APPENDIX 4C: WCFM Future Demand

Purpose

This appendix provides additional details for Chapter 4 of the 2050 Facilities Plan (2050 FP) that are specific to Milwaukee Metropolitan Sewerage District's (MMSD 's) Watercourse and Flood Management (WCFM) Asset System. This appendix is not a stand-alone document; it should always be used in conjunction with MMSD's 2050 FP, which outlines the overall facilities plan for all of MMSD's asset systems.

4 Future Demand

4.1 PURPOSE

The primary function of the Watercourse and Flood Management Asset System is to reduce flood risk to structures along MMSD's jurisdictional streams. MMSD uses a variety of techniques, including stormwater rules for development and redevelopment within the planning area, stormwater conveyance, flood storage, levees and floodwalls, and non-structural measures such as structure acquisition and removal and floodproofing to mitigate risk from Federal Emergency Management Agency (FEMA) defined flood events. When performing stream modifications to address flood risks, MMSD takes the opportunity to restore or maintain natural and native vegetation and habitat in the channel, while mitigating potential increases to flood exposure that may result from restoration. Managing flooding of plumbed structures can reduce inflow and infiltration, potentially lowering the risk of overflows or basement back-ups in the Conveyance and Storage Asset System. Streambank erosion can undermine watercourse projects that have already been completed or may make future improvements more difficult, and can increase downstream total suspended solids. Therefore, it is critical that MMSD analyze and evaluate factors that could lead to changes in stormwater flows and flood risks. The process described in this section will identify future demand on the WCFM asset system.

The purpose of the information presented in this chapter is to document how future demand was developed for the WCFM Asset System for the planning period established for the 2050 FP, which is 2020-2040. Demand on the WCFM Asset System is primarily driven by jurisdictional stream flows that receive runoff from upstream watersheds. Additionally, other factors impact demand including, but not limited to: climate change, permit requirements, and customer expectations.

The 2050 FP establishes a planning period through Buildout, defined below, as well as the 20-year planning period of 2020 to 2040, which is consistent with WDNR facilities planning requirements. The 2050 FP identifies projected demand over a planning period that extends to buildout of the 2050 FP planning area, which is assumed to occur in the year 2050. As part of the overall 2050 FP effort, three conditions were established: Baseline Conditions, Future Conditions and Buildout Conditions, based on modeling using SEWRPC projections of population and land use, as described in Section 4.2. Unlike other asset systems, the WCFM Asset System was not modeled for climate change or for Buildout Conditions. Specific definitions for the conditions are provided below:

- **WCFM Baseline Conditions**. Based on 2010 land use data from SEWRPC.
- **WCFM Future Conditions**. Established as the year 2035 to correspond with MMSD's 2035 Vision. The Future Conditions were developed by SEWRPC by assuming a fraction of the land use and population projections from the Buildout Conditions. Only select watercourses were modeled by SEWRPC for 2035 conditions, and demands were projected on these watercourses only. This report assumes that future

conditions in 2040 will be substantially equivalent to conditions in 2035 because growth in the region is projected to be slow.

- **Buildout Conditions**. Based on population and land use data from SEWRPC and assigned the year 2050 by MMSD. Although specific watercourse modeling was not completed for the year 2050, a qualitative assessment of climate change demands, which are associated with the buildout condition, are included.

This chapter identifies the demand drivers that are projected to impact WCFM asset operation in the future (Section 4.2), documents the projected impact (Section 4.3), and discusses how MMSD manages demand as of 2019 (Section 4.4). The possible impacts to the WCFM Asset System due to baseline and future demand are assessed in Chapter 5.

4.2 Factors Affecting Demand

There are a number of factors that influence demand on the WCFM Asset System within the 2050 FP planning area. These are factors that could influence future demand and thereby affect the ability to meet the level of service targets identified in Chapter 3 of the 2050 FP. These factors are listed below along with a discussion of how they are anticipated to change.

