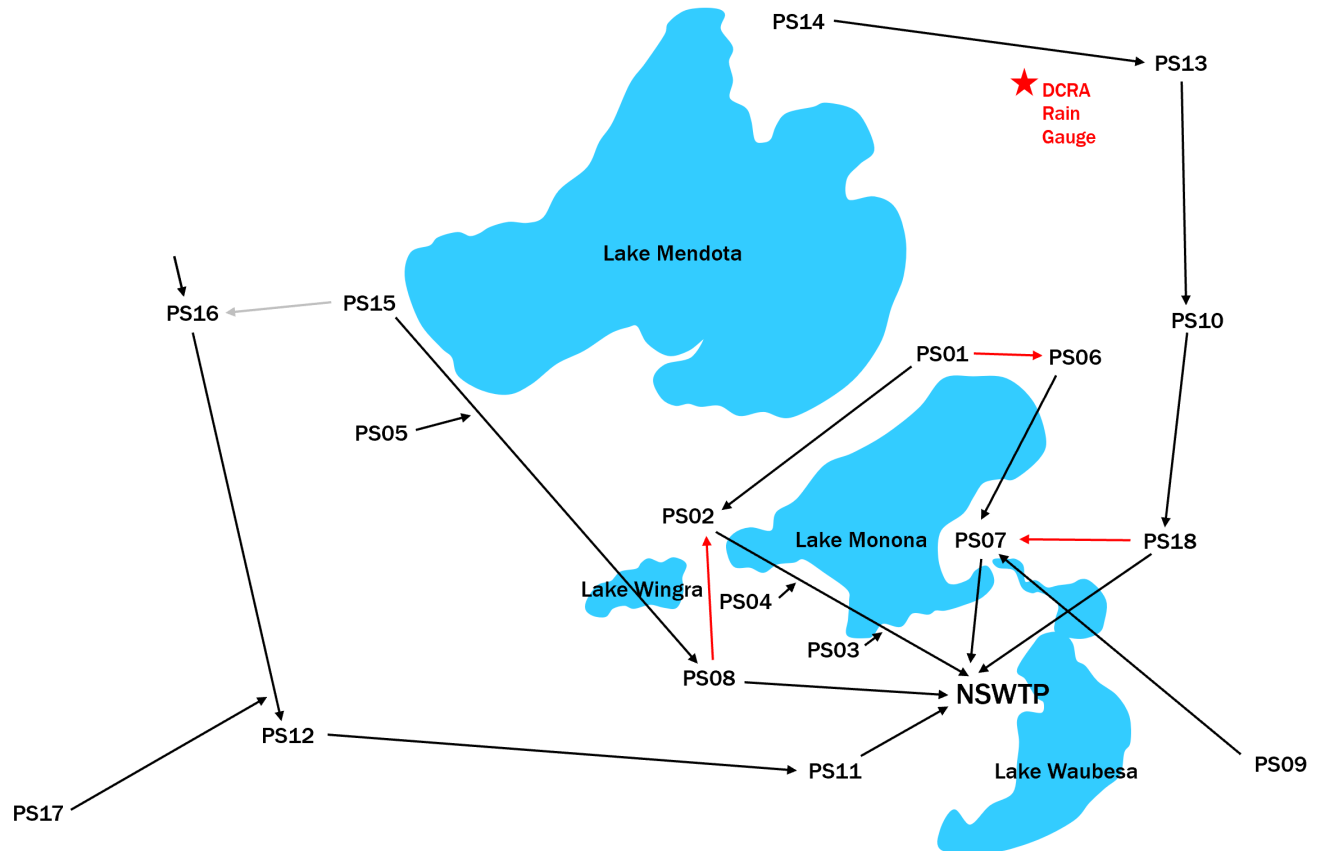


Figure 4. System schematic with monitoring locations

The peak hour wet weather flow and average hourly dry weather flow values for the October 2019 wet weather event are listed in Table 1. The dry weather flows represent the average flow at each site during a 6-day period in May 2019 in which no rain was measured at the Dane County Regional Airport (DCRA) rain gauge. This dry weather period from May 10–16, 2019, was selected because all monitoring sites had consistent data at the same time.

Because the peak wet weather flows occurred at different times during the October 2019 event, the overall NSWWTP influent peak flow of 106 mgd is less than the sum of individual peak flows directly entering the NSWWTP.

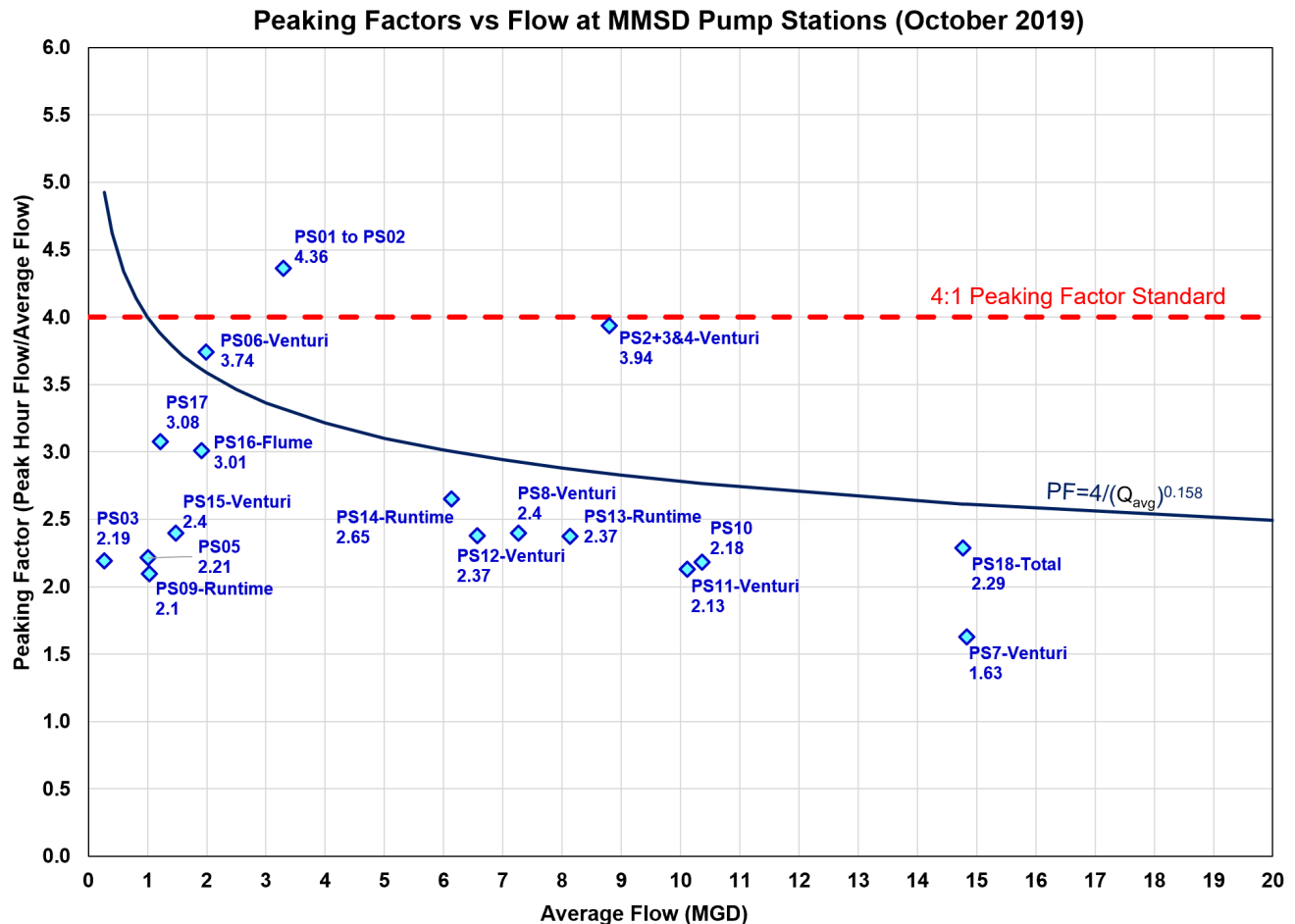
The third column in Table 1 lists the peaking factors, calculated by dividing the peak hour wet weather flow by the average dry weather flow. Larger peaking factors may correspond to a higher likelihood of I/I, but the size of the tributary area must be taken into consideration as smaller areas typically experience greater peaking factors than larger areas. Within the table, the pump stations are grouped and ordered from upstream to downstream.

Table 1. Peaking Factor Summary				
Site Name	Pump Station(s)	Average Hourly Dry Weather Flow (mgd) (May 2019)	Peak Hour Wet Weather Flow (mgd) (Oct 2019)	Peaking Factor (Oct 2019)
Northeast Side Group				
PS14_Flow	14	6.1	16.3	2.7
PS13_Flow	13	8.1	19.3	2.4
PS10_Flow	10	10.4	22.6	2.2
PS18-Total_Flow	18	14.8	33.8	2.3
East of Lake Monona Group				
PS6-Venturi_Flow	6	2.0	7.4	3.7
PS9_Flow	9	1.0	2.2	2.1
PS7-Venturi_Flow	7	14.8	24.2	1.6
Central Isthmus Group				
PS1 to PS2_Flow	1	3.3	14.4	4.4
PS3_Flow	3	0.3	0.6	2.2
PS2+3&4-Venturi_Flow	2, 3, 4	8.8	34.6	3.9
Near West Side Group				
PS15_Flow	15	1.5	3.5	2.4
PS5_Flow	5	1.0	2.2	2.2
PS8-Venturi_Flow	8	7.3	17.4	2.4
Far West Side Group				
PS16-Flume_Flow	16	1.9	5.8	3.0
PS17_Flow	17	1.2	3.7	3.1
PS12-Venturi_Flow	12	6.6	15.6	2.4
PS11-Venturi_Flow	11	10.1	21.5	2.1
NSWWTP		46.2	106.2	2.3

The peaking factors in Table 1 are plotted in Figure 5 versus average flows. On this figure is a reference curve for peaking factor based on the equation $PF=4/(Q_{avg})^{0.158}$ where PF is the peaking factor and Q_{avg} is the average dry weather flow. This is the District's Design Curve developed by Greeley and Hansen in 1961. A second reference line is the dotted red line that represents a PF of 4 to 1 that is referenced in Section 4.6.1 in the District's SUO as an excessive I/I standard. Using this constant peaking factor standard for all sites is one method for determining which peaking factors are high.

