

## APPENDIX 5C: WCFM Assessment of Existing Facilities and Risks

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# Purpose

This appendix provides additional details for 2050 Facilities Plan (2050 FP) Chapter 5 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 the 2050 FP, which outlines a coordinated facilities management plan for all of MMSD's asset systems.

## 5 Assessment of Existing Facilities and Risks

### 5.1 PURPOSE

This chapter provides an overview of the WCFM Asset System and describes the asset information used to assess possible asset system failures.

Assets were evaluated by four possible failure modes. The intent of the failure mode analysis—and the primary output of Appendix 5C—is to provide a summary of identified potential WCFM Asset System risks. Each failure mode analysis describes the dataset that was used and includes an estimated time period when each risk is predicted to occur. The risk evaluation is presented for a planning period from 2020 to 2050; therefore, assets identified to fail beyond 2050 have generally not been included in the potential risks presented.

#### *Intent of Risk Assessment*

Risks are defined as anything that MAY prevent MMSD from managing its assets systems to meet organization goals. The risk assessment process serves as an essential tool to help an organization prioritize its investments and identify the best practices to mitigate risk. The risks discussed in this chapter were identified by MMSD and 2050 FP project team staff and are informed by engineering judgment. When reading these assessments, it is important to note that these are identified as **potential** risks. The projected timing of each risk is based on the risk assessment. Not all of the risks outlined in this chapter are actually occurring, nor may they ever occur.

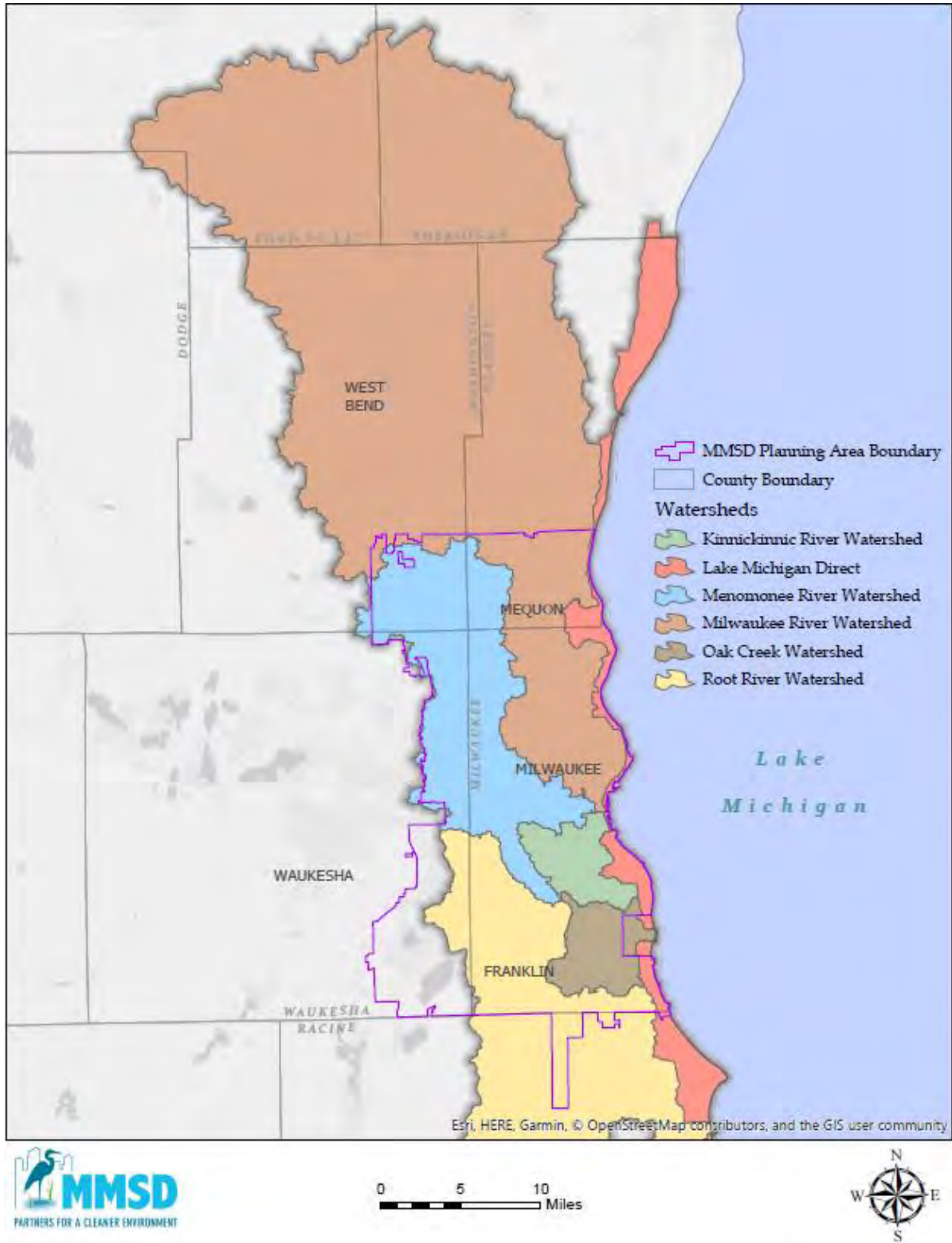
### 5.2 WATERCOURSE AND FLOOD MANAGEMENT ASSET SYSTEM OVERVIEW

An overview of the of the WCFM Asset System is provided in Chapter 1. As described in Chapter 1, the WCFM Asset System is separated into six watersheds, which are shown on Figure 5C-1. Within each watershed, WCFM assets are further divided by watercourse. The WCFM Asset System includes MMSD assets located on streams for which MMSD has jurisdictional flood management authority. The jurisdictional streams are shown in Figure 5C-2. In addition to the six watersheds, MMSD also has stormwater management authority for any area within the planning area. This includes the Fox River watershed in the southwest corner of the planning area. There are no MMSD assets in the Fox River watershed, so it is not included on the watershed map (Figure 5C-1).

For the WCFM system, the term asset does not require MMSD to own the asset, but it does require MMSD to have some type of management responsibility for the asset. Typical assets in this asset system

include open channels, culverts, instream hydraulic features, spillways, structural embankments, flap gates, trash racks, and flood management structures. The asset information development is a work in progress. Some information was available for concrete-lined channels and enclosed underground structures, but limited information was available for other assets. Therefore, a higher-level analysis was done on those assets.

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**FIGURE 5C-1: WATERSHEDS WITHIN MMSD PLANNING AREA BOUNDARY**



FIGURE 5C-2: MMSD JURISDICTIONAL STREAMS

This chapter presents and evaluates the WCFM Asset System at the watershed level. More detailed summaries were developed to provide greater resolution on issues identified for each watershed, which are provided in Appendices 5C-1 through 5C-6.

Table 5C-1 presents an overview of the WCFM Asset System by showing the total drainage area within the planning area boundary, length of jurisdictional streams, miles of concrete-lined channels, and miles of enclosed underground structures.

**TABLE 5C-1: OVERVIEW OF THE WATERCOURSE AND FLOOD MANAGEMENT ASSET SYSTEM**

Watershed	Drainage Area (sq. mi.)	Length of Streams (miles) *	Concrete-Lined Channel (miles) *	Enclosed Underground Structures (miles) *
Lake Michigan Drainage	5	2.8	0.0	0.0
Kinnickinnic River	26	17.9	6.2	3.8
Root River	197	27.0	0.0	0.0
Menomonee River	136	25.5	7.8	8.2
Oak Creek	28	17.4	0.0	0.0
Milwaukee River	700	31.4	0.6	0.6
<b>Totals</b>	<b>1,092</b>	<b>122</b>	<b>14.6</b>	<b>12.6</b>

\* On MMSD's jurisdictional watercourses

### 5.3 RISK-BASED APPROACH

In general, the assessment of the WCFM Asset System followed a risk-based approach as described in Chapter 5. The following methodologies were used to assess the WCFM Asset System: the asset-level risk assessment and the Risk Register, as noted below.

#### *Asset-Level Risk Assessment*

Asset-level risk assessments performed on the WCFM Asset System included an assessment of available MMSD spreadsheet data. MMSD had not established an AssetView database for the WCFM Asset System prior to the development of this plan. Therefore, data was originally gathered from MMSD Watercourse staff during a series of meetings in 2016 and through other spreadsheets, developed by MMSD staff, that contained available asset information.

#### *Risk Register*

The risks in the WCFM Risk Register were generally developed by MMSD staff familiar with the assets and systems, who provided guidance on documenting the risks, developing the likelihood of failure (LOF) and consequence of failure (COF) ratings, which were used to develop the overall risk level of each risk, and determining whether MMSD had already identified projects to address the risks. The WCFM Risk



Register developed in 2016 is provided in Appendix 5C-7 and the COF definitions developed for that WCFM Risk Register are presented in Appendix 5C-8.<sup>1</sup>

## 5.4 ASSESSED FAILURE MODES

An overview of the capacity, physical mortality, level of service, and economic efficiency failure modes is described in Chapter 5. For the WCFM Asset System, quantity and quality of asset information varies throughout the system and failure modes tend to overlap. MMSD seeks to provide flood risk reduction for the 1-percent annual probability (100-year) event. This event could be considered the level of service as well as the capacity of the system. Flooded structures are an indication of both level of service and capacity failures. For ease of analysis for the 2050 FP, risks associated with the 1-percent annual probability event were classified as level of service risks. Risks associated with failure of engineered assets (blocked trash racks, pump station failures, levee failures) were classified as capacity failures.

Because the WCFM Asset System is geographically large and minimal data had been tracked at an asset level, identified risks have been developed based on both available data as well as institutional knowledge gathered from MMSD staff. An additional source of information came from the Southeast Wisconsin Regional Planning Commission (SEWRPC), who conducted a study for MMSD to estimate the number of flooded structures and estimated damages for three recurrence interval flood events.

Depending on the available data, some asset failure modes were analyzed based on asset-level data (i.e., data specific to each asset), while other failure modes were assessed based on staff input. In the case of WCFM, asset level data were available for mortality for some assets (e.g., age and condition assessments of concrete-lined channels) and to a lesser extent for level of service analyses. During development of the WCFM Risk Register, failure in operation of an engineered asset, such as debris blockage at bridges and trash rack clogging/failure, were primarily identified under the capacity failure mode. Structure flooding was identified under the level of service failure mode under the “safety” category due to the risk to human life.

A summary table of the WCFM Risk Register developed in 2016 is provided as Appendix 5C-7. A summary of the level of service risks is provided as Appendix 5C-9, and the economic efficiency risk summary is provided as Appendix 5C-10. Specifically, the following data sources were used as the basis for analysis for each failure mode in the WCFM Asset System:

- **Capacity:** In general, capacity failure was identified by MMSD as a failure in operation of an engineered asset for risks captured in the WCFM Risk Register developed in 2016. Subsequent capacity assessments in the WCFM Asset System are based on the ability of the watercourse to convey current and future projected flows. For this assessment, an asset system (watercourse) is predicted to fail when the predicted flow exceeds its capacity and structures are flooded. However, the level of service failure mode is tied to the protection of structures for the 1-percent annual probability storm, so capacity and how it relates to flooded structures for that event is included in the level of service assessment. The capacity failure mode assessment is presented in Section 5.5, Capacity Failure Mode.
- **Physical Mortality:** Data for physical mortality are based on issues identified by MMSD Watercourse staff in 2016 drawing on their knowledge of the assets. It is also based on limited information included in an inventory of concrete-lined channels and underground enclosures

<sup>1</sup> The LOF definitions, which are defined in Chapter 5, are the same across all asset systems.

titled “MMSD\_ConcreteChannel.xlsx” dated February 2, 2016 developed and provided by MMSD’s Watercourse staff. Additionally, the physical conditions of the concrete-lined channels based on observations and ratings as determined by MMSD summer intern staff and MMSD staff observations from culvert videos were documented in a spreadsheet titled “Watercourse\_Asset\_Table\_EDIT.xlsx” dated October 18, 2018. The physical mortality failure mode assessment is presented in Section 5.6, Physical Mortality Failure Mode.

- Level of service: MMSD’s Watercourse Department has conducted numerous floodplain management studies that have identified flooded structures within the 1-percent annual probability event floodplain. These data are included in an inventory used to track structures no longer threatened by or remaining in the 1-percent annual probability floodplain for all jurisdictional streams from 1999 to 2018 titled “StructuresFloodplain2018.xlsx” dated November 5, 2018. In addition, SEWRPC conducted an evaluation to determine the number of flooded structures and monetary flood damages during the 1-, 2- and 4-percent annual probability events based on 2035 land use for selected sections of various watercourses, which will be used to help prioritize flood management projects in Chapter 6. [1] Other than flooded structure data, limited asset-level data were available to relate asset performance to key performance indicators and performance indicators identified in Chapter 3. Therefore, the risk analysis related to level of service was supplemented with information provided by MMSD Watercourse staff, documented in the WCFM Risk Register in 2016 and presented in Appendix 5C-7. The level of service failure mode assessment is presented in Section 5.7, Level of Service Failure Mode.
- Economic efficiency: The primary basis for risk analysis was the WCFM Risk Register developed by the 2050 FP project team in 2016. The economic efficiency failure mode assessment is presented in Section 5.8, Economic Efficiency Failure Mode.

#### *Words of Caution*

The demand for Future Conditions was calculated by interpolating data points between the Baseline Conditions and Buildout Conditions. Interpolation is the process of **estimating** unknown data points between two quantities, which in this case are Baseline and Buildout Conditions, where Buildout Conditions are based on MMSD municipalities’ projections of growth as documented by the Southeastern Wisconsin Regional Planning Commission (SEWRPC).

All forecasting models rely on historical data and relationships to produce a best estimate about future circumstances. It is important to note that forecasting is an uncertain business and the presence of uncertainty is inherent when making planning, management, or policy decisions. Forecasts invariably turn out to be different than the actual numbers that occur and these forecast errors increase with increased length of the forecast horizon. Therefore, forecasts should be updated when new data, such as 2020 census data, become available.

When reading these projections, it is important to note that the presented numbers are **estimates** of future demand conditions at the time of publication of the 2050 FP based on assumptions and—where noted—on planning judgment and should not be considered precise expectations of future conditions. Actual conditions will almost certainly deviate from these estimates.