- Service and Planning Area Changes, including economic growth and industrial user changes
- Climate Change
- Permit Changes
- Operating and Maintenance Contract Changes
- Changes in Customer Expectations
- Changes in Technology
- Conservation Efforts

Service and Planning Area Changes

Growth in the planning area, including population and land use, is projected by the Southeastern Wisconsin Regional Planning Commission (SEWRPC). SEWRPC issued a memorandum outlining the procedures used to develop the data, titled MMSD 2050 Facilities Plan Population, Household and Selected Land Use Mapping and Data Development Process, dated November 29, 2017, which is included as Appendix 4A-1 of Appendix 4A, Conveyance Future Demand). Land use changes impact surface runoff and pollution generated from land surfaces that can affect flows and pollutant loads seen by the WCFM Asset System. Depending on the land use changes, increases or decreases in flows and pollutant loads can impact flooding, erosion, water quality, and overall health of the streams.

MMSD's responsibilities can be expanded when it assumes authority, or jurisdiction, of new streams within the planning area. For instance, in December 2016, the estuary portions of the three main rivers, the Milwaukee, the Menomonee, and the Kinnickinnic, were added to MMSD's jurisdictional streams. Municipalities may request that MMSD consider making a stream a jurisdictional stream following a procedure outlined in MMSD's Chapter 13 Surface Water and Stormwater Rule. [1] The petition must identify risks for flood losses. SEWRPC's analyses are relied upon to determine if any structures are at risk, and this information is used to make the determination of whether the stream should become a jurisdictional watercourse.

Economic Growth

While service area growth will affect demands, the most significant source of increases to runoff is residential, commercial, and industrial growth, which is directly tied to the economic climate. While MMSD cannot control changes in the regional economic climate, this factor will have significant impacts on future regional growth and therefore flows.

Industrial User Changes

No changes specific to the WCFM Asset System have been identified.

Climate Change

Climate change is predicted to have multiple negative impacts on water resources within MMSD's jurisdictional streams. The demand on WCFM assets is therefore expected to increase because of climate change although it is difficult to predict the specific extent.

The Climate Change Vulnerability Analysis [2] predicts an average summer temperature increase of 5 degrees Fahrenheit (°F) in the MMSD service area by 2050 compared to the historic record baseline condition (1940 to 2004). The number of days with temperatures exceeding 90°F is predicted to increase from 12 to 25 per year. Climate change scenarios show a pattern of increasing precipitation intensity in larger events and a decrease in the size and frequency of smaller events (more drought periods). The proportion of winter precipitation events is expected to be more rain or freezing rain rather than snow.

The climate change modeling performed in support of the 2050 FP for the Conveyance and Storage Asset System was also assessed to determine potential future impacts. Key findings that impact the WCFM Asset System include the following:

- Annual precipitation is predicted to slightly increase under the 90th percentile mid-century climate scenario. Monthly changes are variable, with a tendency for more precipitation in the winter and less in the summer. Therefore, precipitation volume will be about the same; however, the way it falls is different and will impact how the system responds.
- While annual precipitation does not change appreciably, the most intense rainfall events increase significantly, so larger storm events will become even larger and have greater impacts on flooding. Higher peak runoff from more intense precipitation events may result in a decrease in the level of protection provided by flood management facilities. These changes may result in additional structures being put into regulatory floodplains. This can increase project costs, or new structures in floodplains where projects have already been implemented.
- The increased temperature will likely result in greater evapotranspiration, which may offset some of the effects of increased precipitation intensity, particularly in the 2100 time frame. Monthly evapotranspiration increases in all months, with the biggest changes in the summer and fall. Although surface runoff from impervious surfaces is predicted to change very little, runoff from pervious surfaces is predicted to significantly decrease, especially for interflow and baseflow due to higher evapotranspiration.
- Higher temperatures and extended drought periods may lead to decreased average and low flows in jurisdictional watercourses, resulting in a degradation of aquatic and riparian habitat, native species, and water quality, and a decrease in aquatic and riparian species viability.