The equation peaking factor curve (navy blue) is the basis for sizing the capacity of District conveyance facilities. This curve creates a peaking factor reference line that varies depending on the size of the basin. Peaking factors that fall above this curve may be considered large and represent an amount of I/I in excess of what District facilities are sized to convey.

There are three data points in Figure 5 above the peaking factor curve. These include PS1 to PS2, PS2+3&4-Venturi, and PS6-Venturi. The flows during this event for PS01 to PS02 are also above the 4:1 Peaking Factor Standard curve. If the collected data in the District system demonstrate an exceedance of these flow standards, then there are certainly smaller areas tributary to these locations that exceed the standard as well.



1.2.3 Treatment Plant Capacity Conditions

Another consideration for I/I generated in the service area is the impact these flows can have on the downstream wastewater treatment plant. Figure 6 is a schematic of the Nine Springs Wastewater Treatment Plant (NSWWTP), operated by the District. Each of the unit processes at the NSWWTP has a capacity limit, and these values have been documented in several previous studies.

The effluent pumping capacity is the limiting value for the NSWWTP flow, and storage is needed when the influent flow exceeds the effluent pumping capacity of the NSWWTP. Effluent can be pumped to both Badfish Creek and Badger Mill Creek, but during large events the pumps to

Badger Mill Creek are often turned off when the total flow in the creek is greater than 1,000 cubic feet per second (cfs). In general, it is prudent to assume the pumps are only discharging to Badfish Creek at a rate of 75.5 mgd due to pressure limitations in the effluent piping system and accounting for recycle flows. Flow in excess of this limit is diverted and stored in the on-site storage tanks or the lagoon. At some point after a wet weather event is over, the stored flows are diverted to the secondary treatment system before effluent disposal. The average dry weather flow at NSWWTP is approximately 39 mgd. Deducting this flow from the effluent capacity results in a daily capacity of 36.5 million gallons for wet weather flow.

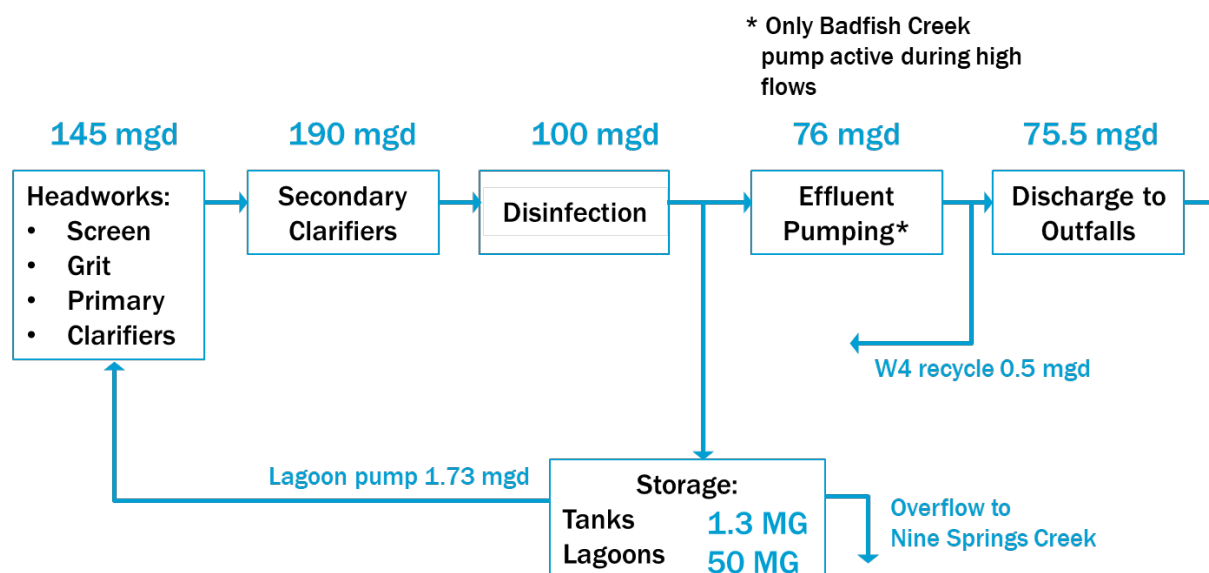


Figure 6. NSWWTP process schematic and capacity limits

Peak flows in the plant were reported to exceed the effluent pumping capacity 19 times in the 23-year period from 1993 to 2015, which is a diversion frequency of nearly 1 event per year. The largest reported diversion was 83 MG in the 6/8/2008 event. This is greater than the maximum volume of the lagoon, so this event caused an overflow to the Nine Springs Creek.

Table 2 is a summary of the maximum daily volume in wet weather compared to the average dry weather daily volume during the October 2019 event. This volume ratio can be used to identify pump station areas that have I/I characteristics with larger volumes. The Isthmus area served by pump stations 1, 2, 3, and 4 have the greatest I/I volumes; the ratios are in the range of 2.5 to 2.9. Any areas generating more than 1.9 times dry weather during a wet day represent a risk to the NSWWTP.

The results in Table 2 are plotted in Figure 7, showing the maximum day volume ratio versus the average dry weather daily flow volume. For reference, this figure also has the peaking derived from dividing the effluent pumping system limit by the daily average plant flow. If all areas tributary to the NSWWTP contributed flows in excess of this standard, plant capacity would be exceeded and treated effluent would need to be stored until influent flows receded, at which point this volume could be pumped back to the headworks for treatment.

Table 2. Maximum Daily Volume Summary				
Site Name	Pump Station(s)	Average Dry Weather Daily Volume (MG) (May 2019)	Max Wet Weather Daily Volume (MG) (Oct 2019)	Max Wet/Average Dry Volume Ratio (Oct 2019)
Northeast Side Group				
PS14_Flow	14	6.1	10.9	1.8
PS13_Flow	13	8.1	14.2	1.8
PS10_Flow	10	10.4	18	1.7
PS18-Total_Flow	18	14.8	27	1.8
East of Lake Monona Group				
PS6-Venturi_Flow	6	2	3.8	1.9
PS9_Flow	9	1	1.6	1.6
PS7-Venturi_Flow	7	14.8	20.2	1.4
Central Isthmus Group				
PS1 to PS2_Flow	1	3.3	9.7	2.9
PS3_Flow	3	0.3	0.4	1.3
PS2+3&4-Venturi_Flow	2, 3, 4	8.8	21.6	2.5
Near West Side Group				
PS15_Flow	15	1.5	2.4	1.6
PS5_Flow	5	1	1.6	1.6
PS8-Venturi_Flow	8	7.3	13.6	1.9
Far West Side Group				
PS16-Flume_Flow	16	1.9	2.7	1.4
PS17_Flow	17	1.2	2.5	2.1
PS12-Venturi_Flow	12	6.6	10.5	1.6
PS11-Venturi_Flow	11	10.1	17.1	1.7
NSWWTP		46.2	86.6	1.9

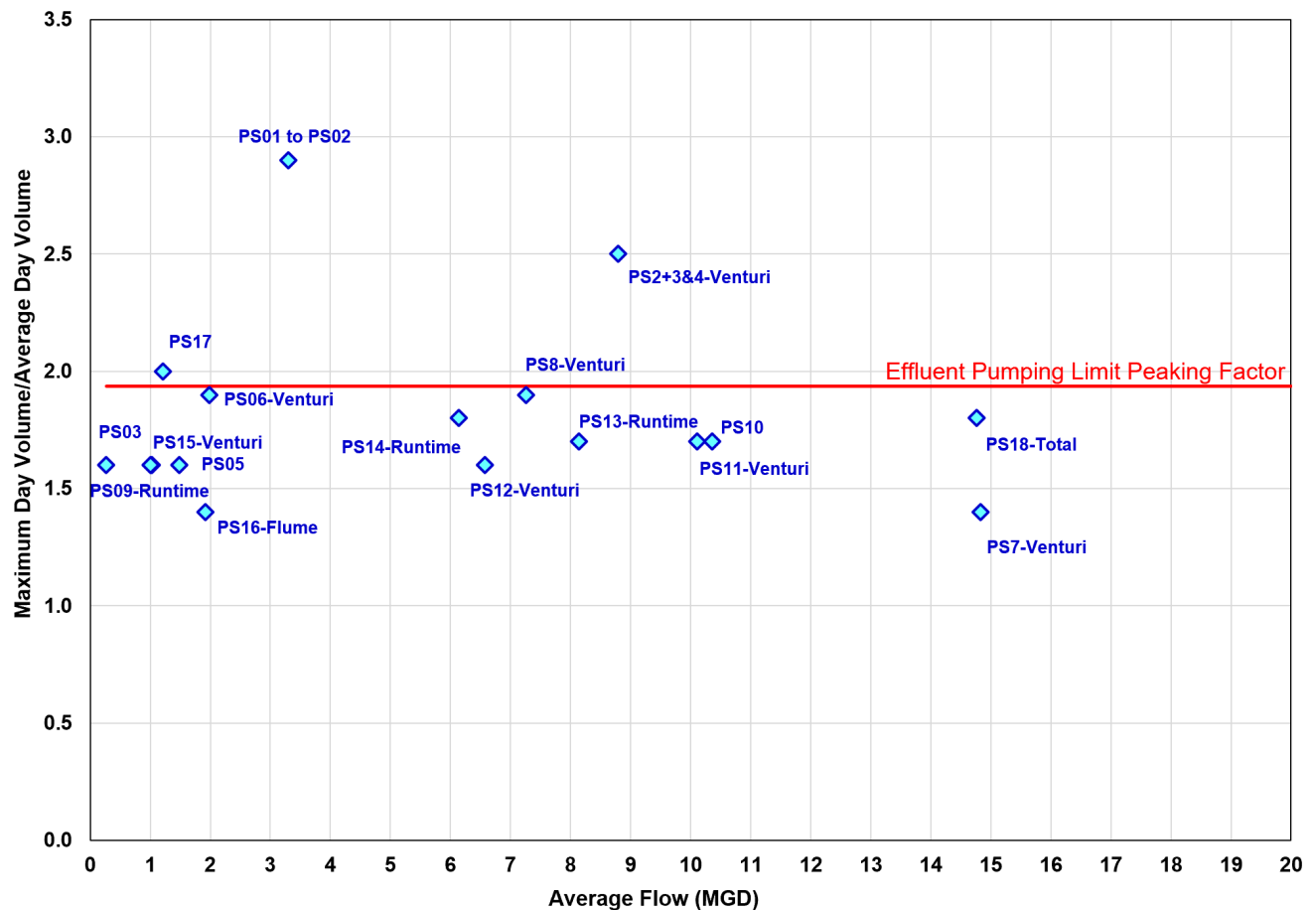


Figure 7. Maximum day volume ratio

1.3 Future I/I Concerns

Additional concerns related to future conditions provide further justification for establishing an I/I Reduction Program based on an excess I/I standard. These concerns include expansion of the service area, degradation of the sewer system in general, the lack of attention to and aging of private sewer laterals, potential climate change impacts, and energy/sustainability concerns associated with conveying and treating excess water.