## 5.5 CAPACITY FAILURE MODE

An asset can fail if the demand for the asset exceeds its design capacity, which can be caused by growth and system expansion. Capacity assessments in the WCFM Asset System are based on the ability of the watercourse to convey current and future projected flows. Based on MMSD goals and the Chapter 13 Rule, MMSD strives to provide watercourse conveyance capacity during the 1-percent annual probability (100-year) event to prevent flooded structures. [2] For this assessment, an asset is predicted to fail when an engineered asset does not function as intended. The purpose of this assessment is to identify engineered watercourse assets that are predicted to fail as intended, such as rehabilitated channels that are not maintained, nuisance vegetation and debris blockage of trash racks, culverts, and bridges. Best management practices such as inspection and maintenance of these assets will help to reduce the probability of failure. Flooded structures are covered under the level of service failure mode in Section 5.7.

### *Methodology*

The WCFM Risk Register developed in 2016 was used to capture potential failure in operation of an engineered asset or maintenance issues that could cause localized capacity issues. MMSD Watercourse staff provided input from their knowledge of the watercourses to populate the WCFM Risk Register. The capacity issues identified included failure in operation of an engineered asset, such as rehabilitated channels that are not maintained, nuisance vegetation and debris blockage of trash racks, culverts and bridges. MMSD focused on high risks for the 2050 FP.

### *Findings*

As mentioned above, the capacity risks identified in the WCFM Risk Register are potential failures in operation of an engineered asset. An overview of these capacity risks throughout the planning area is provided in Table 5C-2. There were no high-level risks identified. Details about these watershed-specific risks related to capacity are documented in the WCFM Risk Register (Appendix 5C-7). MMSD should continue to have inspection and maintenance programs to identify these risks in order to develop projects or routine maintenance plans so that complete failure does not occur. As flood management projects are incorporated and concrete channels are removed, additional annual maintenance and inspections will be needed to ensure long-term project success.

**TABLE 5C-2: IDENTIFIED WATERCOURSE AND FLOOD MANAGEMENT CAPACITY RISKS BY WATERSHED**

Watershed	High Risk	Moderate Risk	Low Risk	Minimal Risk	Total
Lake Michigan Drainage	0	0	0	0	0
Kinnickinnic River	0	6	0	0	6
Root River	0	1	0	0	1
Menomonee River	0	3	1	0	4
Oak Creek	0	3	0	0	3
Milwaukee River	0	2	1	0	3
Multiple watersheds	0	1	0	0	1
<b>Totals</b>	<b>0</b>	<b>16</b>	<b>2</b>	<b>0</b>	<b>18</b>

## 5.6 PHYSICAL MORTALITY FAILURE MODE

Physical mortality assessments are performed to identify the risk of failure due to asset deterioration. The remaining life of an asset can be difficult to predict. The timing of the replacement or rehabilitation of an asset can be estimated based on either the asset age or a condition assessment.

The evaluation used available age and condition information for the concrete-lined channels. Other information used was based on issues identified by MMSD Watercourse staff based on their knowledge of the assets. It should be noted that there are no concrete-lined channels in the jurisdictional reaches within the Root River, Lake Michigan Drainage, or Oak Creek watersheds.

### Methodology

Identifying physical mortality risks was approached in two ways:

1. The Risk Register was used to capture potential failure due to physical mortality as of 2016 based on MMSD Watercourse staff knowledge of the watercourses. MMSD focused on the high-level risks for the 2050 FP.
2. Inspection data as of fall 2018 were used to estimate the physical mortality of concrete-lined channels and underground enclosures (culverts). The lifespan of the concrete-lined channels was assumed to be 50 years.

MMSD Watercourse staff provided input from their knowledge of the watercourses in 2016 to populate the WCFM Risk Register. Available condition assessment data was used to identify the risk levels in the WCFM Risk Register.

MMSD provided information to populate the WCFM Risk Register for select culverts based on video inspection of the culverts by MMSD. MMSD records of construction contracts that provide the age of the concrete-lined channels were reviewed. Note that for many watercourse reaches, the concrete-lined channels were installed under multiple contracts in different years. For this evaluation, the oldest installation year for a particular reach was used to summarize the age of concrete-lined channels in the

various watersheds. The physical conditions of the concrete-lined channels are based on observations and ratings as determined by MMSD summer intern staff in 2016 and MMSD staff observations from culvert videos, documented in a spreadsheet titled “Watercourse\_Asset\_Table\_EDIT.xlsx” dated October 18, 2018. Physical mortality was not evaluated for channel enclosures.

### Findings

#### WCFM Risk Register

Table 5C-3 provides an overview of the identified physical mortality risks throughout the MMSD planning area as documented in the WCFM Risk Register.

**TABLE 5C-3: WATERCOURSE AND FLOOD MANAGEMENT ASSET SYSTEM - PHYSICAL MORTALITY RISKS BY WATERSHED**

Watershed	High Risk	Moderate Risk	Low Risk	Minimal Risk	Total
Lake Michigan Drainage	0	0	0	0	0
Kinnickinnic River	1	3	5	2	11
Root River	0	0	0	0	0
Menomonee River	1	4	6	2	13
Oak Creek	0	0	0	0	0
Milwaukee River	2	4	2	0	8
<b>Totals</b>	<b>4</b>	<b>11</b>	<b>13</b>	<b>4</b>	<b>32</b>

Of the 32 identified risks, four risks are high; these risks are presented in Table 5C-4. MMSD is currently implementing short-term solutions to address three of the high risks. Potential and planned long-term solutions for all four risks are evaluated in Chapter 6.

**TABLE 5C-4: HIGH PHYSICAL MORTALITY RISKS IDENTIFIED IN WATERCOURSE AND FLOOD MANAGEMENT RISK REGISTER NOT ALREADY ADDRESSED BY MMSD STRATEGIES**

Risk ID	Risk Level	Risk Description
W014	High	Increased safety risk from erosion and potential sinkhole formation due to failure of corrugated metal pipe culvert at State Fair (Honey Creek Reach 2)
W015	High	Increased safety risk from erosion and potential sinkhole formation due to failure of corrugated metal pipe culvert at 43rd and Lincoln (43rd St Ditch)
W109	High	Increased safety risk due to metal cage from gabion/revetment fraying, leading to sharp edges poking out (Lincoln Creek Reach 4)
W110	High	Increased safety risk due to metal cage from gabion/revetment fraying, leading to sharp edges poking out (Lincoln Creek Reach 5)

## Concrete-lined Channels

There are about 15 miles of concrete-lined channels on MMSD jurisdictional streams (19.6 miles if enclosed culverts are also included). Table 5C-5 summarizes the age of the concrete-lined channels that are about 50 years old or older. Table 5C-6 summarizes their physical condition. A review of concrete-lined channels determined the following:

### Concrete-lined Channels - Age

- There are approximately 5.5 miles of concrete-lined channel over 50-years old in the Kinnickinnic River watershed, as shown in Table 5C-5. The remaining concrete-lined channels in the Kinnickinnic River watershed were installed between 1950 and 1987.
- The remaining concrete-lined channels in the Menomonee River watershed were installed between 1953 and 1971, with the majority dating to the 1960s. There are approximately 6.9 miles of concrete-lined channel over 50-years old, as shown in Table 5C-5.
- The only concrete-lined channel in the Milwaukee River watershed is a 0.6-mile-long reach along Beaver Creek. The estimated age of this concrete-lined channel is 52 years.

### Concrete Channel Bed / Bank - Condition

- A summary of the condition of the concrete-lined channels as determined by MMSD summer intern staff is included in Table 5C-6. The physical condition assessments for the “bed/bank” of various watercourse reaches in the Kinnickinnic, Menomonee, and Milwaukee River watersheds ranged from “failing” channel to “good” condition. The Menomonee River watershed has the only channel assessed as “failing,” with 0.2 miles, as well as the largest amount of channel assessed as “good,” with 2.8 miles.

**TABLE 5C-5: AGE OF CONCRETE-LINED CHANNEL SUMMARY (EXCEEDING OR APPROACHING 50 YEARS OLD)**

Watershed	Miles of Concrete-Lined Channel, Year Constructed (Age as of 2019)													
	1950 (69)	1951 (68)	1953 (66)	1959 (60)	1960 (59)	1961 (58)	1962 (57)	1963 (56)	1964 (55)	1965 (54)	1966 (53)	1967 (52)	1971 (48)	1973 (46)
Kinnickinnic River	0.40	0.86	-	0.72	2.04	-	0.80	0.55	0.12	-	-	-	-	0.74
Menomonee River	-	-	1.27	-	-	0.48	-	0.75	-	1.04	0.93	2.4	0.98	-
Milwaukee River	-	-	-	-	-	-	-	-	-	-	-	0.62	-	-
<b>Total</b>	<b>0.40</b>	<b>0.86</b>	<b>1.27</b>	<b>0.72</b>	<b>2.04</b>	<b>0.48</b>	<b>0.8</b>	<b>1.30</b>	<b>0.12</b>	<b>1.04</b>	<b>0.93</b>	<b>3.02</b>	<b>0.98</b>	<b>0.74</b>

**TABLE 5C-6: CONCRETE-LINED CHANNEL PHYSICAL CONDITION SUMMARY**

Watershed	Concrete Channel Bed / Bank Physical Condition – 2016 Assessment (miles)*				
	Failing	Very Poor	Poor	Moderate	Good
Kinnickinnic River	0	0.1	2.2	2.8	2.1
Menomonee River	0.2	0	0	4.3	2.8
Milwaukee River	0	0	0	0.05	0.57
<b>Total</b>	<b>0.2</b>	<b>0.1</b>	<b>2.2</b>	<b>7.15</b>	<b>5.47</b>

\* Lengths for the Milwaukee River were adjusted to reflect 2019 concrete-lined channel removal along Beaver Creek

MMSD plans to replace all concrete-lined channels in the future with naturalized channels as they complete flood management projects. Therefore, Chapter 6 evaluates possible mitigation strategies for risks related to concrete-lined channels. Note that as concrete-lined channels are naturalized, additional capacity risks can be created if the channels are not inspected and maintained annually.

## 5.7 LEVEL OF SERVICE FAILURE MODE

### Methodology

The WCFM Risk Register developed in 2016 was used to assess potential level of service risks, which were all assigned to the time period ‘Before 2020.’ The following level of service categories identified in Chapter 3 were used to determine potential level of service failures using the COF definitions provided in Appendix 5C-8, WCFM Risk Register COF Definitions:

- Permit Requirements
- Energy
- Environmental Improvements
- Fiscal Responsibility
- Management Effectiveness
- Safety
- Customer Service, Communication and Employee Development

In addition to the WCFM Risk Register, MMSD’s Watercourse Department has conducted numerous floodplain management studies that have identified flooded structures within the 1-percent annual probability event floodplain. Data for flooded structures summarized in this chapter are based on information developed by MMSD’s Watercourse Department and included in an inventory used to track structures remaining in or no longer threatened by the 1-percent annual probability floodplain for all jurisdictional streams from 1999 to 2018 titled “StructuresFloodplain2018.xlsx” dated November 5, 2018.<sup>2</sup>

In addition, SEWRPC conducted an evaluation to determine the number of flooded structures and monetary flood damages during the 1-, 2- and 4-percent annual probability events based on 2035 land use for selected sections of various watercourses. [1] This information was used to see where flooding occurs more frequently.

Note that the number of flooded structures as determined by MMSD and SEWRPC may differ in part because SEWRPC only evaluated selected reaches of the various watercourses, and the 1-percent annual probability event flows used in SEWRPC’s analysis are based on updated hydrology and 2035 land use whereas MMSD’s tabulation is based on historical studies and data for all jurisdictional streams.

### Findings

#### WCFM Risk Register

Sixty-one identified risks were specific to a watershed and four additional risks identified across multiple watersheds. Table 5C-7 provides a summary of risks identified in the WCFM Risk Register that are related to level of service by watershed. The Menomonee River had the greatest total number of risks, and the Kinnickinnic River had the greatest number of moderate risks among the watersheds (there

<sup>2</sup> The structure counts are based on the best available data for each stream. In some cases, this was the existing Federal Emergency Management Agency (FEMA) regulatory floodplain (based on regulatory flows) as of 2018. In other cases, this was updated mapping with more recent data, but still represents conditions as of 2018.



were no high risks for individual watersheds). For more detail on the risks by watercourse, see Appendices 5C-1 through 5C-6, along with Appendix 5C-9, WCFM Risk Register – LOS Risks.

Two high level risks were identified that impact multiple watersheds, which are summarized in Table 5C-8. The two high level risks that impact multiple watersheds relate directly to planned flood management projects or are anticipated to be addressed in Watercourse Management Plans under development as of 2019.

**TABLE 5C-7: LEVEL OF SERVICE RISKS BY WATERSHED**

Watershed	High Risk	Moderate Risk	Low Risk	Minimal Risk	Total
Lake Michigan Drainage	0	3	0	0	3
Kinnickinnic River	0	12	9	0	21
Root River	0	0	2	0	2
Menomonee River	0	11	13	0	24
Oak Creek	0	3	1	0	4
Milwaukee River	0	3	3	1	7
<i>Subtotal</i>	<i>0</i>	<i>32</i>	<i>28</i>	<i>1</i>	<i>61</i>
Multiple watersheds	2	1	1	0	4
<b>Totals</b>	<b>2</b>	<b>33</b>	<b>29</b>	<b>1</b>	<b>65</b>

**TABLE 5C-8: HIGH LEVEL OF SERVICE RISKS IDENTIFIED IN WATERCOURSE AND FLOOD MANAGEMENT RISK REGISTER NOT ALREADY ADDRESSED BY MMSD STRATEGIES**

Risk ID	Risk Level	Risk Description
W016	High	Risk of unforeseen emergency situations due to a lack of a Watercourse Asset Management Program (multiple watersheds)
W055	High	Risk of downstream MMSD assets (stream restoration projects, conveyance system, WRFs) being adversely impacted by non-MMSD entities not following Chapter 13 Stormwater Rule (multiple watersheds)

### MMSD Internal Documentation

In addition to the capacity issues identified in the Risk Register (Appendix 5C-7), there are 1,267 flooded structures that have been identified in other MMSD documentation. The total number of flooded structures in each watershed based on MMSD data is provided in Table 5C-9. Potential mitigation strategies for these flooded structures are addressed in Chapter 6. A more detailed breakdown by watercourse is provided in Appendices 5C-1 through 5C-6 (Table 2 in each appendix). Flood damages and the number of affected structures determined by SEWRPC for selected portions of the streams are also provided in Appendices 5C-1 through 5C-6 (Table 4 in each appendix).