Permit Changes

There are no anticipated MMSD permit changes that may affect WCFM assets. However, the U. S. EPA recently approved the total maximum daily load calculations (TMDLs) for the Milwaukee River Basin, which includes the Menomonee River, Kinnickinnic River, and Milwaukee River watersheds as well as the Milwaukee Harbor Estuary. New Wisconsin Pollutant Discharge Elimination System (WPDES) permits will require municipalities to reduce phosphorus, total suspended solids and bacteria from stormwater runoff entering these watersheds. Over time, this should help improve water quality within MMSD's jurisdictional streams; however, the impacts of predicted more extended low flow conditions due to climate change may offset some of the anticipated gains from the TMDL limitations. MMSD is developing a Water Quality Improvement Plan (WQIP) that is focused on beginning implementation of the TMDL and developing a monitoring plan to document water quality successes in the watercourses (both plans are still in development as of 2019). MMSD's Water Quality Protection Division has been monitoring Milwaukee area watercourses for over 35 years to document long-term beneficial water quality improvements as required by MMSD's WPDES permit. The WQIP will identify how these data can be used to work toward removing streams from the state's 303(d) list of impaired and threatened waters.

On January 22, 2018, MMSD's Rules Chapter 11 (Discharge Regulations and Enforcement Procedures) was revised to allow discharges of noncontact cooling water (NCCW) to the MMSD conveyance system. Because phosphate is added to drinking water in order to protect against lead leaching from lead water pipes in the Milwaukee area, diverting NCCW will reduce the loads of phosphorus to the watercourses. The overall impact of this is not known, but it should help to show reductions per TMDL limits in WPDES permits.

Effective April 1, 2019, MMSD's Rules Chapter 13 (Surface Water and Stormwater) was revised to require detention using green infrastructure (GI) for new impervious surfaces between 5,000 square feet (SF) and 0.5 acre (the threshold above which a stormwater management plan is required), which will further reduce stormwater runoff from reaching the jurisdictional streams.

Operating and Maintenance Contract Changes

This section focuses on the following contracts:

River Skimmer Program. Veolia Water Milwaukee, LLC (Veolia) is responsible for managing the River Skimmer Program. This involves using a boat, the Lynyrd Skymmr, that was designed to capture floating debris and trash from the water surface on the Milwaukee River, Menomonee River, Kinnickinnic River, Burnham Canal, Menomonee Canal, Milwaukee Harbor Estuary, and inner harbor. No operating contract changes are anticipated.

Watercourse Maintenance Contracts. Several annual watercourse maintenance contracts address routine and non-routine maintenance along MMSD's jurisdictional watercourses. Maintenance contracts are bid annually and are not part of the 10-year Veolia operating and maintenance (O&M) contract.

These contracts, each covering geographic areas in Milwaukee County as of 2019, commit contractors to perform routine maintenance of riparian properties with MMSD ownership or easement. The work includes cutting of turf and natural vegetation areas, snow and ice removal, and debris and trash pickup. On occasion, in accordance with the Chapter 13 Surface and Stormwater Rule and as directed by MMSD, the contractor may assist other riparian property owners with debris or woody vegetation and/or sediment removal when such a blockage may increase the flood risk to structures during the 100-year (1-percent-annual-probability) storm.

In addition to these contracts, there is a separate graffiti removal contract for all MMSD watercourse property. As of 2019, there are invasive species management contracts being put in place to manage restored areas in the Kinnickinnic River watershed, Milwaukee County Grounds Basins, Underwood Creek, and Lincoln Creek. All

stream restoration projects have a post-construction phase to establish the vegetation, but many of the restored streams are past the post-construction time period and must continue to be maintained.

There are no plans to discontinue use of these watercourse maintenance contracts. Work associated with these contracts continues to increase as properties to maintain are added through acquisitions or easements, as MMSD assumes jurisdiction of more streams, and as more stream restoration projects are completed.

Changes in Customer Expectations

Fewer inundated structures and reduced impacts from flooding in general are expected considering the numerous improvements and expenditures MMSD has made in the past and will continue to make. Customer expectations are anticipated to result in a significant increase in the demand for GI to be included in watercourse flood management projects where appropriate. However, these expectations will have to be balanced with the flooding impacts of increasing stream flows. It is anticipated that this will result in the need for constant assessments of the asset system's level of service to determine if capital improvements are required.