In an analysis in support of the 2016 Liquid Processing Improvements Facilities Plan, future flows were estimated to increase 29 percent by 2040, as a result of a 29 percent increase in service area population projected to occur from 2015 to 2040. Under these conditions, the analysis determined that the effluent pumping capacity would be exceeded more than once per year, an event that requires the District to store treated effluent in the storage lagoons. Currently, this does not happen every year. As the frequency of effluent storage events increases, so does the risk of using all of the storage in larger events or extended periods of wet weather. When storage is full, the District is forced to discharge to the Yahara River, a practice that is not allowed by permit except in emergencies. The plan analysis indicated that the likelihood of exceeding the storage volume would increase by three times without I/I management or increasing the capacity of the effluent pumping system. The Liquid Facilities Plan estimated the 2015 cost of expanding the effluent pumping system for future flows to be \$75 million for an additional 100 mgd.

The 2016 Liquid Facilities Plan analysis cited above does not account for I/I increases due to system degradation that could occur without a Regional I/I Reduction Program. It is difficult to predict how much or how soon I/I increases from sewer degradation could occur. Without such a program, the dependency on effluent storage and the risk of exhausting that storage would certainly increase.

One important factor involved in system degradation-related I/I increases is the condition of private sewer laterals. Currently, there is no regional standard for these pipes, and property owners typically only fix them when experiencing a service disruption, such as tree roots or a collapse. Rarely, if ever, will a private sewer lateral owner fix a lateral to address infiltration issues that would matter to the downstream public sewer system owners. One estimate can be made for the magnitude of this problem by considering the age of housing in Dane County, according to Capital Area Regional Planning Commission (CARPC). While the District does not serve all of Dane County, if one assumes that the housing stock age for the county is comparable to that of laterals in the District, the ageing of housing stock, and therefore laterals, can be estimated. Figure 8 shows how housing stock and lateral age will change over time. Using 70 years as an indicator of laterals at an age of concern, by Year 2050 over 50 percent of the laterals will be at that state. Industry guidance varies regarding the useful life of a sewer pipe, but it is not uncommon to assume 75 years for purposes of planning replacements of such infrastructure.

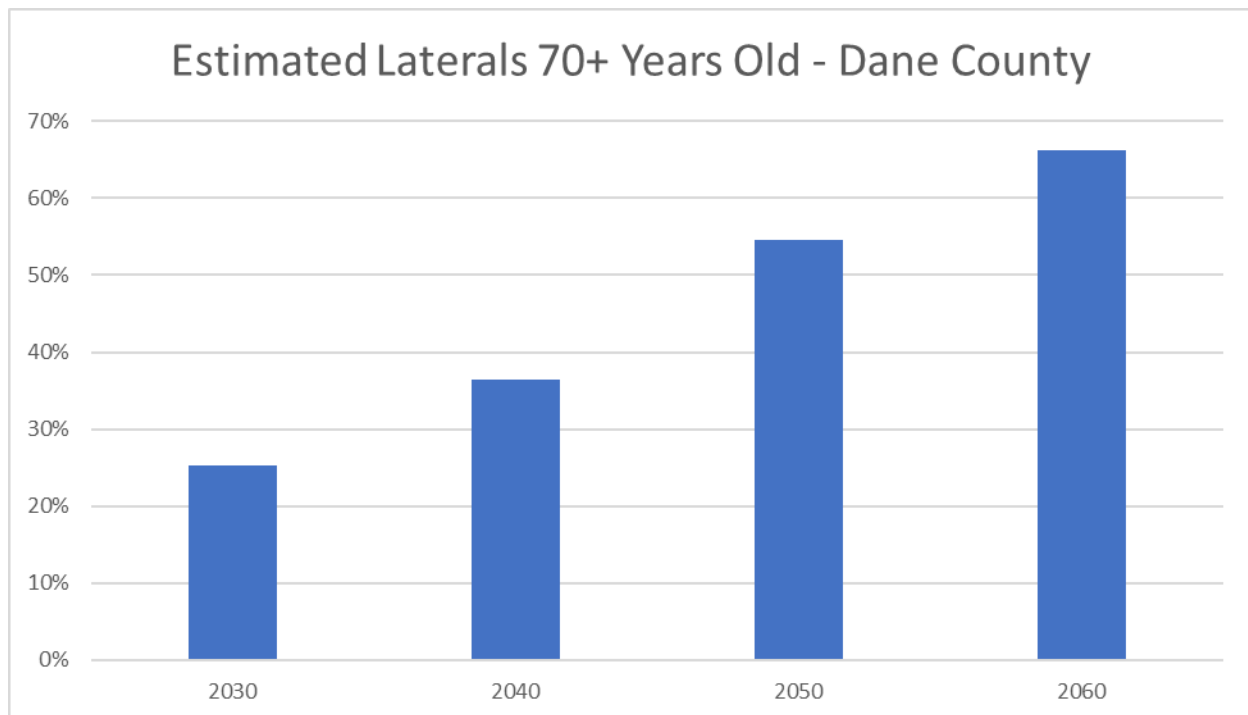


Figure 8. Forecasted lateral age in Dane County based on year of development

Climate change is of growing concern to the District and its service area customers. While there are no specific standard approaches for factoring such risks into this program, having a Regional I/I Reduction Program would help mitigate risks against potential impacts such as larger, more frequent, or more intense rainfall events.

For many years, the District has had considered and implemented strategies for improving and reducing energy use. Wastewater and I/I sent to the District system can be pumped as many as 5 times in order to get to NSWWTP. This situation comes with obvious extra cost and energy usage.

While energy reduction is not directly considered in this Regional I/I Reduction Program, any I/I reduction that is achieved will translate into less energy usage and cost savings.

A final future consideration for the I/I Reduction Program pertains to sustainability. When any treated flows are stored in lagoons, they must be pumped back to the front of NSWWTP after a wet weather event to be re-treated by the plant. While this is preferable to an unpermitted emergency discharge, it would not be considered a sustainable practice since the same water is treated twice. As future flows increase, whether from additional wastewater or I/I, this practice would be required more frequently and for larger volumes of flow. Relying on this practice would be in conflict with one aspect of the District's Vision statement:

"By making small changes and respecting every drop of water we have today, we can set the tone for a resource conscious and sustainable community tomorrow."

District's 2019 Annual Report

1.4 Recommended Metrics for the I/I Reduction Program

The I/I assessment performed in support of developing the I/I Reduction Program focused on two approaches. First, the relationship between peak flow and average dry weather flow observed at each flow monitoring site was evaluated; results are given for the total flow (not the incremental flow). The ratio of peak flow to average flow is known as the peaking factor and is the recommended metric for this review. Second, the volume of wet weather flow during a specified event as compared to dry weather flow at each monitored location was determined and compared. This volume evaluation looked at independently monitored locations and the cumulative volume in the system at the NSWWTP.

Both methods have merit for supporting a Regional I/I Reduction Program. Peak flow is directly referenced in the District's sewer use ordinance, and it has been used for sizing District conveyance facilities for many years. Event volume, and more specifically, daily volume, is better linked to the most pressing concern to the District's system operations at NSWWTP, and it is a more reliable method for estimating contributions from different portions of the service area. As exceedances of both metrics occur at District facilities, there will be areas tributary to the District system that also exceed these metrics. A regional I/I program that imposes peak flow and volume limits on tributary areas would certainly reduce risks that District facilities would have insufficient capacities to convey, treat, and dispose of wet weather flows in the future.

Section 2

I/I Program Description

Section 1 establishes the need for a Regional I/I Reduction Program and recommends objective metrics for achieving desired outcomes. Section 2 details the Regional I/I Program description, including the establishment of excessive I/I standards, requirements for Customer Community Work Plans, the role of the District in approving and overseeing Work Plans, and processes for determining whether implementation of a Work Plan has achieved compliance with the established standards.

2.1 I/I Program Development Process

The Regional I/I Reduction Program described in Section 2 was the result of extensive review of other programs across the United States, focusing heavily on those lessons learned, and regular dialog with an Advisory Committee (AC) made up of representatives from the following Community Customers:

- Mark Moder, City of Madison
- Theran Jacobson, City of Verona
- Robert Anderson, Town of Westport
- Jim Hessling, City of McFarland
- Davis Clark, Town of Windsor
- Ben Kollenbroich, Town of Dunn

The AC met regularly throughout 2020, using both in-person and virtual meeting formats, on the following dates:

- January 22, 2020 (in-person)
- May 27, 2020 (virtual)
- July 22, 2020 (virtual)
- September 23, 2020 (virtual)
- December 9, 2020 (virtual)

The conclusion of this process was the following tenets for formulating the I/I Program:

- The purpose for the I/I program is for:
 - Addressing wet weather flow and impact to District facilities
 - Complying with WDNR Capacity, Management, Operation, and Maintenance (CMOM) program requirements
 - Mitigating deterioration due to aging of neglected private infrastructure
- The District's I/I program should:
 - Require participation in 5 to 10 years
 - Include baseline requirements, but with flexibility for implementation
 - Not have the District be the “big banker”
 - Allow administration of private property work at the local customer community level

2.2 Sewer Use Ordinance Considerations

Most, if not all, communities have ordinances that prohibit clear water from entering the sanitary sewer system. Wisconsin state statute NR210.23 CMOM Programs details the required components for a CMOM Program, including paragraph 210.23(4)(c) Legal authority which states:

Legal authority. Legally binding authorities, such as sewer use ordinances and service agreements, shall ensure the following:

1. Infiltration and inflow sources, including infiltration and inflow into building sewers, private interceptor sewers, or other such sources on private property, are subject to oversight and control, as necessary...