**TABLE 5C-9: ESTIMATED NUMBER OF FLOODED STRUCTURES PER WATERSHED DURING 1-PRECENT ANNUAL PROBABILITY RAINFALL EVENT**

Watershed	Number of Flooded Structures (1-percent Annual Probability Event)
Lake Michigan Drainage and Estuaries (lake effect)	58
Kinnickinnic River	635
Root River	14
Menomonee River	147
Oak Creek	12
Milwaukee River	401
<b>Total</b>	<b>1,267</b>

Source: MMSD Watercourse Department

## 5.8 ECONOMIC EFFICIENCY FAILURE MODE

Economic efficiency assessments are designed to determine if lower cost alternatives are available to meet the required service levels. Due to limited available data, economic efficiency failure risks received limited evaluation in the 2050 FP, but these risks are intended to be analyzed in more detail in future AMPs. For the 2050 FP, broad economic risks were considered and identified in the Risk Register developed in 2016 using the same methodology outlined in Section 5.7. All identified economic efficiency risks were assigned to the time period ‘Before 2020.’ There were eight economic efficiency risks identified, none of which was classified as a high risk, as shown in Table 5C-10. Further information on these risks is available in the Appendix 5C-10, WCFM Risk Register – Economic Efficiency Risks.

**TABLE 5C-10: ECONOMIC EFFICIENCY RISKS BY WATERSHED**

Watershed	High Risk	Moderate Risk	Low Risk	Minimal Risk	Total
Lake Michigan Drainage	0	1	0	0	1
Kinnickinnic River	0	1	0	0	1
Root River	0	0	0	0	0
Menomonee River	0	2	0	0	2
Oak Creek	0	0	0	0	0
Milwaukee River	0	0	0	0	0
Multiple watersheds	0	1	2	1	4
<b>Totals</b>	<b>0</b>	<b>5</b>	<b>2</b>	<b>1</b>	<b>8</b>

## 5.9 SUMMARY OF FINDINGS

The assessments completed in this chapter indicate that physical mortality and level of service issues of various watercourses account for most of the necessary improvements. Additionally, many of the concrete-lined channels will need to be removed due to the advanced age of these assets. The following summarizes the identified risks:

- **Capacity Risks.** There are no high-level risks identified.
- **Physical Mortality Risks.** There are four high-level risks identified in the WCFM Risk Register. In addition, potential mitigation strategies to address the concrete-lined channel risks in the Kinnickinnic, Menomonee, and Milwaukee River watersheds are evaluated in Chapter 6.
- **Level of Service Risks.** There are two high risks identified, both of which apply to the entire WCFM Asset System. In addition, there are 1,267 flooded structures remaining within the 1-percent annual probability event in MMSD’s planning area as of 2018. The Kinnickinnic River watershed contains almost half of these flooded structures, yet it has the second smallest drainage area of the jurisdictional watercourses. Potential mitigation strategies to address the 2 risks plus the flooded structures are evaluated in Chapter 6.
- **Economic Risks.** There are no high-level risks identified.

## 5.10 APPENDICES

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Information used to develop this appendix may be found in the following documents:

- Appendix 5C-1, Kinnickinnic River Watershed Dashboard
- Appendix 5C-2, Lake Michigan Direct Watershed Dashboard
- Appendix 5C-3, Menomonee River Watershed Dashboard
- Appendix 5C-4, Milwaukee River Watershed Dashboard
- Appendix 5C-5, Oak Creek River Watershed Dashboard
- Appendix 5C-6, Root River Watershed Dashboard
- Appendix 5C-7, WCFM Risk Register
- Appendix 5C-8, WCFM Consequence of Failure Definitions
- Appendix 5C-9, WCFM Risk Register – LOS Risks
- Appendix 5C-10, WCFM Risk Register – Economic Efficiency Risks

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## 5.11 REFERENCES

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- [1] Southeastern Wisconsin Regional Planning Commission, *MMSD 2050 Facilities Plan - SEWRPC Floodplain Analyses*, Waukesha, WI: SEWRPC, November 29, 2017.
- [2] Milwaukee Metropolitan Sewerage District, *Chapter 13, Surface Water and Stormwater Rules*, Milwaukee, WI: MMSD, Amended December 19, 2016.

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**APPENDIX 5C-1: Kinnickinnic River Watershed Dashboard**

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# KINNICKINNIC RIVER WATERSHED

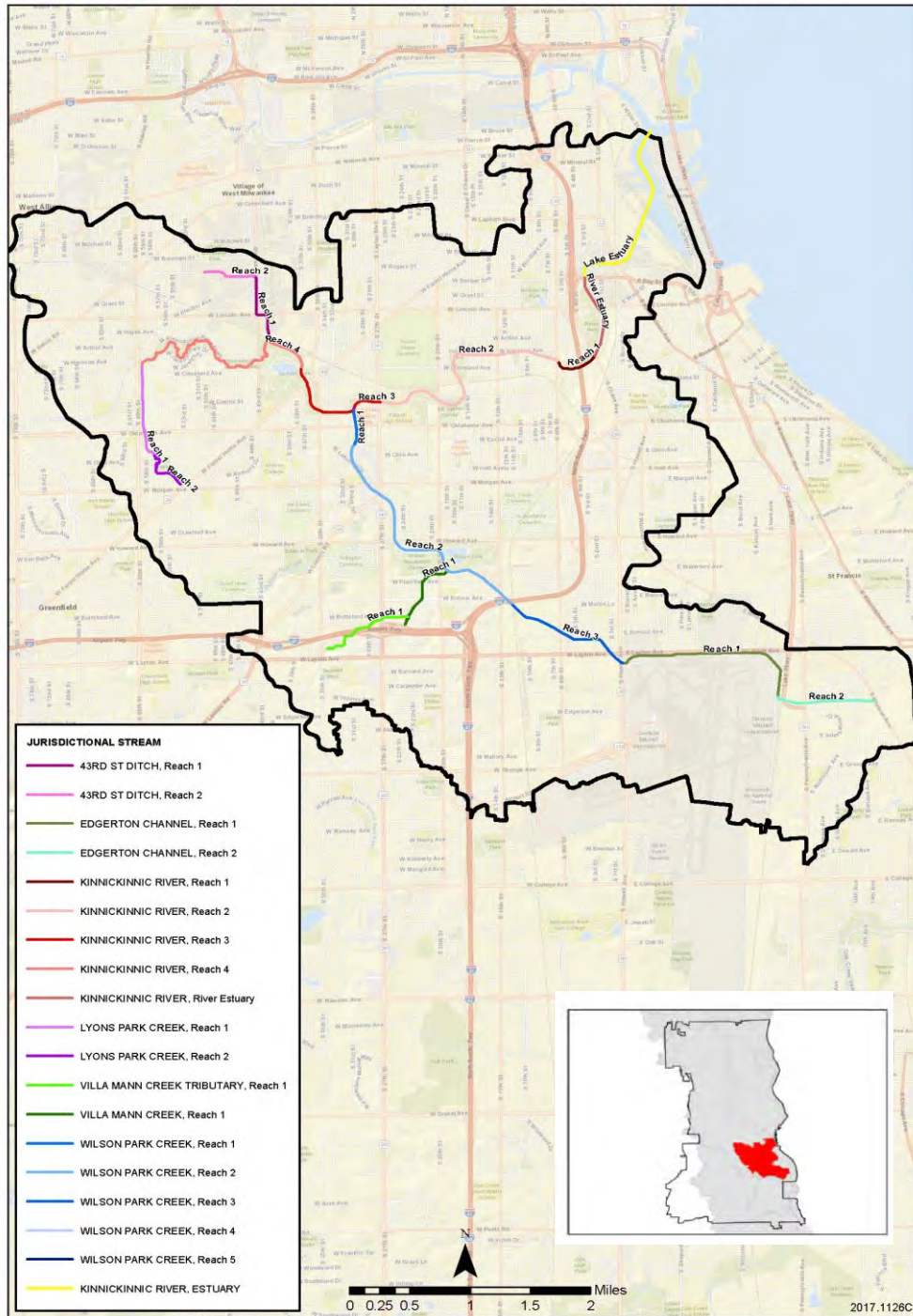


Figure 1: Kinnickinnic River watershed jurisdictional areas

## 1. ASSET SYSTEM DESCRIPTION

There are six watersheds within MMSD’s service area: the Kinnickinnic River, Lake Michigan Tributary Drainage, the Menomonee River, the Milwaukee River, Oak Creek and Root River. MMSD has discretionary authority to maintain these waterways. In the past, this maintenance has included repair and removal of concrete, removal of sediment and flow-impeding objects, and deepening and widening of channels for flood management purposes.

The Kinnickinnic River watershed drains an area of about 26 square miles. Seventy-five percent of the area is within the City of Milwaukee, 6 percent is within the City of Cudahy, 9 percent is within the City of Greenfield, 7 percent is within the City of West Allis, and 2 percent is within the Village of West Milwaukee. There are six streams in the watershed, all of which are under MMSD’s jurisdiction: the Kinnickinnic River Main Stem, Lyons Park Creek, Wilson Park Creek, South 43rd Street Ditch, Villa Mann Creek and Villa Mann Creek Tributary. The streams have been significantly channelized and the watershed is almost fully developed.

Table 1: Kinnickinnic River watershed jurisdictional areas

Watercourse	Municipalities in watershed	Streams under MMSD jurisdiction		Approx. length (miles)
		Upstream terminus	Downstream terminus	
Lyons Creek	Greenfield Milwaukee	W. Forest Home Avenue and W. Morgan Avenue	Kinnickinnic River, at S. 58 <sup>th</sup> Street and Kinnickinnic River Parkway	1.2
Edgerton Channel	Cudahy	S. Whitnall Avenue, south of S. Nicholson Avenue	Wilson Park Creek, east of S. Howell Avenue and 450 feet south of E. Layton Avenue	2.5
Wilson Park Creek	Cudahy Greenfield Milwaukee Saint Francis	East of S. Howell Avenue and 450 feet south of E. Layton Avenue	Kinnickinnic River, near S. 30 <sup>th</sup> Street and W. Manitoba Avenue	3.6
Villa Mann Creek, main stem	Greenfield Milwaukee	I-894, east of S. 27 <sup>th</sup> Street	Wilson Park Creek, near S. 20 <sup>th</sup> Street and W. Plainfield Avenue	0.8
Villa Mann Creek, tributary	Greenfield Milwaukee	W. Colony Drive, east of S. 35 <sup>th</sup> Street	Villa Mann Creek, east of S. 27 <sup>th</sup> Street	0.7
43 <sup>rd</sup> Street Ditch	Milwaukee West Milwaukee	W. Rogers Street and S. 50 <sup>th</sup> Street extended	Kinnickinnic River, near S. 43 <sup>rd</sup> Street and the railroad bridge	1.0
Kinnickinnic River, main stem	Cudahy Greenfield Milwaukee Saint Francis West Milwaukee	S. 58 <sup>th</sup> Street and Kinnickinnic River Parkway	W. Becher Street	6.4
Kinnickinnic River Estuary, lake dominated portion	Milwaukee	W. Becher Street	Milwaukee River	1.7

Source: MMSD Chapter 13 Rule: Maps of District Jurisdictional Watercourses, <https://www.mmsd.com/application/files/2415/5412/8246/JurisdictionalMaps.pdf>

## 2. ASSET PERFORMANCE

There are an estimated 635 structures within the 1-percent probability floodplain along the MMSD jurisdictional streams in the Kinnickinnic River watershed. Eighty (80) structures are no longer in the floodplain due to MMSD projects from 2006 to 2018. Approximately 0.11 miles of concrete-lined channel has been removed from the Kinnickinnic River watershed. There are approximately 8.2 miles of concrete-lined channel and 3.8 miles of underground enclosures. These performance indicators are summarized in Table 2.

Table 2: Kinnickinnic River watershed WCFM performance indicators

Subwatershed	Number of flooded structures *	Miles of concrete-lined channel **	Miles of underground enclosures ***
Main Stem	251	3.52	0.51
Lyons Creek	66	0	0
43 <sup>rd</sup> Street Ditch	8	0.12	0.49
Villa Mann Creek	9	0	0
Wilson Park Creek	274	4.59	2.79
Kinnickinnic River Estuary	27	0	0
<b>Total</b>	<b>635</b>	<b>8.2</b>	<b>3.8</b>

\* Flooded structures within the 1-percent probability event floodplain as of 2018. Source: MMSD, StructuresFloodplain2018.xlsx

\*\* Source: MMSD, MMSD\_ConcreteChannel.xlsx (Aerial/GIS)

\*\*\* Source: MMSD, Watercourse\_Asset\_Table\_EDIT.xlsx

## 3. OPERATIONS & MAINTENANCE AND REHABILITATION/REPLACEMENT FORECAST

MMSD has discretionary authority to maintain waterways under its jurisdiction. Maintenance can include repair and removal of MMSD-installed concrete, removal of sediment and flow-impeding objects, and deepening and widening of channels for flood management purposes. MMSD may provide up to 100 percent of the capital costs for structural and non-structural flood management measures and 100 percent of the operation and maintenance expenditures associated with those measures. The watercourse policy can be found here: [https://onlinemmsd.sharepoint.com/sites/2050fp/Watercourse/Watercourse%20Policy\\_1-01.15\(rev%206-22-15\).doc](https://onlinemmsd.sharepoint.com/sites/2050fp/Watercourse/Watercourse%20Policy_1-01.15(rev%206-22-15).doc).

## 4. RISKS SUMMARY

Risks were identified based on the MMSD asset management Risk Register initially developed as part of the 2050 Facilities Plan. In the Kinnickinnic River watershed, there is one Economic risk, 21 Level-of-Service risks, six Capacity risks, and 11 Physical Mortality risks. There is one high-level risk associated with Physical Mortality (Safety), 22 moderate-level risks, 14 low-level risks, and one minimal-level risk. The moderate-level and high-level risks are shown in Table 3.

Table 3: Kinnickinnic River watershed moderate and high-level risks

Risk ID	Risk Level	Risk Description
W015	High	Corrugated metal pipe culvert is rusting out and failing, causing ground to erode, creating sinkholes.
W018	Moderate	<ul style="list-style-type: none"> <li>• Opportunity for 50-65% USACE cost sharing on feasibility, design and construction projects</li> <li>• WDNR, private, and other grants</li> <li>• MMSD has no dedicated staff to write grants and PMs have limited time to conduct this work. Need someone who can more efficiently and effectively write grants (English major vs. engineer).</li> <li>• MMSD to develop and utilize habitat unit assessment to justify projects for USACE funding.</li> </ul>
W059	Moderate	Risk of flooding of more than 300 residential and commercial structures between S 6th and S 16th Streets. <ul style="list-style-type: none"> <li>• Drop Structures along KK mainstem between 6th and 20th are failing.</li> <li>• Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> </ul>
W061	Moderate	<ul style="list-style-type: none"> <li>• Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.</li> </ul>

Risk ID	Risk Level	Risk Description
W065	Moderate	Concrete channels are beyond their design life and are deteriorated leading to erosion and unsafe conditions (700 linear feet)  Concrete condition assessment: Poor - Very poor
W067	Moderate	<ul style="list-style-type: none"> <li>• High risk of upstream flooding even when maintained properly.</li> <li>• Bridge on KK River at 43rd Street is undersized.</li> </ul>
W068	Moderate	<ul style="list-style-type: none"> <li>• Risk of upstream flooding if not maintained properly.</li> <li>• Culvert in poor condition in KK just d/s of confluence with 43rd St Ditch (4-circular culverts).</li> </ul>
W069	Moderate	<ul style="list-style-type: none"> <li>• High risk of upstream flooding even when maintained properly.</li> <li>• Culvert under RR on 43rd Street Ditch just upstream of KK River confluence is undersized.</li> </ul>
W072	Moderate	Risk of flooding of approximately 66 structures
W074	Moderate	<ul style="list-style-type: none"> <li>• Risk of flooding of approximately 9 structures, primarily located along the enclosed section of the ditch under S 43rd Street.</li> <li>• Roadway flooding at Lincoln and 43rd Street.</li> </ul>
W076	Moderate	Culvert beneath hotel at S 27th St undersized causing hotel to flood.
W077	Moderate	Risk of flooding of approximately 9 structures, primarily located northwest of the I-43/894 and S 27th Street interchange.
W078	Moderate	Risk of flooding for over 50 residential and commercial structures in the vicinity of S 6th Street and W Armour Avenue.