Changes in Technology

The increase in GI implementation is anticipated to enhance flood management practices and potentially reduce the demand on the WCFM Asset System, particularly in smaller reaches in highly developed areas with significant impervious surfaces, although the exact reduction on demand is unknown at this time. Additionally, automatic control technology for the timing and rate of stormwater flow through existing (as of 2017) and new GI facilities has been developed, the implementation of which is anticipated to improve management of GI and its effectiveness in flood management practices. Anticipated reductions in stream flows from introduction of increasing amounts of GI will have to be balanced with the future demands of the watersheds on the watercourses.

Technological advances in GIS and hydraulic models may make the development of floodplain mapping more efficient and accurate, making watercourse changes easier to predict and manage. Another possible technological development that could affect WCFM inspection, operation, and maintenance activities is aerial drone applications for the observation and inspection of difficult to access locations.

Conservation Efforts

No changes specific to the WCFM Asset System have been identified.

4.3 PROJECTED DEMAND TRENDS

As part of the 2050 FP, the demand factors identified above for the WCFM Asset System were not explicitly evaluated or modeled to determine future demand trends, such as future flows or impacts to flooding. This was due to several reasons:

- Information regarding the WCFM assets was very limited when 2050 FP was being developed because the work to organize available data and establish more robust asset management data had not been undertaken, so the focus was directed to prioritizing a list of approximately 40 watercourse and flood management projects that MMSD's Watercourse Section had already assembled through a series of completed planning studies and engineering projects.
- SEWRPC prepared updated floodplain maps and structure damage estimates along selected streams within MMSD's planning area for 2035 land use conditions as documented in a SEWRPC memorandum.

[3] Information about this analysis is summarized below. While this analysis provided useful data, modeling all of the watercourses with revised land use and rainfall data and determining the impact on floodplains and at-risk structures is an extensive task and was not in the scope of the 2050 FP.

- Water quality was the focus of the 2020 FP. Extensive modeling and data analyses were completed during that project that concluded nonpoint pollution sources are the primary source of bacteria, total suspended solids and other pollutants in the jurisdictional streams. Additional water quality modeling was done to determine TMDLs for total phosphorus, total suspended solids, and bacteria (as fecal coliform). [4] Therefore, water quality modeling was not part of the scope of the 2050 FP.

SEWRPC Analysis of 2035 Land Use

Methodology

As part of the November 2017 floodplain analysis noted above, SEWRPC updated the hydrologic and hydraulic models for selected stream reaches to reflect 2035 land use conditions. They used the revised models to compute flow rates and water surface profiles, delineate the 1-percent annual probability event floodplain, and identify flooded structures and damage estimates for the 4-, 2- and 1-percent annual probability events. [3] No comparison between the 2010 condition and the 2035 condition were made. The flooded structures information was used to evaluate the priority of projects in Chapter 6. The revised flows generated by SEWRPC analysis are discussed below.

Excerpts from the hydrologic methodology discussion in the SEWRPC analysis include:

> *Land Use*
>
> *Existing hydrologic models for the studied streams were updated to reflect planned year 2035 land use conditions within the tributary watersheds…For each watershed, the acreage of land use combined with hydrologic soil group was obtained for individual subbasins used in the hydrologic model.*
>
> *For the study, two main types of hydrologic model were used. For streams in the Menomonee River, Oak Creek and Root River watersheds, the U.S. Environmental Protection Agency (USEPA) HSPF continuous simulation model was used… Streams in the Lake Michigan Direct Drainage Area and Milwaukee River watershed employed either the USEPA SWMM or the U.S. Army Corps of Engineers HEC-HMS design storm event models…Flood discharges along the Milwaukee River main stem were developed from statistical analysis of gauged flows.*
>
> *Precipitation*
>
> *In addition to updating land use conditions to year 2035, the hydrologic models were updated to reflect more recent rainfall information. For the HSPF continuous simulation models, the simulation periods were extended using recorded precipitation data through water year 2014. Thus, a total simulation period of 75 years (1940–2014) was utilized. The updated simulation period included several large storm events that had occurred since the HSPF models were originally developed, including events in 2000, 2006, 2008, 2009, and 2010.*
>
> *Those models that employ a single design storm approach were updated to include precipitation estimates reported in the National Oceanic & Atmospheric Administration (NOAA) Atlas 14, "Precipitation-Frequency Atlas of the United States – Volume 8: Midwestern*

States." That report was published in 2013 and supersedes the estimates reported in SEWRPC Technical Report No. 40, "Rainfall Frequency in the Southeastern Wisconsin Region." The 2006 SEWRPC/WDNR temporal storm distribution was applied to the applicable Atlas 14 rainfall volumes to develop the design storms used in the models.