4. If applicable, sewage flows from municipal satellite or other privately owned sewage collection systems are, as necessary, monitored, and controlled. Notwithstanding all other provisions of this chapter, any publicly owned treatment works may establish specific requirements to regulate sewage flows from satellite sewage collection systems.

State statute NR162.08(4) includes similar sewer use ordinance requirements related to I/I for municipal sewer systems that receive loans for the construction of sewage works. The District's July 27, 2017 *Sewer Use Ordinance* includes the following with regards to I/I:

Section 4.6. Maintenance of Community Sewers.

4.6.1. CMOM and Infiltration/Inflow Requirements.

(b) All Community Customers are required to control excessive infiltration and inflow (I/I). Excess inflow and infiltration is defined as any sewer having an hourly wet weather flow peak greater than four (4) times the average daily dry weather flow or hourly peaks greater than four (4) times the typical daily wastewater-only flow anticipated for the served area based on water meter records. The District may also identify excess inflow and/or infiltration as determined by a professional engineer during the conduct of an I/I study. Any Community Customer having excessive infiltration and inflow will be required to submit a corrective action plan to the District that identifies steps that they will take to timely reduce I/I to acceptable levels.

The District's current ordinance defines excessive I/I as an hourly wet weather flow peak that is greater than four times the average daily dry weather flow (ADDWF).

2.3 Excessive I/I Standards

Section 1 described the current state of I/I in the District service area and recommended standards for excessive I/I from two perspectives: peak flow and wet weather volume. The limitation for peak flow is supported by SUO language. The limitation for wet weather volume is not expressly referred to in the SUO but can be supported by the impact that extended wet weather flows can have on the NSWWTP. The established standards will apply at discretely monitored locations, and assessment of compliance with the standards will be based on the collected monitoring data.

Peak I/I Flow Standard The recommended peak I/I flow standard is taken directly from the SUO and the historical Design Curve used by the District. As noted above, the SUO states excess I/I causes peak flows to exceed four times the ADDWF. The Design Curve used by the District results in a lower peaking factor when the ADDWF is greater than 1.0 mgd or 694 gallons per minute (gpm) and a higher peaking factor when ADDWF exceeds these values. For the I/I Program, the Design Curve would set the peaking factor limit for ADDWFs above 1 mgd, and the SUO limit of 4 would apply when

dry weather flows are below 1 mgd. Figure 9 illustrates the concept for the Peak Flow Standard. This standard would apply to any discretely defined tributary area to the District system that could be directly monitored.

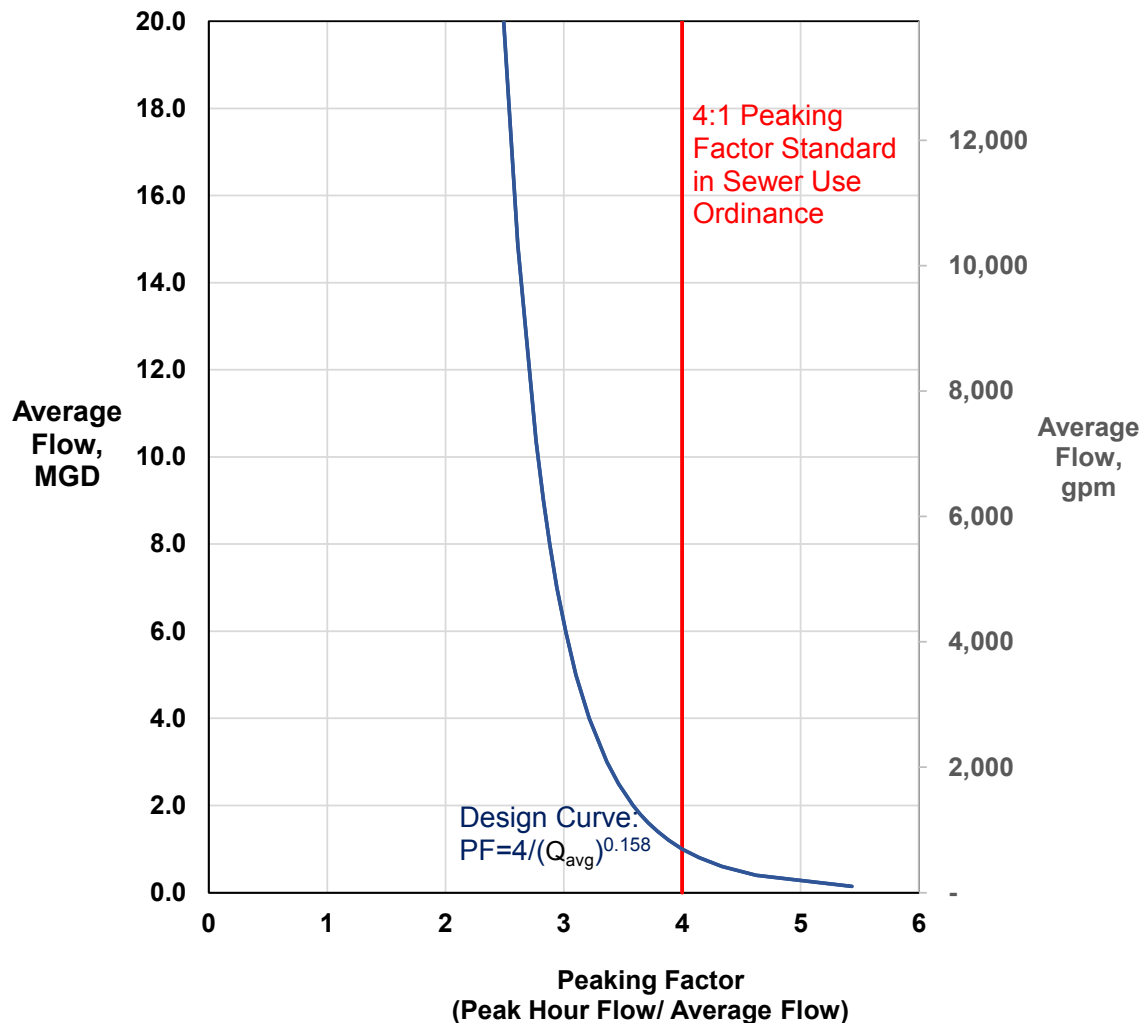
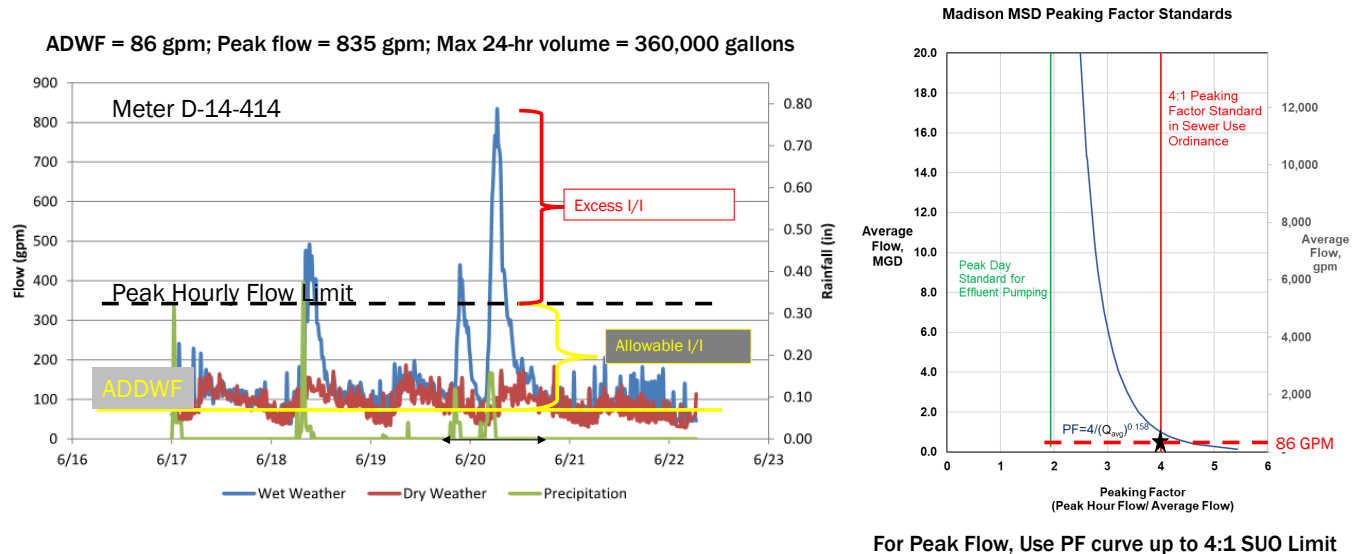


Figure 9. Peak Flow Standard for I/I Program

An example is provided from a prior District I/I study performed in 2015 for the PS14 service area. For the event shown in Figure 10, the ADDWF at meter 14-414 was determined to be approximately 86 gpm, or 0.124 mgd. Because ADDWF is less than 1 mgd, the design curve peaking factor does not apply, and the limit is 4.0 according to the SUO. This sets the peak hour flow limit to 4 times 86 gpm or 344 gpm. The actual peak hourly flow during this event was 835 gpm, meaning this area generated 491 gpm of excess I/I flow.

Daily I/I Volume Standard. An additional standard for maximum 24-hour I/I volume is also established in support of this program. The limit is derived from the difference in capability of the plant to treat influent wastewater and the capacity to discharge that flow back to the environment through permitted discharge points. As explained in Section 1.2.3, any daily flow volumes that exceed 1.9 times ADDWF would require effluent storage and are of concern. This standard is not currently expressly written into the District's SUO.

Using the same example flow meter 14-414 and flow event of interest, the daily maximum volume limit for this area is 1.9 times 124,000 gallons, or 235,000 gallons. As illustrated in Figure 10, this tributary area generated a maximum 24-hour volume of 360,000 gallons, meaning an excess I/I volume of approximately 125,000 gallons.