Risk ID	Risk Level	Risk Description
W081	Moderate	High velocities and steep, slippery concrete side slopes make concrete-lined channels difficult to escape from during high flows.
W082	Moderate	Risk of upstream flooding if culverts not maintained properly: three culverts under the Point Loomis shopping center between W Morgan Avenue and S 27th Street and one under W Lakefield Avenue at W Howard Avenue.
W084	Moderate	High velocities and steep, slippery concrete side slopes make concrete-lined channels difficult to escape from during high flows.
W085	Moderate	Risk of flooding more than 90 structures.
W087	Moderate	High velocities and steep, slippery concrete side slopes make concrete-lined channels difficult to escape from during high flows.
W088	Moderate	Risk of flooding of an underdetermined number of structures. Some structures flood during higher frequency storm events.
W095	Moderate	<ul style="list-style-type: none"> <li>• Risk of upstream flooding if not maintained properly, if local owner does not maintain any debris blockage.</li> <li>• Railroad bridge and 5th and 6th St bridges are undersized.</li> </ul>
W096	Moderate	<ul style="list-style-type: none"> <li>• CMP culverts between Morgan Ave and Loomis Road in poor shape (likelihood of failure higher than normal and COF high).</li> <li>• CMP culverts are owned by MMSD, while the concrete culverts under Morgan and Loomis are not.</li> </ul>

Risk ID	Risk Level	Risk Description
W101	Moderate	MMSD took over jurisdiction for the estuary. There are 33 structures prone to flooding.
W116	Moderate	<ul style="list-style-type: none"> <li>• Risk of flooding if not maintained properly</li> <li>• WPA wall holding up 16th St along KK Mainstem in poor condition.</li> </ul>

## 5. SEWRPC FLOOD DAMAGES ASSESSMENT

MMSD’s goal is to protect structures that are within the 1-percent probability floodplain (100-year recurrence interval). There are an estimated 635 structures within the 1-percent probability floodplain in the Kinnickinnic River watershed. MMSD assesses the conditions of the watersheds under its jurisdiction on a routine basis.

To provide a more accurate assessment of the overall asset capacity, structure flooding must be evaluated for more frequent storm events than the 1-percent probability storm event. Subwatersheds that contain structures that flood more frequently have a higher likelihood of failure and a greater impact on safety and fiscal responsibility. Table 4 provides available estimates from the Southeastern Wisconsin Regional Planning Commission (SEWRPC) on the number of structures with damages and the cost of those damages.

Table 4: Estimated total damages to structures during selected annual probability flood events

Sub-watershed	25-year RI		50-year RI		100-year RI	
	# of structures with damages	Total estimated damages	# of structures with damages	Total estimated damages	# of structures with damages	Total estimated damages
Main Stem						
Lyons Creek						
43 <sup>rd</sup> Street Ditch						
Villa Mann Creek						
Wilson Park Creek						
Kinnickinnic River Estuary						
Total						

*Data for the Kinnickinnic River was not prepared for the 2050 Facilities Plan*

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**APPENDIX 5C-10: WCFM Risk Register – Economic Efficiency Risks -**

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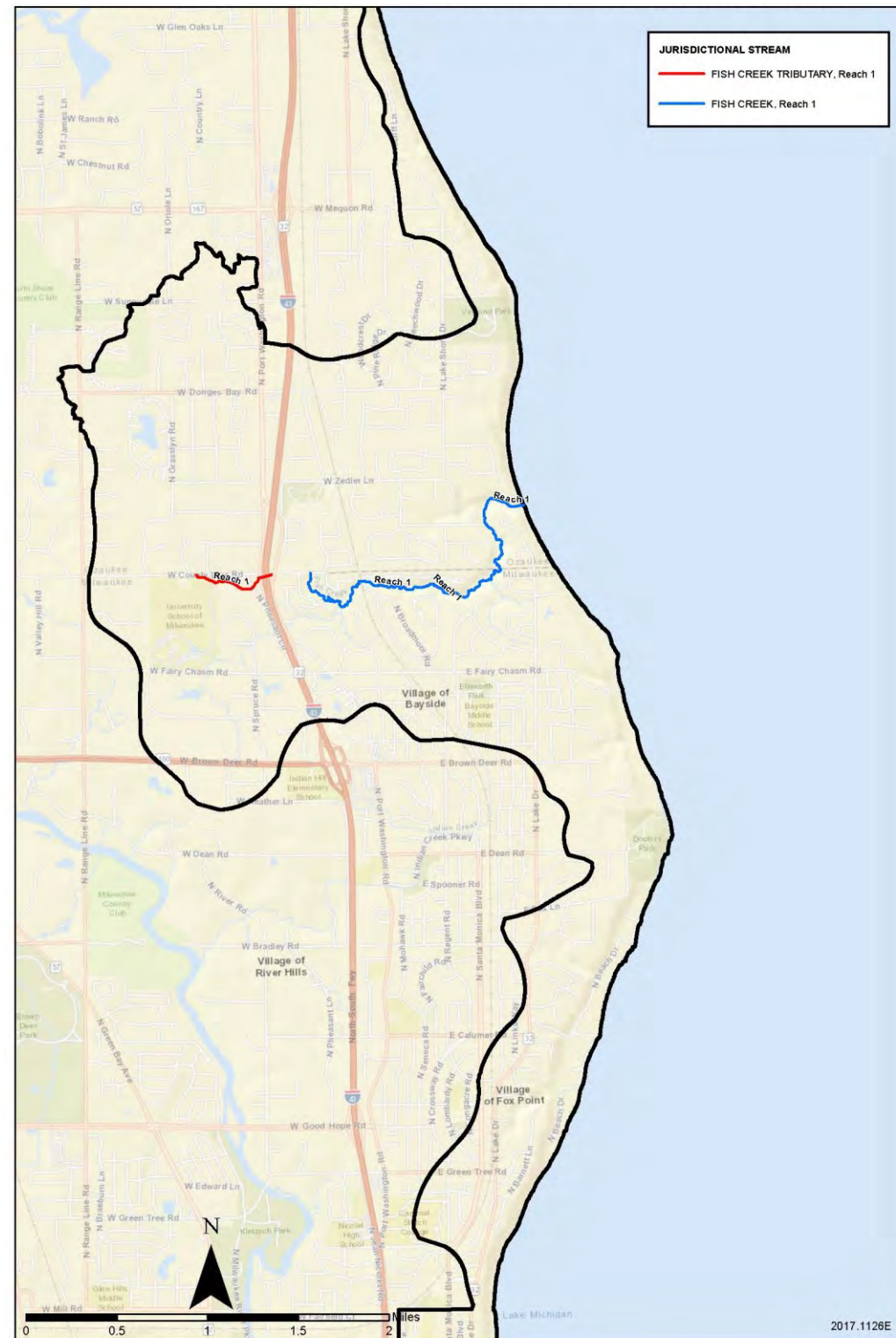
MMSD 2050 Facilities Plan  
Watercourse and Flood Management Asset System  
Risk Register - Economic Efficiency Risks

Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W003	Increased cost to MMSD if fail to effectively pursue and maximize opportunities for cost sharing on projects (Multiple)	Multiple	<ul style="list-style-type: none"> <li>Opportunity for 50-65% USACE cost sharing on feasibility, design and construction projects</li> <li>WDNR, private, and other grants</li> <li>MMSD has no dedicated staff to write grants. PMs do not have much time to conduct this work and it is beyond their job description.</li> <li>City of Milwaukee bridges and culvert work improvements</li> <li>Milwaukee County conducting storage and channel work improvements in parks.</li> </ul>	<ul style="list-style-type: none"> <li>Proactive and timely submittals of letter requests to USACE</li> <li>Tracking of USACE stages of planning or design for channel projects</li> </ul>	Very Low	Proactively submitting letter request	High	\$1,000,000 - \$10,000,000 total financial impact	Low	Economic	Fiscal Responsibility
W005	Increased maintenance cost and potential decrease in water quality benefits due to use of turf grass vs. native vegetation	Multiple	<ul style="list-style-type: none"> <li>Mowing frequency/cost is higher than native vegetation.</li> <li>Projects such as W33002 N. Branch Root River WC Mgmt, W34001 W. Branch Root River, and W35002 Lower Whitnall Park Creek FM deconstruct structures in the floodplain and restore the turf grass. The turf grass on these properties now must be maintained by MMSD.</li> </ul>	Vegetation maintenance contracts	High	<ul style="list-style-type: none"> <li>Preliminary tech memo states a 36 to 72 percent reduction in annual vegetation maintenance costs when native vegetation is used instead of turf grass.</li> <li>Triple bottom line benefits of native vegetation shown in memo.</li> </ul>	High	Regional (multiple watersheds) erosion and/or negative impact to water quality	Moderate	Economic	Fiscal Responsibility
W008	Increased cost to MMSD if fail to meet ICA, MOU, and grant requirements	Multiple	<ul style="list-style-type: none"> <li>ICU, MOU, and grant agreements not followed and/or not up-to-date, could result in unexpected costs incurred by MMSD.</li> <li>Past examples include W20021 Menomonee River Stream Management and W20025 Removal of Five Low Head Barriers in the Menomonee River</li> </ul>	MMSD has list of agreements (it is assumed a more recent list exists and the date needs to be updated by MMSD).	Very High	Current list of items dated January 18, 2012	Very Low	Violation of municipal/state ICA/MOU/permit identified internally	Minimal	Economic	Fiscal Responsibility
W011	Risk of legal action due to failure to meet Wisconsin State Standards for MMSD structures that are classified as bridges (Trans 212)	Multiple	<ul style="list-style-type: none"> <li>According to Trans 212, MMSD must inspect structures classified as bridges (openings &gt; 200 feet) every other year. Some MMSD "culverts" are "bridges."</li> <li>Other entities sometimes inspect bridges for MMSD, but MMSD must make sure that the inspections are occurring every other year.</li> <li>In addition to legal issues, there have been some potential issues with Swan Blvd bridge at Milwaukee County Grounds flood management facility regarding public perception issues, structural and surface condition and safety if not maintained properly.</li> </ul>	O&M (mainly inspection every other year)	Very Low	No MMSD "bridge" appears to have an active issue.	High	Significant adverse impact to arterial streets and/or multiple community or industrial buildings, or widespread residential buildings	Low	Economic	Permit Requirements
W017	Increased cost to MMSD if fail to effectively pursue and maximize opportunities for cost sharing on Underwood Creek projects - high priority (Underwood Reach 2)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Opportunity for 50-65% USACE cost sharing on feasibility, design and construction projects</li> <li>WDNR, private, and other grants</li> <li>MMSD has no dedicated staff to write grants and PMs have limited time to conduct this work. Need someone who can more efficiently and effectively write grants (Writer vs. Engineer).</li> <li>MMSD to develop and utilize habitat unit assessment to justify projects for USACE funding.</li> </ul>	<ul style="list-style-type: none"> <li>Proactive and timely submittals of letter requests to USACE</li> <li>Tracking of USACE stages of planning or design for channel projects</li> </ul>	High	Feasibility study pending	High	\$1,000,000 - \$10,000,000 total financial impact	Moderate	Economic	Fiscal Responsibility
W018	Increased cost to MMSD if fail to effectively pursue and maximize opportunities for cost sharing on Kinnickinnic projects - high priority (Kinnickinnic, multiple)	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Opportunity for 50-65% USACE cost sharing on feasibility, design and construction projects</li> <li>WDNR, private, and other grants</li> <li>MMSD has no dedicated staff to write grants and PMs have limited time to conduct this work. Need someone who can more efficiently and effectively write grants (English major vs. engineer).</li> <li>MMSD to develop and utilize habitat unit assessment to justify projects for USACE funding.</li> </ul>	<ul style="list-style-type: none"> <li>Proactive and timely submittals of letter requests to USACE</li> <li>Tracking of USACE stages of planning or design for channel projects</li> </ul>	High	Feasibility study pending	High	\$1,000,000 - \$10,000,000 total financial impact	Moderate	Economic	Fiscal Responsibility
W049	Increased cost to MMSD if fail to effectively pursue and maximize opportunities for cost sharing on Honey Creek projects (Honey Creek Reach 1)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Opportunity for 50-65% USACE cost sharing on feasibility, design and construction projects</li> <li>WDNR, private, and other grants</li> <li>MMSD has no dedicated staff to write grants and PMs have limited time to conduct this work. Need someone who can more efficiently and effectively write grants (English major vs. engineer).</li> <li>MMSD to develop and utilize habitat unit assessment to justify projects for USACE funding.</li> </ul>	<ul style="list-style-type: none"> <li>Proactive and timely submittals of letter requests to USACE</li> <li>Tracking of USACE stages of planning or design for channel projects</li> </ul>	High	Feasibility study pending	High	\$1,000,000 - \$10,000,000 total financial impact	Moderate	Economic	Fiscal Responsibility
W099	Contaminated sediment cleanup/cap in Burnham Canal may not occur if federal funding is not obtained.	LAKE MICHIGAN	Miller Compressing is required to resolve environmental issues within the canal. Through a public-private partnership, MMSD is able to help them improve water quality in the canal. Risks involve not obtaining funding from sources such as USACE, NOAA, Fund for Lake Michigan, and other sources who are interested in wetland restoration and creation. Contamination has been there for many years. No new immediate threat has been identified.	Miller Compressing has instituted guidelines to prevent future contamination and are working with EPA and MMSD to remediate.	High	Contaminants are already in the stream and are having an adverse effect on aquatic species.	High	The site is not listed on the National Priorities List (NPL) but is considered to be a NPL-caliber site and is being addressed through the Superfund Alternative Approach.	Moderate	Economic	Environmental Improvements



## APPENDIX 5C-2: Lake Michigan Direct Watershed Dashboard

# LAKE MICHIGAN DRAINAGE WATERSHED



## 1. ASSET SYSTEM DESCRIPTION

There are six watersheds within MMSD’s service area: the Kinnickinnic River, Lake Michigan Tributary Drainage, the Menomonee River, the Milwaukee River, Oak Creek and Root River. MMSD has discretionary authority to maintain these waterways. In the past, this maintenance has included repair and removal of concrete, removal of sediment and flow-impeding objects, and deepening and widening of channels for flood management purposes.