Flood profiles for the 50-, 4-, 2- and 1-percent annual probability events were then computed for the streams and reaches in the SEWRPC analysis, as listed in Table 4C-1, using the U.S. Army Corps of Engineers HEC-RAS model. [3]

TABLE 4C-1: STUDIED STREAM LENGTHS

Watershed	Stream Name	Reach Description	Length (river miles)
Lake Michigan	Fish Creek	Mouth to Donges Bay Road	3.53
	Unnamed Tributary to Fish Creek	Mouth to confluence with South and West tributaries	0.03
	South Branch of Unnamed Tributary to Fish Creek	Mouth to 220 feet upstream of Sleepy Hollow Lane	0.45
	West Branch of Unnamed Tributary to Fish Creek	Mouth to Port Washington Road	0.52
	County Line Road Tributary to Fish Creek	Mouth to upstream side of Columbia Drive	1.18
	Watershed Total		*5.71*
Menomonee River	Menomonee River	North Avenue to Lilly Creek	10.67
	Little Menomonee River	Mouth to County Line	7.13
	Watershed Total		*17.80*
Milwaukee River	Milwaukee River	Mouth to County Line	16.41
	Beaver Creek	Mouth to Northridge Lake	2.45
	Brown Deer Park Creek	Mouth to WEPCO service road	2.33
	Watershed Total		*21.19*
Oak Creek	Oak Creek	Mouth to 0.25 mile upstream of Puetz Road	9.30
	Mitchell Field Drainage Ditch	Mouth to 0.5 mile upstream of Howell Avenue	3.76
	North Branch of Oak Creek	Mouth to North Airport Spur ramp	5.97
	Watershed Total		*19.03*
Root River	North Branch Root River	Root River Canal to 124th Street	16.85
	East Branch Root River	Mouth to S. Melinda Street (Greenfield)	6.05
	West Branch Root River	Mouth to S. 145th Street	2.75
	Crayfish Creek main stem	County Line Road to Oakwood Road	1.10
	Whitnall Park Creek	Mouth to Kelly Lake	3.09
	Tess Corners Creek	Mouth to 0.5 mile upstream of Grange Avenue	9.06
	Lower Crayfish Creek main stem	Mouth to County Line Road	0.39
	104th Street Branch	Mouth to storm sewer outfall (99th Street)	0.36
	Hale Creek	Mouth to Lincoln Avenue	0.92
	Watershed Total		*40.57*
Study Total			**104.30**

Land Use Trends

Land use trends based on SEWRPC's projections include the following:

- **Industrial land use area** – Projections show a 41 percent increase between Baseline (2010) and Future (2035) Conditions
- **Commercial land use area** – Projections show a 50 percent increase between Baseline (2010) and Future (2035) Conditions

Land use changes impact surface runoff and pollution generated from land surfaces that can affect flows and pollutant loads seen by the WCFM Asset System. Increases in industrial and commercial land use tend to add impervious surfaces, which can lead to higher streamflows. MMSD's Chapter 13 Rule is aimed at minimizing the effects on streamflows from new developments and redevelopments.

Pollutant loads are typically higher from industrial and commercial land use as well. This may impact flooding, erosion, water quality and overall health of the streams. Additional information regarding SEWRPC's population and land use projections developed for the 2050 FP is described in Appendix 4A, Conveyance Future Demand.