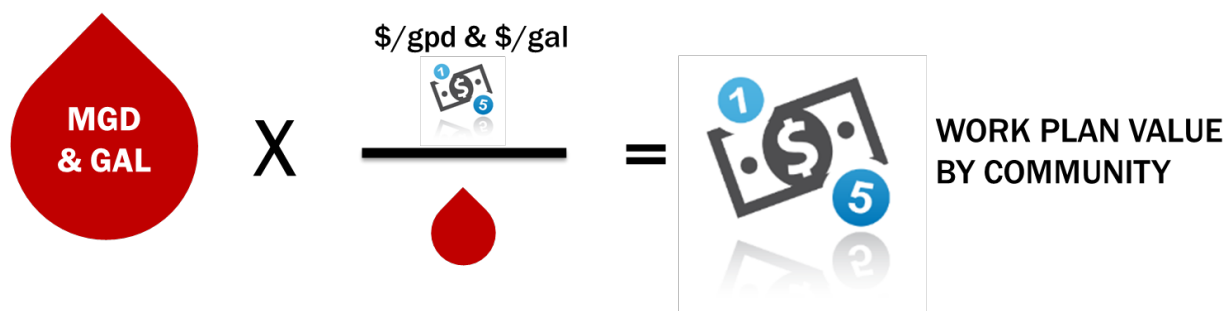
To determine compliance with the Excessive I/I Standards, the District will deploy flow meters to monitor specific tributary areas. Flow meters will be installed by March 1, and monitoring will continue for a period of 6 months, through August. Section 6 provides further details of the Flow Monitoring and Analysis activities required to support the program.

2.4 Customer Community Work Plans

Activity to reduce I/I reduction under this program would be driven through Work Plans implemented by the Community Customers. Any Customer Community with a tributary area found to have I/I that exceeds either the peak flow or daily volume standard would be required to develop an I/I Reduction Work Plan, and submit it to the District for review and approval. This section describes the construct for these Work Plans.

Work Plan Value

All Work Plans will need to consist of a minimum dollar value commitment by the Customer Community, referred to as the "Work Plan Value." The minimum amount will be based on the amount of excessive I/I peak flow and volume determined for the tributary area. After determining that excess amount, the following formula will be used to derive the Work Plan Value:



Using the example from Figure 10, the Work Plan would be calculated as follows:

Excess Peak Flow Component

86 gpm Avg Flow -> PF = 4.0;
 Peak Flow Limit = 86 gpm x 4.0 = 344 gpm
 Excess peak flow = 835 gpm - 344 gpm =
491 gpm or 707,000 gallons per day (gpd)
\$1/gpd x 707,000 gpd = \$707,000 for peak flow

Excess Daily Volume Component

86 gpm Avg Flow -> PF = 1.9;
 Daily Volume Limit = 86 gpm x 1.9 -> 0.236 Mgal
 Excess daily volume = 0.360 Mgal - 0.236 Mgal =
124,704 gallons
\$1/gal x 124,704 gallons = \$124,704 for volume

Total Work Plan Value: \$707,040 + \$124,704 = \$831,744

The basis for establishing \$1 per gallon per day (gpd) comes from extensive evaluations of I/I reduction projects performed across the United States by Brown and Caldwell, according to an analysis standard published by the Water Environment Research Foundation in 2004. As illustrated in Figure 11, the results of these analyses indicate that \$1 per gpd of peak flow has regularly been achieved and would serve as a realistic starting point for budgeting I/I reduction activities for areas targeted with this approach.

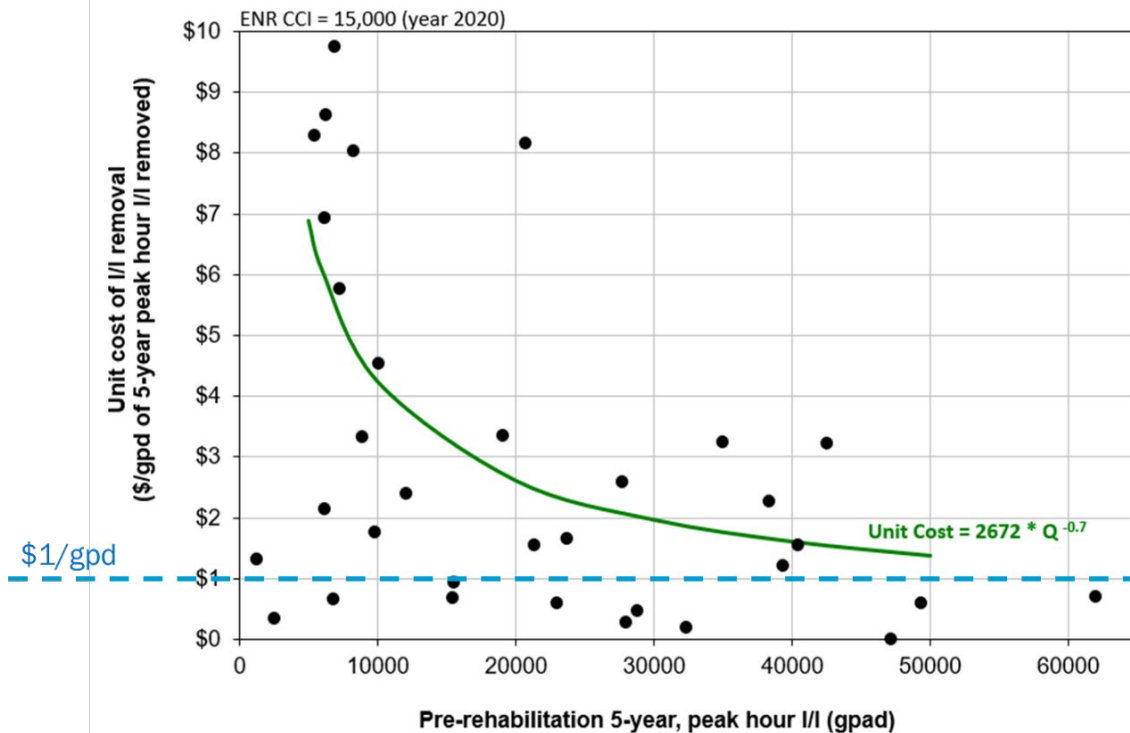


Figure 11. I/I Reduction unit costs achieved on previous projects

The basis for the \$1 per gallon of excessive I/I volume is derived from the estimated cost for expanding effluent pumping at NSWWTP. The 2016 Liquid Facilities Plan estimate of \$75 million for 100 mgd of capacity translates to \$0.75/gallon for a full day of flow. By inflating those costs to 2036, a point 15 years into the I/I Reduction Program, this cost basis would scale to approximately \$1 per gallon (20 years at 1.5 percent annual inflation).

Eligible Activities and Limits Toward Plan Value

Only certain activities would count toward the prescribed minimum Work Plan Value. As the District is interested in having the bulk of the value applied toward I/I reduction activities, the following criteria would be established:

- Maximum of 25 percent toward I/I investigations and other non-construction related costs, including flow monitoring upstream in the non-compliant tributary basin
- If the peak flows and event volumes are found to exceed the standard in more than 3 events during the monitoring period, only 10 percent can be applied toward I/I investigations and non-construction related costs

Plan Components

The District intends to provide latitude and flexibility to the Community Customers in developing Work Plans in support of the I/I Reduction Program. A minimum amount of information will be required for defining the activities expected to bring a tributary area into compliance with the I/I standard.

1. Overview of Tributary Area
2. Previous Efforts to Investigate and Address I/I Sources in Tributary Area
3. Scope of Proposed Work Plan
4. Budgetary Elements of Proposed Work Plan, including Statement of Financial Commitment

5. Schedule of Work and Expenditures for Proposed Work Plan

During 2021, the District will develop further guidance and templates in support of Work Plan development by Community Customers.

Duration of Plans

Each Work Plan is to be designed for a maximum 5 years of implementation.

2.5 District Approval and Oversight of Work Plans

The process for requiring and implementing a Work Plan under this program will follow these specific steps, as illustrated in Figure 12:

1. District identifies a tributary area for flow monitoring
2. District deploys flow monitors for 6 months by March 1
3. District collects and analyzes dry weather and wet weather data
4. District determines compliance status of the tributary area
5. District informs Customer Community of compliance status and requirements for a Work Plan
6. Customer Community develops Work Plan and submits for District review and approval
7. District approves Work Plan, or works with Customer Community to revise and reissue
8. Customer Community implements Work Plan and provides annual updates to the District
9. Upon completion of Work Plan, District monitors tributary area for compliance with Excessive I/I Standard

Prior to program initiation, the District will develop a Flow Monitoring Plan describing the methodology for prioritizing when and where flow monitoring will be performed in support of the program. Section 6 provides further details on the proposed approach for developing this plan.

Submittal Process

Upon receiving notification from the District that a monitored tributary area was determined to be non-compliant with excessive I/I standards, the Customer Community will be required to develop and submit a Work Plan for achieving compliance. The community will have 120 days to develop and submit a Work Plan that is consistent with guidelines developed by the District.

Review and Approval Process

The District will review any proposed Work Plans for consistency with District published guidelines. These Work Plan Guidelines will be developed in 2021. The District will provide feedback or approval on any submitted Work Plan within 90 days of submittal.

Oversight Process

The District will require annual progress updates on approved Work Plans, including expenditures on eligible activities compared to the schedule in the approved Work Plan.