Fish Creek and a tributary to Fish Creek, which drain an area of about five square miles, are the only jurisdictional streams in the Lake Michigan Drainage watershed. Approximately 55 percent of the drainage area is within the City of Mequon, 25 percent is within the Village of Bayside, and 20 percent is within the Village of River Hills. MMSD’s jurisdictional limits for the Lake Michigan Drainage watershed are shown in Table 1.

Table 1: Lake Michigan Drainage Watershed Jurisdictional areas

Watercourse	Municipalities in watershed	Streams under MMSD jurisdiction		
		Upstream terminus	Downstream terminus	Approx. length
Fish Creek, main stem	Bayside Mequon River Hills	W. County Line Road, between N. Sequoia Drive and N. Wakefield Court	Lake Michigan, north of the Milwaukee County/Ozaukee County border	2.3 mi
Fish Creek, tributary		W. County Line Road, between N. Columbia Creek Lane and N. Glenview Lane	W. County Line Road, Between I-43 and N. Port Washington Road	0.5 mi

Source: MMSD Chapter 13 Rule: Maps of District Jurisdictional Watercourses, <http://www.mmsd.com/rulesandregs/rules>

Figure 1: Lake Michigan Drainage watershed jurisdictional areas

## 2. ASSET PERFORMANCE

There are an estimated 58 structures within the 1-percent probability floodplain along the MMSD jurisdictional streams in the Lake Michigan Drainage watershed including the Menomonee River, Milwaukee River, and Kinnickinnic River estuaries 1-percent probability event water surface elevation on Lake Michigan. There are no underground enclosures or concrete-lined channels in the Lake Michigan Drainage watershed under MMSD jurisdiction. These performance indicators are summarized in Table 2.

Table 2: Lake Michigan Drainage watershed WCFM performance indicators

Subwatershed	Number of flooded structures *	Miles of concrete-lined channels	Miles of underground enclosures
Fish Creek	7	0	0
Menomonee River Estuary **	22	0	0
Milwaukee River Estuary **	10	0	0
Kinnickinnic River Estuary **	19	0	0
Total	58	0	0

\* Flooded structures within the 1-percent probability event floodplain as of 2018. Source: MMSD, StructuresFloodplain2018.xlsx

\*\* Lake effect

## 3. OPERATIONS & MAINTENANCE AND REHABILITATION/REPLACEMENT FORECAST

MMSD has discretionary authority to maintain waterways under its jurisdiction. Maintenance can include repair and removal of MMSD-installed concrete, removal of sediment and flow-impeding objects, and deepening and widening of channels for flood management purposes. MMSD may provide up to 100 percent of the capital costs for structural and non-structural flood management measures and 100 percent of the operation and maintenance expenditures associated with those measures. The watercourse policy can be found at:

[onlinemmsd.sharepoint.com/sites/2050fp/Watercourse/Watercourse%20Policy\\_1-01.15\(rev%206-22-15\).doc](https://onlinemmsd.sharepoint.com/sites/2050fp/Watercourse/Watercourse%20Policy_1-01.15(rev%206-22-15).doc)

## 4. RISK SUMMARY

Risks were identified based on the MMSD asset management Risk Register initially developed as part of the 2050 Facilities Plan. In the Lake Michigan Drainage watershed three Level-of-Service risks and one Economic risk were identified. There are four moderate-level risks and no high-level or low-level risks. The moderate-level risks are shown in Table 3.

Table 3: Lake Michigan Drainage watershed moderate and high level of service risks

Risk ID	Risk Level	Risk Description
W001	Moderate	<ul style="list-style-type: none"> <li>Seven structures flood during 100-year event due to overbank flooding at confluence within current MMSD jurisdiction.</li> <li>Update with SEWRPC July 2016 floodplain for mainstem and tributary.</li> </ul>
W098	Moderate	<ul style="list-style-type: none"> <li>One structure floods during 100-year event due to overbank flooding at confluence within current MMSD jurisdiction.</li> <li>Update with SEWRPC July 2016 floodplain for mainstem and tributary.</li> </ul>
W099	Moderate	Miller Compressing is required to resolve environmental issues within the canal. Through a P3 agreement, MMSD is able to help them improve water quality in the canal. Risks involve not obtaining funding from sources such as USACE, NOAA, Fund for Lake Michigan, and other sources who are interested in wetland restoration and creation. Contamination has been there for many years. No new immediate threat has been identified.
W100	Moderate	MMSD took over jurisdiction for the estuary. There are an underdetermined number of structures prone to flooding.

## 5. SEWRPC FLOOD DAMAGES ASSESSMENT

MMSD's goal is to protect structures that are within the 1-percent probability floodplain (100-year recurrence interval). There are an estimated 58 structures within the 1-percent probability floodplain in the Lake Michigan Drainage Watershed. MMSD assesses the conditions of the watersheds under its jurisdiction on a routine basis.

To provide a more accurate assessment of the overall asset capacity, structure flooding must be evaluated for more frequent storm events than the 1-percent probability storm event. Subwatersheds that contain structures that flood more frequently have a higher likelihood of failure and a greater impact on safety and fiscal responsibility. Table 4 provides estimates from the Southeastern Wisconsin Regional Planning Commission (SEWRPC) on the number of structures with damages and the cost of those damages.

Table 4: Estimated total damages to structures during selected annual probability flood events\*

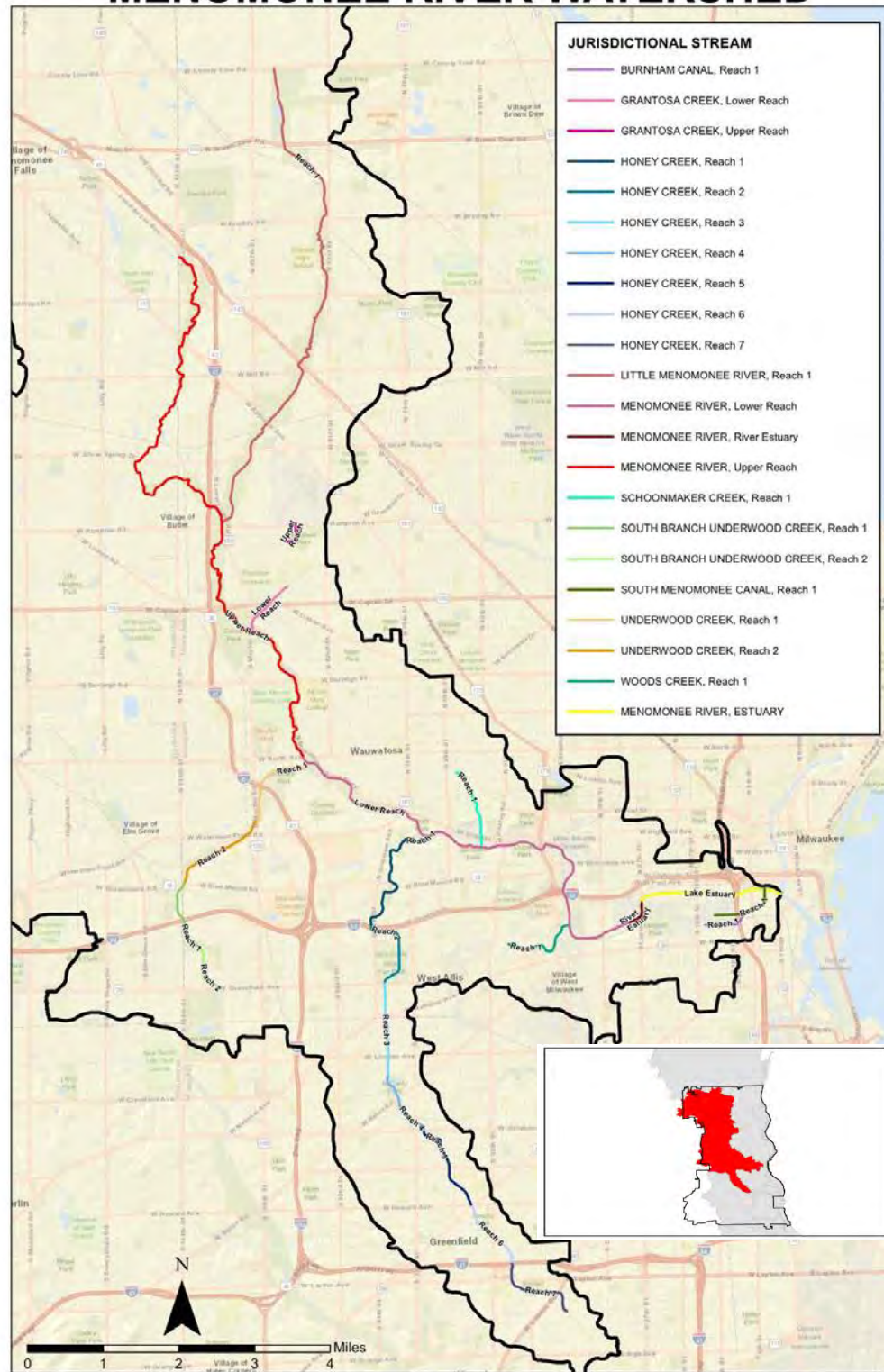
Sub-watershed	25-year RI		50-year RI		100-year RI	
	# of structures with damages	Total estimated damages	# of structures with damages	Total estimated damages	# of structures with damages	Total estimated damages
Fish Creek	21	\$561,810	27	\$734,210	53	\$1,720,160
Total	21	\$561,810	27	\$734,210	53	\$1,720,160

\* Only data available from SEWRPC's 2050 Facilities Plan Assistance contract (Contract No. M03037PI090) is shown.

## APPENDIX 5C-3: Menomonee River Watershed Dashboard



# MENOMONEE RIVER WATERSHED



## 1. ASSET SYSTEM DESCRIPTION

There are six watersheds within MMSD’s service area: the Kinnickinnic River, Lake Michigan Tributary Drainage, the Menomonee River, the Milwaukee River, Oak Creek and Root River. MMSD has discretionary authority to maintain these waterways. In the past, this maintenance has included repair and removal of concrete, removal of sediment and flow-impeding objects, and deepening and widening of channels for flood management purposes.

The Menomonee River Watershed drains an area of approximately 136 square miles. Municipalities in this watershed include the cities of Brookfield, Greenfield, Mequon, Milwaukee, New Berlin, Wauwatosa, West Allis and the villages of Butler, Elm Grove, Germantown, Greendale, Menomonee Falls, and West Milwaukee. Most of the lower two-thirds of the watershed are nearly fully developed in Milwaukee, Wauwatosa, West Allis, Elm Grove, and Brookfield. Significant developable land still exists in Mequon, Menomonee Falls, and Germantown. Major tributaries to the Menomonee River within Milwaukee County include Underwood Creek, Honey Creek, Grantosa Creek, Little Menomonee River, Woods Creek, South Branch Underwood Creek, and Schoonmaker Creek.

Table 1: Menomonee River watershed jurisdictional areas

Watercourse	Municipalities in watershed	Streams under MMSD jurisdiction		
		Upstream terminus	Downstream terminus	Approx. length
Grantosa Creek, upper reach	Milwaukee Wauwatosa	W. Hampton Ave., east of N. 100th St.	N. 100th St., north of W. Glendale Ave.	0.8 mi
Grantosa Creek, lower reach		W Grantosa Dr. at N. 100th St.	Menomonee River, east of N. Mayfair Rd., south of N. Menomonee River Pkwy	0.3 mi
Honey Creek	Greenfield Milwaukee Wauwatosa West Allis	S. 43rd St. near W. Edgerton Ave.	Menomonee River, near W. Hampton Ave. and N. Mayfair Rd.	8.8 mi
Little Menomonee River	Germantown Mequon Milwaukee	Border of Milwaukee and Ozaukee counties at W. County Line Rd., east of N. 107th St.	Menomonee River, near W. Hampton Ave. and N. Mayfair Rd.	6.9 mi

Watercourse	Municipalities in watershed	Streams under MMSD jurisdiction		
		Upstream terminus	Downstream terminus	Approx. length
Menomonee River, main stem	Brookfield Butler Elm Grove Germantown Greendale Greenfield Menomonee Falls Mequon Milwaukee New Berlin Wauwatosa West Milwaukee	Border of Milwaukee and Ozaukee counties, south of US 45	Estuary at S. 29th St., extended	16.3 mi
Schoonmaker Creek	Milwaukee Wauwatosa	W. Lloyd St. at N. 66th St.	Menomonee River, near N. 62nd St.	1.1 mi
Menomonee River, Burnham Canal	Milwaukee	S. 15th Street, extended	South Menomonee Canal	0.6 mi
Menomonee River, South Menomonee Canal	Milwaukee	S. 13th Street, extended	Menomonee River	0.9 mi
Menomonee River Estuary, lake dominated portion	Milwaukee	W. Canal Street	Milwaukee River	1.9 mi
Underwood Creek, main stem	Brookfield Elm Grove Milwaukee New Berlin Wauwatosa West Allis	Border of Milwaukee and Waukesha counties, north of W. Bluemound Rd.	Menomonee River, near W. North Ave. and N. Menomonee River Pkwy	2.6 mi
Underwood Creek, south branch	Wauwatosa West Allis	W. Greenfield Ave., west of S. 116th St.	Underwood Creek, main stem, north of W. Bluemound Rd., west of Underwood Creek Pkwy	1.0 mi
Woods Creek	Milwaukee West Allis West Milwaukee	S. 56th St., north of W. Walker Ave.	Menomonee River, near S. 44th St.	1.1 mi

Source: MMSD Chapter 13 Rule: Maps of District Jurisdictional Watercourses, <https://www.mmsd.com/application/files/2415/5412/8246/JurisdictionalMaps.pdf>

Figure 1: Menomonee River watershed jurisdictional areas

## 2. ASSET PERFORMANCE

There are an estimated 123 structures along the streams and 24 along the Menomonee River estuary within the 1-percent annual probability floodplain in the Menomonee River watershed. Two-hundred and sixty-four (264) structures are no longer in the floodplain due to MMSD projects from 2002 to 2018. Approximately 0.83 miles of concrete-lined channel have been removed from the Menomonee River watershed. There are approximately 9.5 miles of concrete-lined channels and 8.2 miles of underground enclosures remaining. These performance indicators are summarized in Table 2.