SEWRPC Findings – Flood Flows

A comparison of the 1-percent probability flood flows computed by the SEWRPC study and the regulatory 1-percent probability flood flows along selected streams and locations is summarized in Table 4C-2. The regulatory flows are published in the FEMA Flood Insurance Study (FIS) for Milwaukee County and Incorporated Areas. [5]

Comparing flows from the two sources should be considered carefully. The flows calculated by the SEWRPC study were based on an estimation of 2035 land use and hydrologic data from 1940 through 2014, whereas the regulatory flows were based on conditions at the time of the FIS (2008). Additionally, for some streams studied in the FIS, the hydrologic data was developed several years before the effective date of the FIS and were just adopted as part of the 2008 countywide FIS effort. The potentially significant differences in land use and the period of record for rainfall data could result in large variations in flows for a given stream and location between the two studies.

Because the two studies do not provide flows at the same locations, the flows listed in Table 4C-2 were taken where the location descriptions correlated reasonably well. Additionally, there may be some effect from hydraulic routing within longer reaches that could affect the discharge value reported. It is beyond the scope of the 2050 FP to confirm that the flows published in the two studies correlate exactly.

The results show increases for the SEWRPC study compared to the FIS at all locations listed. Percent increases range from 7 percent for all the Milwaukee River locations to 128 percent for one location along the Menomonee River. While differences in data and/or methodology for the two studies are potentially significant, the increased 1-percent flood flows can be considered a potential future demand trend as related to impacts to flooding and overall management of the WCFM Asset System.

TABLE 4C-2: Comparison of 1% Probability Flows

Comparison of 2008 Milwaukee County Flood Insurance Study Flows and 11/29/2017 SEWRPC Staff Memorandum - MMSD 2050 Facilities Plan - SEWRPC Floodplain Analysis (for 2035 Land Use Conditions) Flows						
Stream	Location		1% Probability Flows (cfs)		Difference (cfs)	Percent Increase
	FIS Description	SEWRPC Description	FIS	SEWRPC		
Fish Creek	At downstream crossing of Ozaukee-Milwaukee Co. Line	180' d/s of Co. Line Rd. to 863' u/s of Co. Line Rd.	705	1,213	508	72%
Menomonee River	At Hampton Ave. Bridge	West Capitol Dr. to confluence w/ Little Menomonee River	3,687	6,620	2,933	80%
	At 124th St. near Fond du Lac Ave.	Confluence w/ Dretzka Park Trib. to confluence w/ Lilly Cr.	2,200	5,010	2,810	128%
Little Menomonee River	At confluence with Menomonee River	Mouth to W. Appleton Ave.	1,500	1,820	320	21%
	At Brown Deer Road	West Brown Deer Rd. to West County Line Rd.	580	758	178	31%
Milwaukee River	Just u/s of confluence with Kinnickinnic River	Mouth to N. Water Street	26,700	28,500	1,800	7%
	Buffalo Street to Port Washington Rd. Bridge	N. Water Street to I-43	14,800	15,800	1,000	7%
	At the north end of Lincoln Park	400' u/s of W. Hampton Ave. to N. end of Lincoln Park	14,380	15,350	970	7%
	At the Ozaukee-Milwaukee County Line	N. end of Lincoln Park to West County Line Road	14,340	15,310	970	7%

TABLE 4C-2: Comparison of 1% Probability Flows

Comparison of 2008 Milwaukee County Flood Insurance Study Flows and 11/29/2017 SEWRPC Staff Memorandum - MMSD 2050 Facilities Plan - SEWRPC Floodplain Analysis (for 2035 Land Use Conditions) Flows						
Stream	Location		1% Probability Flows (cfs)		Difference (cfs)	Percent Increase
	FIS Description	SEWRPC Description	FIS	SEWRPC		
Oak Creek	At Mouth	Mouth to Mill Road	2,160	2,900	740	34%
	At USGS Gage No. 04087204 (15th Ave. in S. Milwaukee)	15th Ave (1st Crossing) to Rawson Ave.	2,070	2,850	780	38%
	At USGS Gage No. 04087200 (Nicholson Rd. in Oak Creek)	Union Pacific RR to 0.25 mi. d/s of S. Shepard Ave.	1,500	1,830	330	22%
	Just u/s of S. 27th Street	S. 27th Street to 270' u/s of S. 27th St.	625	829	204	33%
North Branch of Oak Creek	At confluence with Oak Creek	Mouth to confluence with Southland Creek	1,380	1,780	400	29%
	Just u/s of confluence with Southland Creek	Confluence with Southland Cr. to 170' u/s of Weatherly Drive	1,490	1,950	460	31%
	Just u/s of confluence with N. Br. Oak Cr. Tributary N7	170' u/s of Weatherby Drive to CP Railroad	1,190	1,440	250	21%
	Just u/s of confluence with N. Br. Oak Cr. Tributary N5	CP Railroad to 0.25 mi. d/s of Marquette Avenue	915	1,370	455	50%
	Just u/s of Rawson Ave.	W. Rawson Ave. to 585' d/s of MATC driveway	795	943	148	19%