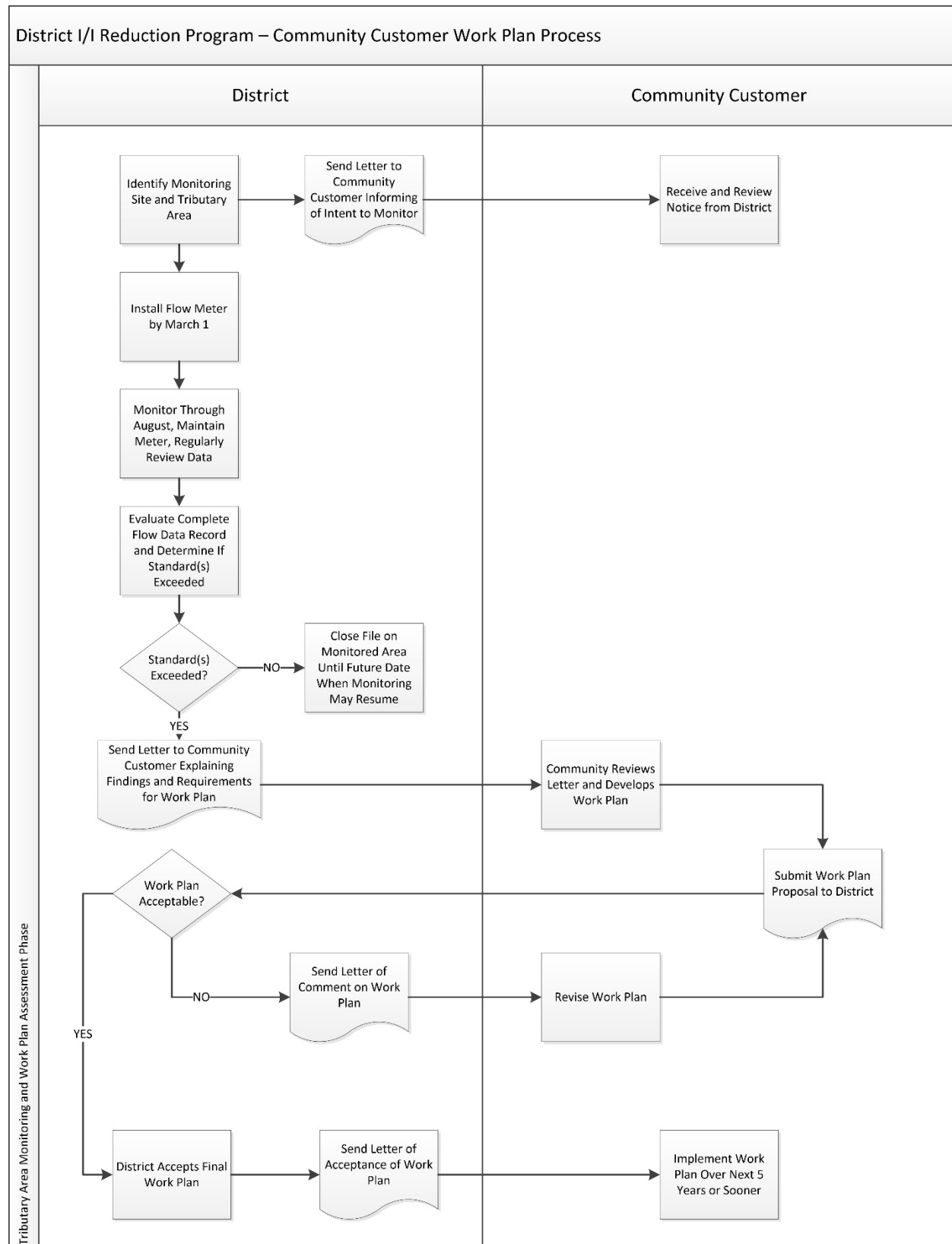


Figure 12. Work Plan development and approval process

2.6 Flow Assessments After Completion of Work Plans

At the conclusion of the Work Plan, the tributary area will be monitored to determine compliance status. The Customer Community can request that compliance monitoring commence earlier than the originally proposed Work Plan schedule if it believes and can provide support for the belief that significant I/I sources have been developed to the point of achieving compliance. The flow monitoring and analysis after Work Plan completion will be the same as that done to determine compliance prior to the Work Plan. Section 6 details the proposed approach for monitoring and analysis efforts to support the I/I Reduction Program.

Section 3

Incorporation Into District CMOM

The overall intention of a Capacity, Management, Operations and Management (CMOM) program is to define the operation and maintenance requirements for an organization's sewer collection system. The District's CMOM Plan was prepared to comply with the rule known as the "Sanitary Sewer Overflow (SSO) rule" which was adopted in the Wisconsin Administrative Code under Order WT-23-11 and is in the Register July 2013 No. 691 Code. The District's CMOM Plan was last revised on August 14, 2018, and is intended to be regularly updated as the goals and organization of the District change. With the adoption of the Regional I/I Reduction Program, the District's CMOM Plan will need to be updated. This section provides a summary of the most likely updates that could be made to reflect the purposes, goals, and structure of the I/I Reduction Program.

3.1 Chapter 2 – Management Plan

Chapter 2 of the CMOM Plan describes the Management Plan for oversight of the sewer collection system. Topics of this chapter include major elements needed to implement CMOM. Those elements that are most likely to be affected by adoption of the I/I Reduction Program include Goals, the Organizational Structure, Finances, Data Management and Documentation, Customer Service, Legal, Private Property Programs, and Performance Metrics. Suggested changes to these elements, if any, are described in this section.

Section 2.3 – Goals

The following CMOM Goals provide support for adoption of the Regional I/I Reduction Program.

- Goal 3: "Comply with regulatory requirements... including the 2013 Wisconsin 'SSO Rule'"
- Goal 4: "Take all feasible steps to cease sanitary sewer overflows"
- Goal 8: "Reduce the potential threat to human health from sewer overflows"
- Goal 9: "Provide adequate capacity to convey peak flows"
- Goal 10: "Take all feasible steps to eliminate excess infiltration and inflow"
- Goal 13: "Assist satellite communities"

Section 2.4 - Organizational Structure

The purpose for the CMOM Management Plan to define the Organizational Structure is to clearly state what positions and individuals are responsible for ensuring CMOM activities are documented and followed by the organization. With the Regional I/I Reduction Program being adopted, the responsible position and individual responsible for program should be identified in this section.

Section 2.6 – Financial

The financial element of the CMOM Management Plan documents the specific budget items, whether from Capital or Operating funds, that are related to the collection system. It is recommended that this list also include funding activities in support of the Regional I/I Reduction Program.

Section 2.8 – Data Management and Documentation

The Regional I/I Reduction Program will generate a significant amount of additional flow monitoring data. These data in particular will require diligent review and storage to support the enforcement of the program. This section of the CMOM Management Plan should be updated to reflect the specific needs of the I/I Program once these are better defined by 2021 activities.

Section 2.9 – Customer Service

The District should update this section to reflect the adoption of the Regional I/I Reduction Program since it reflects a significant additional point of interface between the District and its Community Customers.

Section 2.10 – Legal

Adoption of the Regional I/I Reduction Program will prompt several updates to the 2.10 Legal section. Specifically, Program adoption will necessitate eventual changes to the District's Sewer Use Ordinance, discussed in Section 2.10.1. of the CMOM Program Management Plan, and the numerous points of interaction between the District and Community Customers should be reflected in updates to Section 2.10.3 Satellite Communities.

Section 2.14 – Private Property Programs

The Regional I/I Reduction Program does not specifically target Private Property I/I (PPII), but it will focus attention on areas where concerted PPII efforts may be necessary to achieve compliance with excessive I/I standards. As part of implementing the I/I Reduction Program, the District will partner with Community Customers in identifying technical support the District could provide to help with locally-driven PPII reduction efforts. Technical support could include drafting model PPII Program policy documents, standards for PPII investigations, and materials to support public education on PPII. This activity should be referenced in Section 2.14 of the CMOM Management Plan.

Section 2.15 – Performance Metrics

The Regional I/I Reduction Program will be driven by compliance status of monitored tributary area compared to the established excessive I/I standards. These standards effectively establish a new set of performance measures for municipal flows discharging to District system. Additional performance metrics for the program can include District activities related to oversight of the program including

- Number of monitoring sites implemented in a year
- Amount of time needed to review monitoring data and determine compliance status
- Percent of Work Plans reviewed within 90 days of receipt

3.2 Chapter 3 – Operation and Maintenance Plan

Section 3.18 – Flow Monitoring should be expanded to discuss the flow monitoring that will be done in support of the Regional I/I Reduction Program.

3.3 Chapter 4 – Asset Management Plan

The Asset Management Plan chapter in the District's CMOM document details activities related to Condition Assessment, Condition Assessment Recommendations, and Rehabilitation and Replacement performed by the District to ensure cost-effective operation and maintenance of District assets. The chapter notes that I/I reduction is a key consideration for management of District conveyance assets with respect to satisfying levels of service established for them. This chapter should be updated to reference the Regional I/I Reduction Program as a tool in protecting the established levels of service for conveyance capacity.

3.4 Chapter 5 – Capacity Plan

The Capacity Plan chapter of the CMOM Program document describes the District's practices that ensure sufficient capacity is provided to safely manage and convey both dry and wet weather flows. Numerous sections of this chapter should be modified to reflect the adoption of the Regional I/I Reduction program, including:

- **Section 5.2 Capacity** - references District activities to inspect for and address I/I
- **Section 5.3 Field Investigations** - includes flow monitoring among the list of activities
- **Section 5.4 Flow Modeling** – is an activity that relies upon flow monitoring data for accuracy
- **Section 5.5 Flow Monitoring** – is an activity that will be utilized heavily in implementation of the Regional I/I Reduction Program
- **Section 5.6 I/I Reduction** – this section would need to be substantially updated to reflect the existence of the Regional I/I Reduction program.

3.5 Chapter 6 – Emergency Overflow Response Plan

The Emergency Overflow Response Plan (EORP) documented in Chapter 6 is concerned with District activities before, during, and after the release of untreated wastewater from the District system. One important activity performed after an SSO is known as a Root Cause Failure Analysis (RCFA). The District RCFA process described in CMOM Section 6.8 can be updated to note that data from I/I Program monitors may be useful in some circumstances to diagnose the reasons for the release.

3.6 Chapter 7 – Communication Plan

The purpose of the Communications Plan chapter of the CMOM document is to describe the activities the District uses to communicate to stakeholders regarding actions taken or to be taken on the collection system. Specific activities described in Chapter 7 that should be updated after Regional I/I Reduction Program adoption include:

- **Section 7.2 – Satellite Community (Customer) Communication** – should be updated to reflect the I/I Program's existence and the communication activities anticipated, including notification of tributary area non-compliance with excessive I/I standards
- **Section 7.3 – CMOM Communication** – should be updated to include the most current list of tributary areas under active Work Plans

Section 4

District Support for Municipal Programs

The District recognizes that Community Customers will need different levels of support and assistance when developing and implementing I/I reduction Work Plans that may be required under this Regional I/I Reduction Program. This section discusses specific activities that the District is considering in this regard. Many of these were identified and discussed during the Advisory Committee meetings held during the development of the I/I Program.