Table 2: Menomonee River Watershed WCFM performance indicators

Subwatershed	Number of flooded structures *	Miles of concrete-lined channels **	Miles of underground enclosures ***
Grantosa Creek	0	0	0
Hart Park <sup>1</sup>	2	n. a	0
Honey Creek	12	6.6	6.0
Little Menomonee	1	0	0
Menomonee River Estuary <sup>1</sup>	24	0	0
Menomonee River Parkway <sup>1</sup>	11	n.a.	0
Menomonee Valley <sup>1</sup>	0	n.a.	0
Menomonee River, Lower Reach	n.a.	n.a.	1.0
Schoonmaker Creek	48	TBD	0
Underwood Creek, Main Stem	0	1.32	0
Underwood Creek, South Branch	0	1.7	1.2
Valley Park <sup>1</sup>	0	n.a.	0
Western Milwaukee <sup>1</sup>	49	n.a.	0
Woods Creek	0	0	0
Total	147	9.5	8.2

\* Flooded structures within the 1-percent probability event floodplain as of 2018. **Source:** MMSD, StructuresFloodplain2018.xlsx

\*\* **Source:** MMSD, MMSD\_ConcreteChannel.xlsx (Aerial/GIS)

\*\*\* **Source:** MMSD, Watercourse\_Asset\_Table\_EDIT.xlsx

<sup>1</sup> These areas are not subwatersheds. Rather, they are general areas used to approximately locate flooded structures.

## 3. OPERATIONS & MAINTENANCE AND REHABILITATION/REPLACEMENT FORECAST

MMSD has discretionary authority to maintain waterways under its jurisdiction. Maintenance can include repair and removal of MMSD-installed concrete, removal of sediment and flow-impeding objects, and deepening and widening of channels for flood management purposes. MMSD may provide up to 100 percent of the capital costs for structural and non-structural flood management measures and 100 percent of the operation and maintenance expenditures associated with those measures. The watercourse policy can be found at [onlinemmsd.sharepoint.com/sites/2050fp/Watercourse/Watercourse%20Policy\\_1-01.15\(rev%206-22-15\).doc](https://onlinemmsd.sharepoint.com/sites/2050fp/Watercourse/Watercourse%20Policy_1-01.15(rev%206-22-15).doc).

## 4. RISKS SUMMARY

Risks were identified based on the MMSD asset management Risk Register initially developed as part of the 2050 Facilities Plan. In the Menomonee River watershed, there are two Economic risks, 24 Level-of-Service risks, four Capacity risks, and 13 Physical Mortality risks. There is one high-level risk associated with Physical Mortality (Safety), 20 moderate-level risks, 20 low-level risks, and two minimal-level risks. The high-level and moderate-level risks are shown in Table 3.

Table 3: Menomonee River watershed high-level and moderate-level risks

Risk ID	Risk Level	Risk Description
W009	Moderate	Dam breach during design event would result in 15 structures within the hydraulic shadow upon completion of Western Milwaukee Phase 2B. Currently, 79 structures are within the hydraulic shadow.
W010	Moderate	<ul style="list-style-type: none"> <li>Risk of upstream flooding if not maintained properly.</li> <li>Inlets along Honey Creek between State Fair and Lincoln Ave need to have proper O&amp;M (property access unknown)</li> </ul>
W012	Moderate	Risk of flooding if not maintained properly.
W013	Moderate	High risk of flooding if not maintained properly.

Risk ID	Risk Level	Risk Description
W014	High	Corrugated metal pipe culvert is rusting out and failing, causing ground to erode, creating sinkholes on a major road. Condition is not known for all parts of the CMP.
W017	Moderate	<ul style="list-style-type: none"> <li>Opportunity for 50-65% USACE cost sharing on feasibility, design and construction projects</li> <li>WDNR, private, and other grants</li> <li>MMSD has no dedicated staff to write grants and PMs have limited time to conduct this work. Need someone who can more efficiently and effectively write grants (Writer vs. Engineer).</li> <li>MMSD to develop and utilize habitat unit assessment to justify projects for USACE funding.</li> </ul>
W026	Moderate	Floodproofing of Muellner building in Wauwatosa (commercial property).
W027	Moderate	Risk of flooding for 11 structures in the vicinity of Menomonee River Parkway and W Concordia Avenue.
W030	Moderate	Risk of flooding for approximately 62 structures along the Menomonee River between N 63rd Street and W Monarch Place
W031	Moderate	Risk of flooding for approximately 24 structures along the Menomonee River between S 29th Street and W Canal Street. Updated SEWRPC flooding mapping (due to new climatological data) has preliminarily identified these structures within the floodplain.
W033	Moderate	<ul style="list-style-type: none"> <li>Not maintaining designed conveyance capacity increases the risk of flooding. Specifically, rehabilitated channels where MMSD has removed concrete.</li> <li>Future flow rates will increase and eventually exceed original channel capacity (i.e., atmospheric changes and redevelopment driven)</li> </ul>



Risk ID	Risk Level	Risk Description
W037	Moderate	High velocities and steep, slippery concrete side slopes make concrete-lined channels difficult to escape from during high flows.
W042	Moderate	Risk of flooding of approximately 2 structures between W Howard Avenue and I-43
W044	Moderate	Risk of flooding of approximately 18 structures from W Oklahoma Avenue upstream to W Howard Avenue. This is new flooding (SEWRPC floodplains) that was identified between Euclid and Ohio Avenues.
W046	Moderate	Risk of flooding of approximately 4 structures from W Arthur Avenue upstream to W Oklahoma Avenue
W048	Moderate	SEWRPC has updated the effective floodplain maps to incorporate climatological changes. These maps have increased the floodplain in many areas, either adding structures to the floodplain or increasing flood depths at structures already in the floodplain.
W049	Moderate	<ul style="list-style-type: none"> <li>• Opportunity for 50-65% USACE cost sharing on feasibility, design and construction projects</li> <li>• WDNR, private, and other grants</li> <li>• MMSD has no dedicated staff to write grants and PMs have limited time to conduct this work. Need someone who can more efficiently and effectively write grants (English major vs. engineer).</li> <li>• MMSD to develop and utilize habitat unit assessment to justify projects for USACE funding.</li> </ul>
W056	Moderate	Economic and public safety impact of major flooding events to residences and roadways within the Schoonmaker Creek Watershed

Risk ID	Risk Level	Risk Description
W113	Moderate	<ul style="list-style-type: none"> <li>• Loss of native plantings; diminished aesthetics; higher maintenance costs; complaints from neighbors; invasive species takeover; potential increase in erosion if we lose native plantings; decreased bank/slope stability.</li> <li>• Invasives, particularly crown vetch, are a problem in the Milwaukee County Grounds basins. Crown vetch is susceptible to mass die-outs and the root structure does not offer good soil stabilization. It spreads incredibly quickly, crowding out native species.</li> </ul>
W115	Moderate	<ul style="list-style-type: none"> <li>• Risk of flooding if not maintained properly</li> <li>• Valley Park Floodwalls are critical to prevent flooding.</li> </ul>
W117	Moderate	<ul style="list-style-type: none"> <li>• Risk of flooding if not maintained properly</li> <li>• Western Milwaukee levees will work in conjunction with the Hart Park berm to provide flood protection. Currently, the full protection is not realized because the Western Milwaukee project (2B) has not been built.</li> </ul>

## 5. SEWRPC FLOOD DAMAGES ASSESSMENT

MMSD’s goal is to protect structures that are within the 1-percent probability floodplain (100-year recurrence interval). There are an estimated 147 structures within the 1-percent probability floodplain in the Menomonee River watershed. MMSD assesses the conditions of the watersheds under its jurisdiction on a routine basis.

To provide a more accurate assessment of the overall asset capacity, structure flooding must be evaluated for more frequent storm events than the 1-percent probability storm event. Subwatersheds that contain structures that flood more frequently have a higher likelihood of failure and a greater impact on safety and fiscal responsibility. Table 4 provides estimates from the Southeastern Wisconsin Regional Planning Commission (SEWRPC) on the number of structures with damages and the cost of those damages.

Table 4: Estimated total damages to structures during selected annual probability flood events\*

Sub-watershed	25-year RI		50-year RI		100-year RI	
	# of structures with damages	Total estimated damages	# of structures with damages	Total estimated damages	# of structures with damages	Total estimated damages
Grantosa Creek	Data not available	Data not available	Data not available	Data not available	Data not available	Data not available
Honey Creek	Data not available	Data not available	Data not available	Data not available	Data not available	Data not available
Little Menomonee	1	\$16,000	1	\$17,000	5	\$217,410
Menomonee River Estuary	Data not available	Data not available	Data not available	Data not available	Data not available	Data not available
Menomonee River, main stem **	0	0	1	\$2,660	4	\$213,790
Schoonmaker Creek	Data not available	Data not available	Data not available	Data not available	Data not available	Data not available
Woods Creek	Data not available	Data not available	Data not available	Data not available	Data not available	Data not available
Total	1	\$16,000	1	\$17,000	9	\$431,200

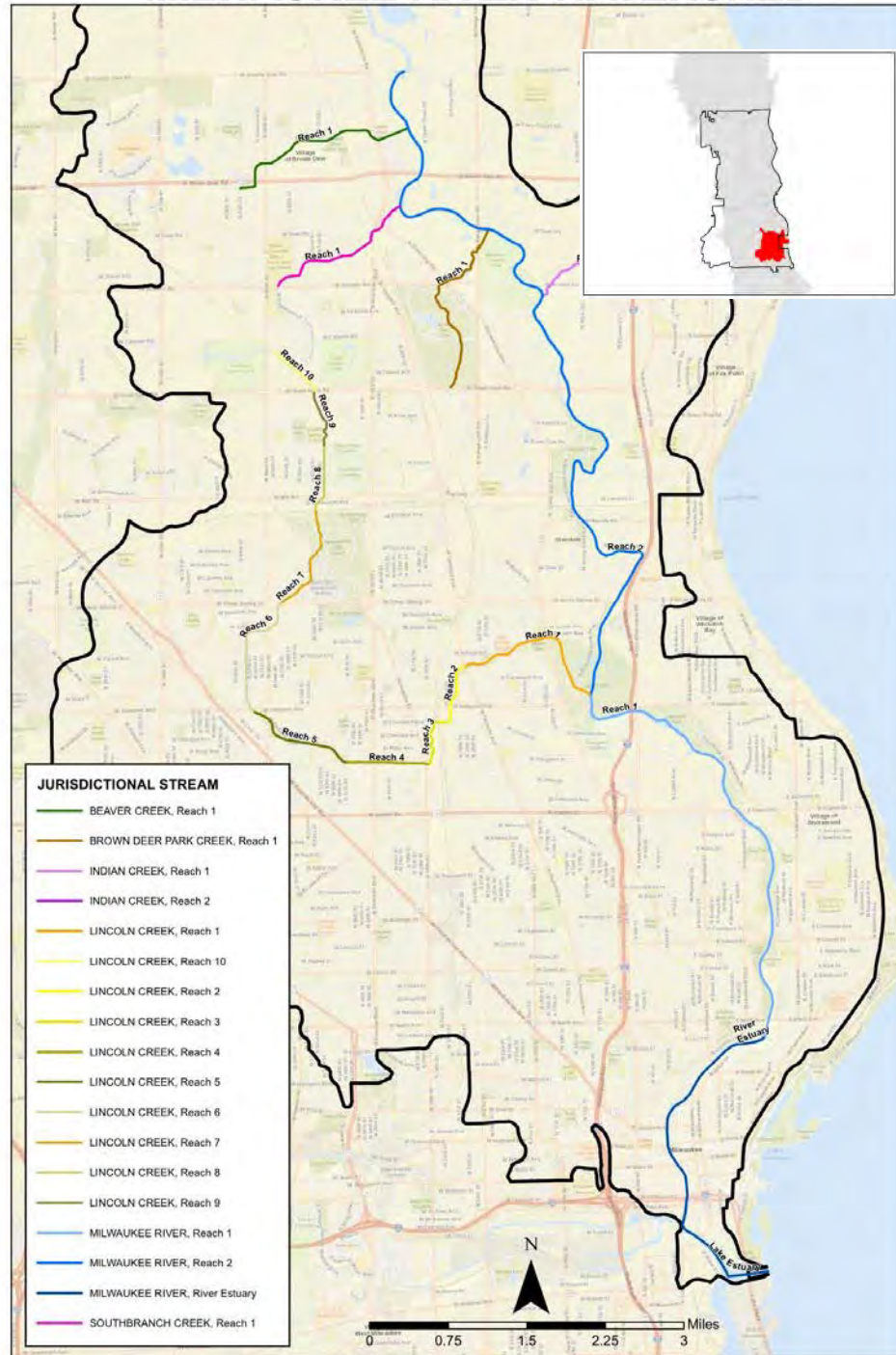
\* Only data available from SEWRPC’s 2050 Facilities Plan Assistance contract (Contract No. M03037PI090) is shown.

\*\* Upstream from Capitol Drive

## APPENDIX 5C-4: Milwaukee River Watershed Dashboard



# MILWAUKEE RIVER WATERSHED



## 1. ASSET SYSTEM DESCRIPTION

There are six watersheds within MMSD’s service area: the Kinnickinnic River, Lake Michigan Tributary Drainage, the Menomonee River, the Milwaukee River, Oak Creek and Root River. MMSD has discretionary authority to maintain these waterways. In the past, this maintenance has included repair and removal of concrete, removal of sediment and flow-impeding objects, and deepening and widening of channels for flood management purposes.

The Milwaukee River watershed drains an area about 700 square miles in Fond du Lac, Dodge, Sheboygan, Ozaukee, Washington, and Milwaukee Counties. The Milwaukee River is nearly 100 miles in length, although only a small portion of the mainstem is under MMSD jurisdiction. Approximately 25 percent of the watershed is developed, mainly within Milwaukee County. The 13-mile portion of the mainstem of the Milwaukee River under MMSD jurisdiction includes the reach from the Milwaukee-Ozaukee County boundary at County Line Road downstream to the former North Avenue Dam located 1,000 feet south of East North Avenue as summarized in Table 1.