TABLE 4C-2: Comparison of 1% Probability Flows

Comparison of 2008 Milwaukee County Flood Insurance Study Flows and 11/29/2017 SEWRPC Staff Memorandum - MMSD 2050 Facilities Plan - SEWRPC Floodplain Analysis (for 2035 Land Use Conditions) Flows						
Stream	Location		1% Probability Flows (cfs)		Difference (cfs)	Percent Increase
	FIS Description	SEWRPC Description	FIS	SEWRPC		
Mitchell Field Drainage Ditch	At confluence with Oak Creek	Mouth to Union Pacific RR	800	1,120	320	40%
	Just u/s of Rawson Avenue	W. Rawson Avenue to 200' u/s of W. Rawson Avenue	790	996	206	26%
	Just u/s of College Avenue	West College Avenue Crossing	565	712	147	26%
	Just u/s of Howell Avenue	D/s side of S. Howell Ave. to Airport Service Road	355	441	86	24%

Climate Change

MMSD's Climate Change Vulnerability Analysis evaluated the potential effect of climate change on MMSD facilities, operations, and performance. [6] For the WCFM Asset System, the study evaluated changes in high and low flows in two selected reaches of the Kinnickinnic and Menomonee Rivers as a result of different climate change scenarios. The results included the following:

- One-hundred-year (1-percent-annual-probability) flows will increase up to 16 percent and 10-year (10-percent-annual-probability) peak flows will increase from 6 percent to 13 percent.
- Low flows will decrease by as much as 73 percent, but the absolute incremental decrease is minor relative to total contributions to the river base flows. Therefore, it is likely the lowest flows will not be impacted based on the scenarios analyzed.

The general impacts to the WCFM Asset System are expected to include the following:

- Higher peak runoff from more intense precipitation events may result in a decrease in the level of protection provided by flood management facilities.
- Higher temperatures and extended drought periods may lead to decreased average and low flows in jurisdictional watercourses, resulting in a degradation of aquatic habitat and water quality and a decrease in aquatic species viability.

Although not available or explicitly developed for all the jurisdictional watercourses, the anticipated changes potentially indicate a need for more flood management capacity for the more frequent high-intensity precipitation events. They also indicate the potential for lower low flows, which could

potentially lead to the degradation of habitat and water quality, particularly in streams that have low base flows.

Hydrologic and hydraulic modeling done by SEWRPC as described in 4.3 did not include an analysis of climate change and its impact on flows, water surface elevations, and floodplain extents.

4.4 Demand Management

MMSD uses a number of different methods to manage increased and changing demand on the WCFM Asset System, including:

Watercourse management planning and flood management projects – MMSD identifies flooded structures, evaluates options to manage the flooding, and designs and implements projects to reduce the risk of flooding and reduce damages. The watercourse management plans synchronize projects based not only on these benefits but also by how the projects work together to result in approvable revised FEMA floodplain maps.

Operation and maintenance of jurisdictional streams – MMSD performs general maintenance of various watercourse channels and riparian properties, including routine maintenance of turf and natural vegetation areas, removal of debris and woody vegetation, species management, and insect control where applicable. These activities help maintain stream conveyance capacity for the 100-year (1-percent-annual-probability) storm.