4.1 Technical Support

It is in the best interest of both the District and affected Community Customers to initiate and complete Work Plans that are developed with the best technical basis possible. Some communities may have limited experience with I/I investigation and reduction. Others may have experience, but lack capacity to satisfy the prescribed 5-year duration. The following technical support activities have been defined by the District as potentially being offered at some point after program adoption:

- Develop a library of I/I investigation and repair best practices
- Systemwide contracts for flow monitoring, field investigations, and engineering support
- Guidance documents for establishing local private property I/I reduction programs
- Legal, policy, and model ordinances for private property I/I reduction programs

4.2 Funding of Private Property Pilot Projects

At some point in the future, the District may be interested in funding pilot I/I reduction projects. There are restrictions in state statutes for the District funding projects for improving local sewer systems, but these restrictions do not extend to private property. Some communities may not be ready to implement PPII until local pilot work has proven this as a successful strategy for reducing overall I/I. The District has expressed an interest in performing such pilots in the future, depending on funding available and having a willing Customer Community partner to assist with implementation.

4.3 PPII Policy and Program Advising

It may be necessary for some work plans to rely heavily on PPII reduction in order to achieve compliance in tributary areas found to exceed excessive I/I standards. In such cases, the community may want to consider establishing a PPII program, based on an established PPII policy. The District may establish a regional contract to provide consulting services to the Communities for the purpose of developing such policies and programs. Any direct assistance provided through this District contract would need to be reimbursed by that Community.

4.4 Public and Customer Education

Public and Customer Community education will be needed for explaining the Regional I/I Reduction Program in general and how it will apply to specific customers. In addition, many customers will need to develop educational materials for their rate payers, including those in non-compliant tributary areas that may need investigation and rehabilitation work to come into compliance. The District is interested in developing content on I/I and the program for use on its own web pages, and for use by Community Customers. Additionally, the District may set up regional consulting contracts in the future for assisting communities with private property owner outreach in targeted tributary areas. Any direct assistance performed through District contract would be paid for by the assisted community.



Section 5

Changes to District Sewer Use Ordinance

Implementation of the recommended Regional I/I Reduction Program will require several changes to the District's existing SUO.

5.1 Excessive I/I Standards

Section 4.6.1 CMOM and Infiltration/Inflow Requirements paragraph (b) already references an excessive I/I standard:

4.6.1.(b)

All Community Customers are required to control excessive infiltration and inflow (I/I). Excess inflow and infiltration is defined as any sewer having an hourly wet weather flow peak greater than four (4) times the average daily dry weather flow or hourly peaks greater than four (4) times the typical daily wastewater-only flow anticipated for the served area based on water meter records. The District may also identify excess inflow and/or infiltration as determined by a professional engineer during the conduct of an I/I study. Any Community Customer having excessive infiltration and inflow will be required to submit a corrective action plan to the District that identifies steps that they will take to timely reduce I/I to acceptable levels.

(Revised July 27, 2017 and Effective August 18, 2017)

At a minimum, the District will want to make the following specific modifications to this section to establish the Regional I/I Reduction Program:

- Establish the Excessive Daily Volume Standard – the volume over a continuous 24-hour period that is more than 1.9 times the average daily dry weather volume over that same 24-hour period.
- Modify this paragraph to state that any Community Customer exceeding either standard will be required to develop, submit, and implement an I/I Reduction Work Plan consistent with the requirements of the Regional I/I Reduction Program.

5.2 Establish the Regional I/I Reduction Program

The District may wish to add a new paragraph 4.6.1.(c) that defines the Regional I/I Reduction Program, including the construct of a Work Plan, calculation of Work Plan values to apply to the excessive I/I flows and volumes, and reference to guidance to be published by the District concerning the administration of the program.

5.3 Additional Modifications in Support of the I/I Program

The District may wish to make additional specific changes in support of the long-term vision for the Program, such as a requiring Customer Communities to submit annual Compliance Maintenance Annual Report (CMAR) to the District.

Section 6

Flow Monitoring and Analysis Processes

A robust flow monitoring and analysis program will be required to support the Regional I/I Reduction Program. This section outlines the current concept for the District's approach to gathering and evaluating the data. Future efforts will further define these support efforts to meet the needs of the Program. A flowchart of expected activities is shown in Figure 13.

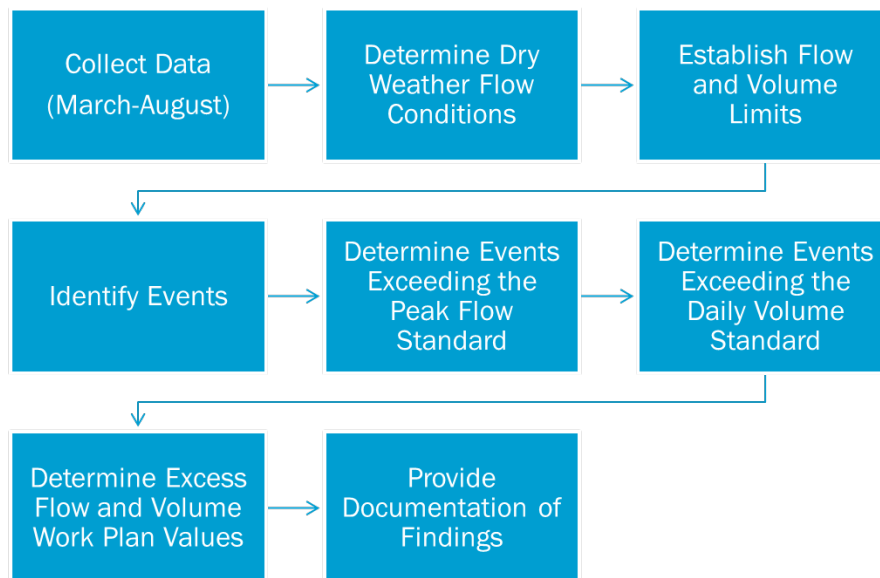


Figure 13. Flow data collection and analysis process for Regional I/I Reduction Program

6.1 Flow Monitoring

Flow monitoring will be performed on tributary areas with meters placed in Community Sewers in most cases. The District's SUO section 1.4.4 General Right to Entry allows the District access to local sewers for measurement.

Flow monitoring equipment will be temporarily installed, with most monitoring devices installed for 6 months, typically from March through August. This time frame of monitoring will normally provide the best chance of measuring a wide variety of I/I events, including spring events with saturated ground conditions and intense summer thunderstorms. Having a wide variety of events to evaluate will be important for assessing both the peak flow and volume characteristics of monitored tributary areas. The months of March through August were selected based on an analysis of rainfall event frequency each month from historical records at DCRA (1948 through 2013). Figure 14 shows the long-term average frequency of significant events (1 inch of daily rain or greater) for each month.

March is chosen instead of September in order to establish dry weather conditions before typical April rainstorms.

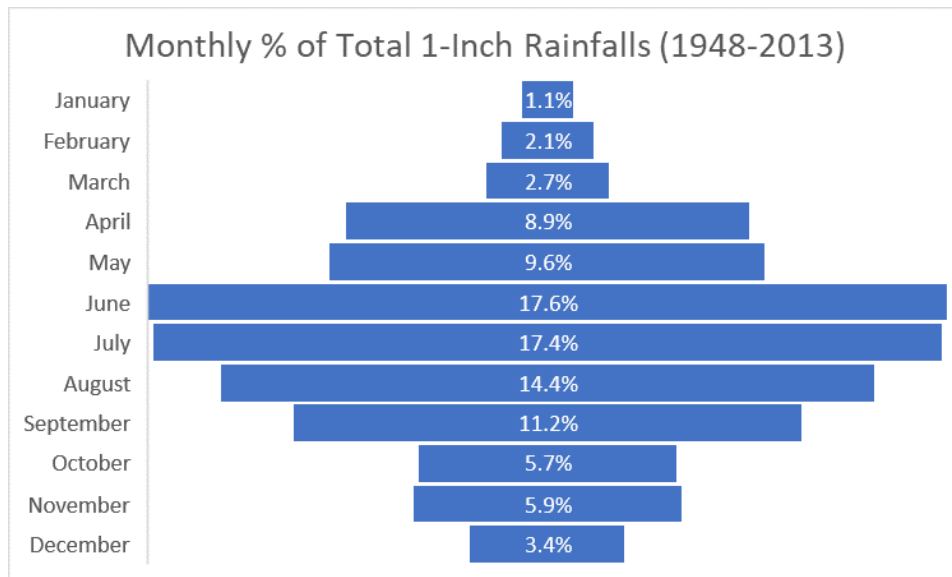


Figure 14. Percent of annual average 1-inch rainfall days each month at Dane County Airport

The number of sites the District will monitor each year is yet to be determined but will likely be on the order of 20. The District may consider out-sourcing the monitoring activities, including equipment installation and site maintenance. Outsourcing provides advantages of placing uptime and data quality requirements on the contractor, which should help improve the availability of timely and accurate data during important wet weather events. Alternatively, the District could perform some or all of the required monitoring with existing equipment and staff.

Flow monitoring sites will be prioritized, with the initial sites targeting areas suspected of exceeding the flow standards. In order to set these priorities, the District will improve the Collection System Model starting in 2021, so that dynamic flow responses during wet weather can be properly accounted for, making the inferring of where significant I/I enters the system more reliable. As flow data become available from the I/I Program, the Collection System Model can be further calibrated and improved as a system diagnostic tool.

In 2021, the District will develop a Flow Monitoring Plan in support of the Regional I/I Reduction Program. It will lay out the priorities for initial stages of monitoring and the approaches to be used for monitoring the first set of sites.

6.2 Flow Data Analysis

A standard process will be followed for analyzing the data in support of the Regional I/I Reduction Program. The major steps are detailed below:

Determine Dry Weather Flow Conditions: Dry weather flows will be captured within the monitoring period. If the analysis suggests that all dry weather during the monitoring period is significantly above or below average when compared to the nearest District pump station, the tributary area dry weather flows will be scaled accordingly in order to set a more accurate baseline for determining allowable peak flows and volumes.

Establish Flow and Volume Limits: After setting the tributary average dry weather flow, the peak flow limit will be determined by multiplying the allowable peak flow factor by the dry weather flow. The allowable peak flow factor will be the lower of 4 and the number derived from the District peaking factor curve equation. The 24-hour volume limit will be determined by multiplying the average dry weather flow by 1.9.

Identify Events: The monitoring data will be reviewed to identify potential wet weather events. The review will consider the monitoring data and the nearest rainfall data available.