Table 1: Milwaukee River watershed jurisdictional areas

Watercourse	Municipalities in watershed	Streams under MMSD jurisdiction		
		Upstream terminus	Downstream terminus	Approx. length
Beaver Creek	Brown Deer Mequon Milwaukee	N. 64th St., south of W. Brown Deer Rd.	Milwaukee River, east of N. Green Bay Rd. and north of Deerwood Dr. extended	1.9 mi
Brown Deer Park Creek	Brown Deer Glendale Milwaukee River Hills	W. Good Hope Rd., 0.5 mile west of N. Range Line Rd.	Milwaukee River, east of N. Range Line Rd.	1.9 mi
Indian Creek	Bayside Fox Point Glendale River Hills	E. Dean Rd. and N. Indian Creek Pkwy	Milwaukee River, south of W. Bradley Rd.	1.9 mi
Lincoln Creek	Brown Deer Glendale Milwaukee	Railroad culvert east of N. 60th St., north of W. Hemlock St.	Milwaukee River, near N. Green Bay Rd. and W. Lawn Ave.	8.1 mi
Milwaukee River, main stem	Bayside Brown Deer Glendale Mequon Milwaukee River Hills Shorewood Thiensville Whitefish Bay	Border of Milwaukee and Ozaukee counties at W. County Line Rd., east of N. Green Bay Rd.	N. Humboldt Avenue	13.1 mi
Milwaukee River Estuary, lake dominated portion*	Milwaukee	N. Humboldt Avenue	Lake Michigan	3.0 mi
Southbranch Creek	Brown Deer Milwaukee River Hills	W. Bradley Rd. and N. Edgeworth Dr.	Milwaukee River, east of N. Green Bay Rd. and N. Teutonia Ave.	1.5 mi

Source: MMSD Chapter 13 Rule: Maps of District Jurisdictional Watercourses, <https://www.mmsd.com/application/files/2415/5412/8246/JurisdictionalMaps.pdf>

Figure 1: Milwaukee River watershed jurisdictional areas

## 2. ASSET PERFORMANCE

There are an estimated 401 structures within the 1-percent annual probability floodplain along the MMSD jurisdictional streams in the Milwaukee River watershed. 2,094 structures are no longer in the floodplain due to MMSD projects from 2000 to 2018. Approximately 3.5 miles of concrete-lined channel have been removed from the Milwaukee River watershed. There are approximately 0.6 miles of concrete-lined channels and 0.6 miles of underground enclosures remaining in the Milwaukee River watershed. These performance indicators are summarized in Table 2.

Table 2: Milwaukee River Watershed WCFM performance indicators

Subwatershed	Number of flooded structures *	Miles of concrete-lined channels	Miles of underground enclosures **
Beaver Creek	13	0.6	0.2
Brown Deer Creek	1	0	0
Indian Creek	7	0	0
Lincoln Creek	0	0	0.4
Milwaukee River, main stem	387	0	0
Southbranch Creek	0	0	0
Total	401	0.6	0.6

\* Flooded structures within the 1-percent probability event floodplain as of 2018. Source: MMSD, StructuresFloodplain2018.xlsx

\*\* Source: MMSD, Watercourse\_Asset\_Table\_EDIT.xlsx

## 3. OPERATIONS & MAINTENANCE AND REHABILITATION/REPLACEMENT FORECAST

MMSD has discretionary authority to maintain waterways under its jurisdiction. Maintenance can include repair and removal of MMSD-installed concrete, removal of sediment and flow-impeding objects, and deepening and widening of channels for flood management purposes. MMSD may provide up to 100 percent of the capital costs for structural and non-structural flood management measures and 100 percent of the operation and maintenance expenditures associated with those measures. The watercourse policy can be found at [onlinemmsd.sharepoint.com/sites/2050fp/Watercourse/Watercourse%20Policy\\_1-01.15\(rev%206-22-15\).doc](https://onlinemmsd.sharepoint.com/sites/2050fp/Watercourse/Watercourse%20Policy_1-01.15(rev%206-22-15).doc).

## 4. RISKS SUMMARY

Risks were identified based on the MMSD asset management Risk Register initially developed as part of the 2050 Facilities Plan. In the Milwaukee River watershed, there are seven Level-of-Service risks and three Capacity risks. There are two high-level risks associated with Physical Mortality (Safety), nine moderate-level risks, six low-level risks, and one minimal-level risk.

Table 3: Milwaukee River watershed moderate and high level of service risks

Risk ID	Risk Level	Risk Description
W019	Moderate	Flood risk for 389 homes - mostly in Glendale
W020	Moderate	Flood risk for 13 structures at confluence with Milwaukee River.
W022	Moderate	Recurring property damage from limited stormwater conveyance capacity. This is flooding due to inadequate stormwater drainage, not riverine flooding.
W023	Moderate	If flood management facilities are not maintained, storage capacity is reduced, and flooding can occur.
W024	Moderate	Risk of flooding if not maintained properly

Risk ID	Risk Level	Risk Description
W105	Moderate	<ul style="list-style-type: none"> <li>Risk of upstream flooding if not maintained properly, if local owner does not maintain any debris blockage.</li> <li>Some culverts MMSD cannot inspect since they cannot visually see during a watercourse channel inspection which pose a risk to whether or not the owner (such as a RR) is performing O&amp;M.</li> <li>Bridges located along Reach 6 of Lincoln Creek.</li> </ul>
W107	Moderate	<ul style="list-style-type: none"> <li>Metal caging is fraying, leading to sharp edges sticking up, causing a hazard located in areas where public has access. Many children play in and around the creek in this area.</li> <li>MMSD mows vegetation and the mower blade will catch on the frayed metal and can rip it off and propel the sharp metal – another hazard.</li> </ul>
W109	High	<ul style="list-style-type: none"> <li>Metal caging is fraying, leading to sharp edges sticking up, causing a hazard located in areas where public has access. Many children play in and around the creek in this area.</li> <li>MMSD mows vegetation and the mower blade will catch on the frayed metal and can rip it off and propel the sharp metal – another hazard.</li> </ul>
W110	High	<ul style="list-style-type: none"> <li>Metal caging is fraying, leading to sharp edges sticking up, causing a hazard located in areas where public has access. Many children play in and around the creek in this area.</li> <li>MMSD mows vegetation and the mower blade will catch on the frayed metal and can rip it off and propel the sharp metal – another hazard.</li> </ul>

Risk ID	Risk Level	Risk Description
W111	Moderate	<ul style="list-style-type: none"> <li>• Metal caging is fraying, leading to sharp edges sticking up, causing a hazard located in areas where public has access. Many children play in and around the creek in this area. Growing Power is located here.</li> <li>• MMSD mows vegetation and the mower blade will catch on the frayed metal and can rip it off and propel the sharp metal – another hazard.</li> <li>• Metal caging downstream of Silver Spring is different from</li> </ul>
W114	Moderate	<ul style="list-style-type: none"> <li>• Risk of flooding if not maintained properly</li> <li>• Floodwalls along Lincoln Creek Reach 4 are critical to prevent flooding.</li> </ul>

### 5. SEWRPC FLOOD DAMAGES ASSESSMENT

MMSD’s goal is to protect structures that are within the 1-percent probability floodplain (100-year recurrence interval). There are an estimated 450 structures within the 1-percent probability floodplain in the Milwaukee River watershed. MMSD assesses the conditions of the watersheds under its jurisdiction on a routine basis.

To provide a more accurate assessment of the overall asset capacity, structure flooding must be evaluated for more frequent storm events than the 1-percent probability storm event. Subwatersheds that contain structures that flood more frequently have a higher likelihood of failure and a greater impact on safety and fiscal responsibility. Table 4 provides estimates from the Southeastern Wisconsin Regional Planning Commission (SEWRPC) on the number of structures with damages and the cost of those damages.

Table 4: Estimated total damages to structures during selected annual probability flood events\*

Sub-watershed	25-year RI		50-year RI		100-year RI	
	# of structures with damages	Total estimated damages	# of structures with damages	Total estimated damages	# of structures with damages	Total estimated damages
Beaver Creek	4	\$50,610	11	\$1,591,100	16	\$2,660,760
Brown Deer Creek	1	\$184,440	2	\$276,850	2	\$314,300
Indian Creek	<i>Data not available</i>	<i>Data not available</i>	<i>Data not available</i>	<i>Data not available</i>	<i>Data not available</i>	<i>Data not available</i>
Lincoln Creek	<i>Data not available</i>	<i>Data not available</i>	<i>Data not available</i>	<i>Data not available</i>	<i>Data not available</i>	<i>Data not available</i>
Main Stem	178	\$3,864,810	307	\$9,046,880	491	\$18,770,370
Southbranch Creek	<i>Data not available</i>	<i>Data not available</i>	<i>Data not available</i>	<i>Data not available</i>	<i>Data not available</i>	<i>Data not available</i>
Total	183	\$4,099,860	320	\$10,914,830	509	\$21,745,430

\* Only data available from SEWRPC’s 2050 Facilities Plan Assistance contract (Contract No. M03037PI090) is shown.

**APPENDIX 5C-5: Oak Creek Watershed Dashboard**



## OAK CREEK WATERSHED

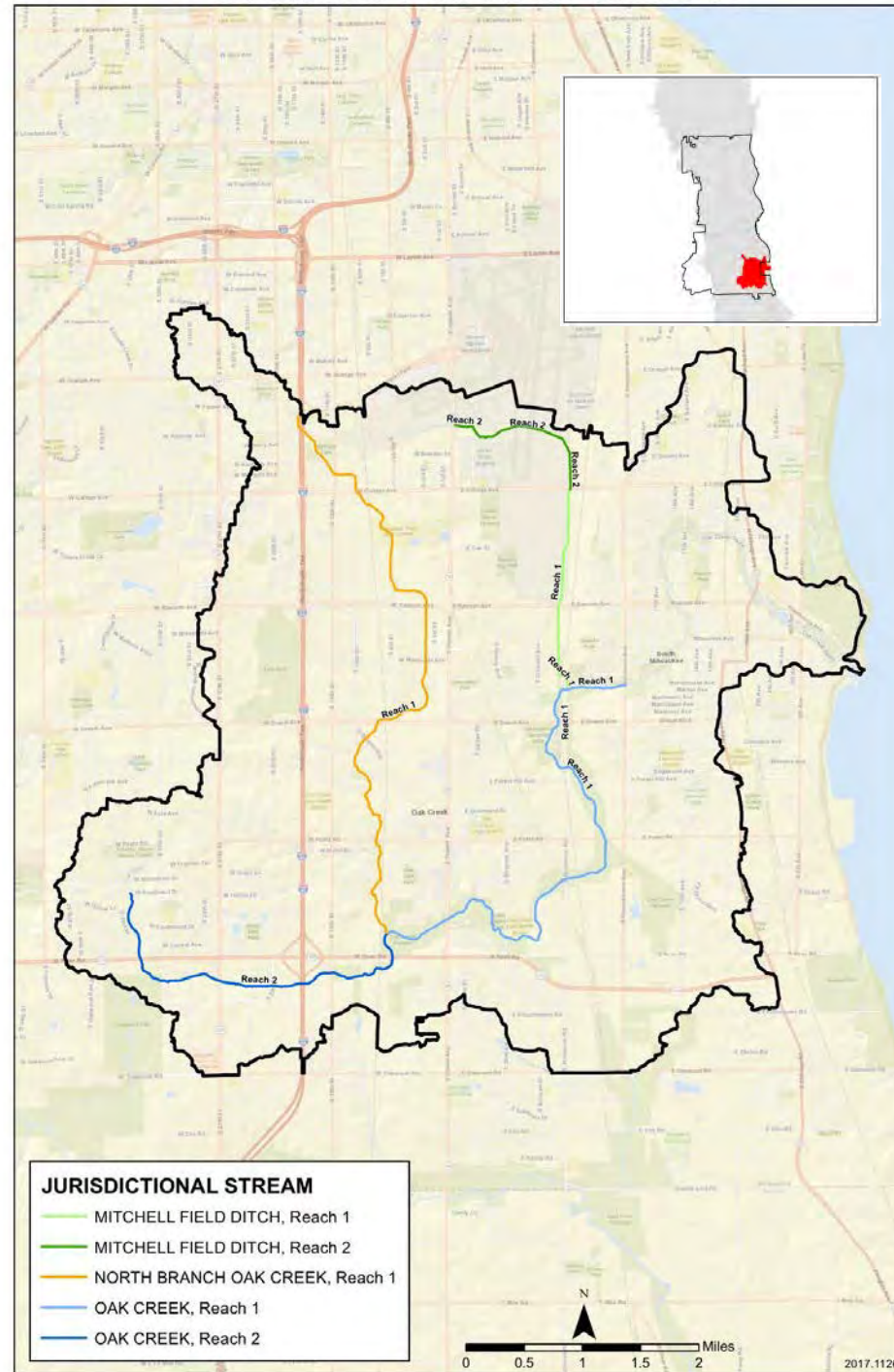


Figure 1: Oak Creek watershed jurisdictional areas

### 1. ASSET SYSTEM DESCRIPTION

There are six watersheds within MMSD’s service area: the Kinnickinnic River, Lake Michigan Tributary Drainage, the Menomonee River, the Milwaukee River, Oak Creek and Root River. MMSD has discretionary authority to maintain these waterways. In the past, this maintenance has included repair and removal of concrete, removal of sediment and flow-impeding objects, and deepening and widening of channels for flood management purposes.

The Oak Creek Watershed drains an area of about 28 square miles. Sixty-four percent of the area is within the City of Oak Creek, 12 percent is within the City of South Milwaukee, 10 percent is within the City of Milwaukee, 9 percent is within the City of Franklin, 4 percent is within the City of Cudahy and 1 percent is within the City of Greenfield. There are three streams in the watershed, all of which are under MMSD’s jurisdiction: the Oak Creek Main Stem, North Branch of Oak Creek, and Mitchell Field Ditch. Portions of the streams have been significantly channelized and the watershed has experienced significant development over the past 40 years.

Table 1: Oak Creek watershed jurisdictional areas

Watercourse	Municipalities in watershed	Streams under MMSD jurisdiction		
		Upstream terminus	Downstream terminus	Approx. length
Mitchell Field Ditch	Cudahy Milwaukee Oak Creek	S. Howell Ave. and E. Citation Way	Oak Creek (main stem), in Clement Avenue Park, east of the railroad tracks	3.3 mi
Oak Creek, main stem	Cudahy Franklin Greenfield Milwaukee Oak Creek South Milwaukee	W. Southland Dr.	S. Pennsylvania Ave., north of Manitowoc Ave.	8.4 mi
Oak Creek, north branch	Greenfield Milwaukee Oak Creek	Culvert under the most southerly crossing of the Airport Spur Freeway	Oak Creek (main stem), near W. Ryan Rd., west of S. Howell Ave.	5.7 mi

Source: MMSD Chapter 13 Rule: Maps of District Jurisdictional Watercourses, <https://www.mmsd.com/application/files/2415/5412/8246/JurisdictionalMaps.pdf>

### 2. ASSET PERFORMANCE

There are an estimated 12 structures within 1-percent probability floodplain along the MMSD jurisdictional streams in the Oak Creek watershed. One structure is no longer in the floodplain due to MMSD projects from 2016 to 2018. There are no concrete-lined channels or underground enclosures along within the Oak Creek watershed under MMSD’s jurisdiction. These performance indicators are summarized in Table 2.