Programs and policies – MMSD has several programs and policies that are used to manage WCFM demands, including:

- *Chapter 13: Surface Water and Stormwater Rule* - MMSD manages the impact of increased stormwater runoff from new development and redevelopment on flood flows through Chapter 13. [1] The purpose is to 1) reduce the unsafe conditions, property damage, economic losses, and adverse health effects caused by flooding, 2) maximize the effectiveness of flood abatement facilities and watercourse improvements, 3) reduce the number and magnitude of releases of sewage to the environment from sanitary and combined sewers and to protect sewage collection and treatment facilities from high flows, 4) promote comprehensive watershed planning and intergovernmental cooperation, and 5) restore and enhance opportunities to use and enjoy watercourses.
- *Greenseams®* - Greenseams is an innovative flood management program that permanently protects key lands containing water absorbing (hydric) soils. By storing and draining water into the ground naturally, Greenseams helps alleviate future flooding and water pollution while supporting and protecting MMSD's structural flood management projects, which are infrastructure investments that are worth hundreds of millions of dollars. The program makes voluntary purchases of undeveloped, privately-owned properties in areas expected to have major growth in the next 20 years and open space along streams, shorelines, and wetlands. There are Greenseams sites in Milwaukee, Ozaukee, Washington, and Waukesha Counties.
- *Working Soils Program®* - The Working Soils Program acquires easements on agricultural land in the Milwaukee River watershed to preserve floodplains and improve the soil health so it can store rainwater, recharge ground water, and reduce water pollution. Implementation of the agricultural planting strategies and soil management techniques outlined in this program reduce the risk of flooding and limit erosion to preserve nutrient rich soil and reduce sediment in waterways. Through collaboration with the Milwaukee River Watershed Conservation

Partnership (MRWCP) project partners, MMSD's Working Soils Program supports the acquisition of eight agricultural easements across 800 acres. One million dollars in Natural Resources Conservation Services (NRCS) easement allocations will be paid to MMSD as cost-share reimbursement after each easement acquisition once MMSD has paid for each easement in full.

- *Greater Milwaukee Regional Conservation Partnership Program (GMRCP)* - The purpose of this project is to work with agricultural producers and landowners to place voluntary easements on undeveloped, privately-owned properties along streams, shorelines, and wetlands in areas expected to have major growth in the next 20 years. This limited-time, innovative flood management program permanently protects key lands containing water-absorbing soils.

In addition, MMSD has completed significant water quality monitoring, studies and improvement work. An example is the water quality study completed under the Regional Water Quality Initiative with SEWRPC as part of the 2020 FP. This project led to MMSD developing third-party TMDLs for the Menomonee River, Kinnickinnic River and Milwaukee River watersheds as well as the Milwaukee Harbor estuary. The Water Quality Improvement Plan (WQIP) submitted to WDNR by March 1, 2020 is focused on beginning implementation of the TMDL and establishing a monitoring plan to document water quality successes in the watercourses.

Continued use of these methods for managing future demand on the WCFM Asset System is discussed in Chapters 6 and 7.

4.5 REFERENCES

[1] Milwaukee Metropolitan Sewerage District, *Chapter 13, Surface Water and Stormwater Rules,* Milwaukee, WI: MMSD, Amended December 19, 2016.

[2] Brown and Caldwell, "Climate Change Vulnerability Analysis," MMSD, Milwaukee, WI, 2014.

[3] Southeastern Wisconsin Regional Planning Commission, *MMSD 2050 Facilities Plan - SEWRPC Floodplain Analyses,* Waukesha, WI: SEWRPC, November 29, 2017.

[4] CDM Smith, "Total Maximum Daily Loads for Total Phosphorus, Total Suspended Solids, and Fecal Coliform Mikwaukee River Basin, Wisconsin," CDM Smith, Milwaukee, WI, March 2018.

[5] Federal Emergency Management Agency, "Flood Insurance Study (FIS) for Milwaukee County and Incorporated Areas," FEMA, September 26, 2008.

[6] Brown and Caldwell, "Climate Change Vulnerability Analysis," Brown and Caldwell, Milwaukee, WI, 2014.