Determine Events Exceeding the Peak Flow Standard: The measured data will be converted to hourly average flow for comparison to the Peak Flow Standard. The number of events with peak hourly flow exceeding the standard will be determined, as will the amount the Peak Flow Standard was exceeded in each event.

Determine Events Exceeding the Daily Volume Standard: The 24-hour running average flow time series will be calculated for each site. The maximum 24-hour running average value for each identified I/I event will be determined and compared to the standard. The volume exceeding the standard will be the difference between the event maximum 24-hour volume and the standard.

Determine Excess Flow and Volume Work Plan Values: Based on the largest exceedance of peak flow and volume during the monitored period, the total work plan value will be calculated. A rate of \$1 per gallon per day hourly flow exceeding the Peak Flow Standard and \$1 per gallon of 24-hour volume exceeding the volume standard will be used. The number of times either standard were exceeded will also be identified for purposes of determining how much work plan value may be satisfied with non-construction-related activities.

Provide Documentation of Findings: A brief written report will summarize the data collected and the findings of the analysis for use by the I/I Reduction Program Manager in communicating with the Community Customer.

Section 7

Program Implementation

Each of the major activities required for start-up and management of the Regional I/I Reduction Program is identified and described below. The total estimated or budgeted costs for either start-up or annual program costs associated with ongoing management activities are:

- Total for Start-up District Costs: \$550,000
- Total for Annual Program District \$500,000 by 2026

These costs are described below and summarized in Table 3. Figure 15 visually shows the schedule for these activities. This schedule is contingent upon Commission acceptance of this plan and subsequent authorization for the budgets identified.

Start-Up Costs

Fixed costs to start-up the program include the following.

Model Update (2021-2022) – The existing District collection system model requires updates to make it useful as a tool for defining the Regional I/I Reduction Program Flow Monitoring Plan. The updates will include adding dynamic I/I hydrology and calibrating the model to data collected at District pump stations. The model update will be complete before the end of 2022 for a budget of approximately \$100,000.

Flow Monitoring Plan (2022) – The Flow Monitoring Plan will define the process for selecting sites, equipment, data collection and management processes, and analysis procedures. The plan will also identify the first set of monitoring sites for the program, based on the collection system model updates. The budget for this plan is \$25,000, and the plan will be completed by the end of 2022.

Regional I/I Reduction Program Guidance (2021) – Guidance will be needed for helping Community Customers develop Work Plans and communicate with their own customers about the I/I program. Activities in 2021 will include preparing Work Plan Development Guidelines and a Template Work Plan, as well as collaborating with the I/I AC members during workshops every other month. Future guidance will be likely but has not been identified at this time. For 2021 activities, \$25,000 has been budgeted.

Capacity and Cost-Effectiveness Evaluation (2022-23) – The District would like to better understand the cost-effectiveness of this program, as compared to constructing additional capacity to convey, treat, and discharge I/I. At this time, the tools are not available to perform this analysis. Specifically, the collection system model needs to be updated so that dynamic I/I conditions and their impact on District facilities can be better represented. This evaluation will also consider future I/I conditions that may result from not having a Regional I/I Reduction Program and what capacity investments the District may need as a result. The evaluation would be performed in 2022 and 2023 for a budget of \$200,000.

Sewer Use Ordinance Change (2023-24) – The District's SUO will require updates in order for the program to be implemented as defined in this plan. These activities would begin in 2023, after the completion of the Capacity and Cost-Effectiveness Evaluation. The process is

expected to take more than one year to complete. A budget of \$50,000 is established for legal support during this process, provided by District outside counsel.

Develop Technical Guidance (2023-24) – Communities participating in the I/I AC meetings during development of this plan indicated a strong interest in having the District develop technical guidance that would support local I/I reduction work. Specific guidance has not been defined at this time. A budget of \$100,000 is established for this start-up activity that is intended to benefit all Community Customers, regardless of status in the I/I Reduction Program.

Educational Materials (2023-24) – Like the technical guidance, the AC members indicated interest in the District developing educational materials that would help them with implementing local I/I reduction activities and public outreach. These materials could be useful for communicating with elected officials and the general public on I/I topics. A budget of \$50,000 is established for this work, expected to occur starting in 2023.

Annual Program Costs

The following summarizes the annual costs for maintaining the I/I program, with an assumed escalation rate of 3 percent each year.

District Program Management (Starting 2023) – To support program start-up and implementation, District staff will need budget for management activities. This support will start during the SUO change effort and continue throughout the program. Specific activities are yet to be defined, but could include miscellaneous technical support by a consultant. A \$50,000 per year budget is assigned to this support, starting in 2023.

Monitoring Program Implementation (Start 2024) – After adoption of the SUO changes, the first monitoring sites recommended in the Flow Monitoring Plan would be installed by March 1, 2024. These initial 20 sites would be installed for 6 months to characterize dry weather and wet weather flow responses in a variety of conditions for comparison to the excessive I/I standards. An annual budget estimate for monitoring 20 sites at a time is \$240,000, which includes equipment installation, regular site maintenance, data retrieval, and initial data review. These costs assume the District would contract out this activity.

Technical and Education Support (Starting 2024) – Based on input received during I/I AC meetings during the development of the program, the District will establish technical and education support contracts for use by Community Customers. These efforts are intended to help customers develop and implement Work Plans required by the program. While the District would make contracts available, any Community Customer engagement would be reimbursed by the customer. Due to the on-demand nature of this assistance, no specific budget is assigned.

Analysis of Annual Flow Monitoring Data (Starting 2025) – At the conclusion of each annual I/I monitoring period, the District would have each site evaluated for compliance with the excessive I/I standards established in the SUO. A budget of \$80,000 is estimated for having an outside contractor perform this activity annually.

Compliance Communication (Starting 2026) – After the flow monitoring data is complete, the District will begin the process of informing affected Community Customers of a tributary area exceeding I/I standards and the need to develop a Work Plan. It is expected that this communication activity would be performed by District staff, but contracted assistance would be required for reviewing any submitted Work Plans. An annual support budget for this activity is estimated at \$50,000.

Table 3. I/I Reduction Program Costs							
Start Up Costs	2021	2022	2023	2024	2025	2026	Total
Model Update	\$75,000	\$25,000					\$100,000
Flow Monitoring Plan		\$25,000					\$25,000
Regional I/I Reduction Program Guidance	\$25,000						\$25,000
Capacity and Cost-Effectiveness Evaluation		\$100,000	\$100,000				\$200,000
Sewer Use Ordinance Change			\$25,000	\$25,000			\$50,000
Develop Technical Guidance			\$50,000	\$50,000			\$100,000
Education Materials			\$25,000	\$25,000			\$50,000
Totals for Start Up by Year:	\$100,000	\$150,000	\$200,000	\$100,000	\$0	\$0	\$550,000
Annual Costs	2021	2022	2023	2024	2025	2026	
District Program Management			\$50,000	\$51,500	\$53,045	\$54,636	\$209,181
Monitoring Program Implementation				\$240,000	\$247,200	\$247,200	\$734,400
Technical and Educational Support							\$0
Analysis of Annual Flow Monitoring Data					\$80,000	\$82,400	\$162,400
Compliance Communication						\$50,000	\$50,000
Totals for Annual Costs by Year:	\$0	\$0	\$50,000	\$291,500	\$380,245	\$434,236	\$1,155,981
Total Program Costs by Year:	\$100,000	\$175,000	\$250,000	\$391,500	\$380,245	\$434,236	\$1,730,981
	2021	2022	2023	2024	2025	2026	
	Current Year (existing budget)	Year 1	Year 2	Year 3	Year 4	Year 5	
Idea for Ramp-Up Plan Costs by Year:	\$100,000	\$175,000	\$250,000	\$400,000	\$450,000	\$500,000	\$1,875,000

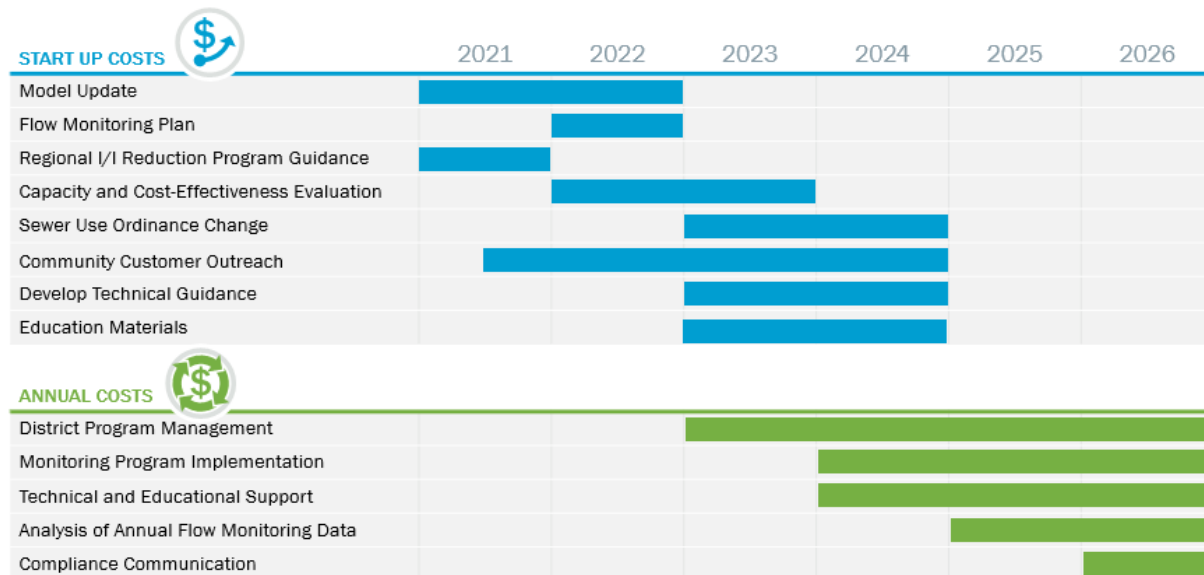


Figure 15. Schedule for I/I Reduction Program Implementation

Section 8

Limitations

This document was prepared solely for the District in accordance with professional standards at the time the services were performed and in accordance with the contract between the Madison Metropolitan Sewerage District (District) and Brown and Caldwell dated September 25, 2019. This document is governed by the specific scope of work authorized by the District; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by the District and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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