Table 2: Oak Creek watershed WCFM performance indicators

Subwatershed	Number of flooded structures*	Miles of concrete-lined channels	Miles of underground enclosures
Mitchell Field Ditch	0	0	0
Oak Creek, main stem	12	0	0
Oak Creek, north branch	0	0	0
Total	12	0	0

\* Flooded structures within the 1-percent probability event floodplain as of 2018. Source: MMSD, StructuresFloodplain2018.xlsx

### 3. OPERATIONS & MAINTENANCE AND REHABILITATION/REPLACEMENT FORECAST

MMSD has discretionary authority to maintain waterways under its jurisdiction. Maintenance can include repair and removal of MMSD-installed concrete, removal of sediment and flow-impeding objects, and deepening and widening of channels for flood management purposes. MMSD may provide up to 100% of the capital costs for structural and non-structural flood management measures and 100% of the operation and maintenance expenditures associated with those measures. The watercourse policy can be found here at [onlinemmsd.sharepoint.com/sites/2050fp/Watercourse/Watercourse%20Policy\\_1-01.15\(rev%206-22-15\).doc](https://onlinemmsd.sharepoint.com/sites/2050fp/Watercourse/Watercourse%20Policy_1-01.15(rev%206-22-15).doc).

### 4. RISKS SUMMARY

Risks were identified based on the MMSD asset management Risk Register initially developed as part of the 2050 Facilities Plan. In the Oak Creek watershed, there are four Level-of-Service risks and three Capacity risks. There are no high-level risks, six moderate-level risks, and one low-level risk. The moderate-level risks are shown in Table 3.

Table 3: Oak Creek watershed moderate-level risks

Risk ID	Risk Level	Risk Description
W089	Moderate	<ul style="list-style-type: none"> <li>Flood damage to 15 structures in current 1%, 7 in 2%, and 2 in 4% probability floodplains (per SEWRPC data).</li> <li>Hotel flooded at/near College and S 13th St</li> <li>Little slope on culvert under S 13th St just north of the intersection of S 13th St &amp; W Granada St. There are three culverts at this location. Center culvert causes some nearby flooding.</li> </ul>
W090	Moderate	<ul style="list-style-type: none"> <li>Flood damage to 9 structures in current 1%, 5 in 2% and 4 in 4% probability floodplains (per SEWRPC data). Flooding between Southland Dr and Ryan Road; could add structures in other locations as well.</li> <li>Flooded structures south of Ryan Road.</li> </ul>

Risk ID	Risk Level	Risk Description
W092	Moderate	North Branch Oak Creek often clogged often with cattails.
W093	Moderate	<ul style="list-style-type: none"> <li>Risk of upstream flooding if not maintained properly.</li> <li>Little slope on culvert under S 13th Street just North of the intersection of S 13th St &amp; W Granada St. There are three culverts at this location. Blockage increases nearby flooding. Culvert is filled with sediment and cattails.</li> </ul>
W094	Moderate	<ul style="list-style-type: none"> <li>Risk of upstream flooding if not maintained properly, if local owner does not maintain any debris blockage.</li> <li>RR culvert just south of College is not kept clean which aggravates upstream flooding issue. Culvert is filled with sediment and cattails.</li> </ul>
W123	Moderate	<ul style="list-style-type: none"> <li>Flood damage to 2 structures in current 1%, 2 in 2% and 1 in 4% probability floodplains (per SEWRPC data).</li> </ul>

### 5. SEWRPC FLOOD DAMAGES ASSESSMENT

MMSD’s goal is to protect structures that are within the 1-percent probability floodplain (100-year recurrence interval). There are an estimated three structures within the 1-percent probability floodplain in the Oak Creek River watershed. MMSD assesses the conditions of the watersheds under its jurisdiction on a routine basis.

To provide a more accurate assessment of the overall asset capacity, structure flooding must be evaluated for more frequent storm events than the 1-percent probability storm event. Subwatersheds that contain structures that flood more frequently have a higher likelihood of failure and a greater impact on safety and fiscal responsibility. Table 4 provides estimates from the Southeastern Wisconsin Regional Planning Commission (SEWRPC) on the number of structures with damages and the cost of those damages.

Table 4: Estimated total damages to structures during selected annual probability flood events

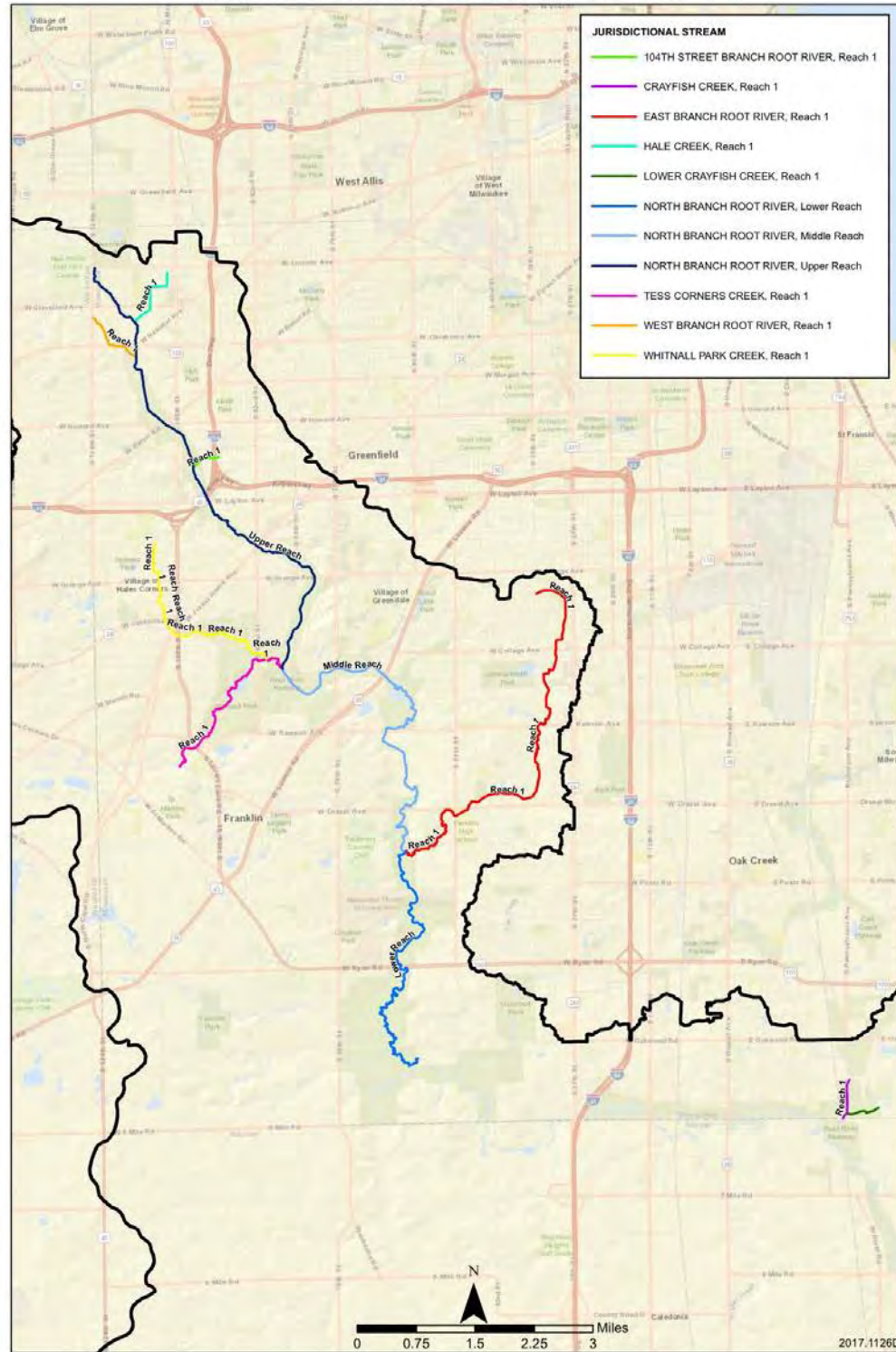
Sub-watershed	25-year RI		50-year RI		100-year RI	
	# of structures with damages	Total estimated damages	# of structures with damages	Total estimated damages	# of structures with damages	Total estimated damages
Mitchell Field Ditch	1	\$131,740	2	\$267,360	2	\$510,330
N. Br. Oak Creek	2	\$547,660	8	\$1,370,250	15	\$2,108,220
Upper Oak Creek	0	0	1	\$13,160	2	\$28,210
Middle Oak Creek	4	\$61,640	4	\$69,410	6	\$101,050
Lower Oak Creek	0	0	0	0	1	\$15,090
Total	7	\$741,040	15	\$1,720,180	26	\$2,762,900

## APPENDIX 5C-6: Root River Watershed Dashboard

DRAFT



# ROOT RIVER WATERSHED



## 1. ASSET SYSTEM DESCRIPTION

There are six watersheds within MMSD’s service area: the Kinnickinnic River, Lake Michigan Tributary Drainage, the Menomonee River, the Milwaukee River, Oak Creek and Root River. MMSD has discretionary authority to maintain these waterways. In the past, this maintenance has included repair and removal of concrete, removal of sediment and flow-impeding objects, and deepening and widening of channels for flood management purposes.

The Root River watershed drains an area of about 197 square miles. Approximately 72 square miles are within MMSD’s service area. There are 59 square miles within Milwaukee County, 32 within the City of Franklin, 6 within the City of Greenfield, 1 within the City of Milwaukee, 8 within the City of Oak Creek, 3 within the City of West Allis, 5 within the Village of Greendale, and 3 within the Village of Hales Corners. There are 13 square miles within Waukesha County, 9 within the City of New Berlin, and 4 within the City of Muskego. According to 1990 SEWRPC land use data, approximately 80 percent of the upper watershed located within Milwaukee County and Waukesha County is currently developed, with significant developable land remaining in the municipalities of Franklin, Oak Creek, New Berlin, and Muskego.

Table 1: Root River watershed jurisdictional areas

Watercourse	Municipalities in watershed	Streams under MMSD jurisdiction		Approx. length (miles)
		Upstream terminus	Downstream terminus	
Crayfish Creek, main stem	Oak Creek	E. Elm Rd., 0.5 miles east of S. Nicholson Rd.	County Line Rd, 0.5 miles east of S. Nicholson Rd.	0.5
Hale Creek	Oak Creek	W. Lincoln Ave., west of WIS 100	Root River (north branch), near W. Montana Ave.	1.3
Lower Crayfish Creek, main stem	Oak Creek	S. 14th St. (extended), north of County Line Rd.	County Line Rd., 0.5 miles east of S. Nicholson Rd.	0.4
Root River, 104th St. branch	Greenfield Milwaukee	West of 99th St., north of W. Cold Spring Rd.	Root River (north branch), south of W. Cold Spring Rd.	0.5
Root River, east branch	Franklin Greendale Greenfield Milwaukee Oak Creek	S. Melinda St., south of W. Parnell Ave.	Root River (north branch), west of S. 60th St. and W. Cascade Dr.	5.2
Root River, north branch	Franklin Greendale Greenfield Hales Corners Milwaukee Muskego New Berlin Oak Creek West Allis	S. Root River Pkwy and W. Lincoln Ave.	S. 60th St., south of W. Oakwood Rd.	13.2
Root River, west branch	New Berlin West Allis	S. 124th St., south of W. Cleveland Ave.	Root River (north branch), south of W. National Ave.	1.0
Tess Corners Creek	Franklin Greendale Muskego New Berlin	0.5 miles southwest of W. Rawson Ave. and S. Lovers Ln.	Root River (north branch), near W. College Ave. and S. Root River Pkwy	2.2
Whitnall Park Creek	Franklin Greenfield Hales Corners Muskego New Berlin	W. Edgerton Ave. and S. 113th St.	Tess Corners Creek, near S. 92nd St. and W. College Ave.	2.7

Figure 1: Root River watershed jurisdictional areas



## 2. ASSET PERFORMANCE

There are an estimated 14 structures within the 1-percent probability floodplain along the MMSD jurisdictional streams in the Root River watershed. Ninety-eight (98) structures are no longer in the floodplain due to MMSD projects from 2002 to 2018. There are no concrete-lined channels or underground enclosures within the Root River watershed under MMSD jurisdiction. These performance indicators are summarized in Table 2.

Table 2: Root River watershed WCFM performance indicators

Subwatershed	Number of flooded structures *	Miles of concrete-lined channels	Miles of underground enclosures
Crayfish Creek	0	0	0
Hale Creek	2	0	0
Lower Crayfish Creek	0	0	0
Root River, 104th St. Branch	0	0	0
Root River, North Branch	0	0	0
Root River, West Branch	2	0	0
Root River, East Branch	1	0	0
Tess Corners Creek	0	0	0
Whitnall Park Creek	9	0	0
Total	14	0	0

\* Flooded structures within the 1-percent probability event floodplain as of 2018. Source: MMSD, StructuresFloodplain2018.xlsx

## 3. OPERATIONS & MAINTENANCE AND REHABILITATION/REPLACEMENT FORECAST

MMSD has discretionary authority to maintain waterways under its jurisdiction. Maintenance can include repair and removal of MMSD-installed concrete, removal of sediment and flow-impeding objects, and deepening and widening of channels for flood management purposes. MMSD may provide up to 100 percent of the capital costs for structural and non-structural flood management measures and 100 percent of the operation and maintenance expenditures associated with those measures. The watercourse policy can be found at:

[onlinemmsd.sharepoint.com/sites/2050fp/Watercourse/Watercourse%20Policy\\_1-01.15\(rev%206-22-15\).doc](https://onlinemmsd.sharepoint.com/sites/2050fp/Watercourse/Watercourse%20Policy_1-01.15(rev%206-22-15).doc)

## 4. RISKS SUMMARY

Risks were identified based on the MMSD asset management Risk Register initially developed as part of the 2050 Facilities Plan. In the Root River watershed, there are two Level-of-Service risks and one Capacity risk. There are no high-level risks, one moderate level risk, and two low-level risks. The moderate-level risk is shown in Table 3.

Table 3: Root River watershed moderate-level risks

Risk ID	Risk Level	Risk Description
W097	Moderate	<ul style="list-style-type: none"> <li>• Risk of upstream flooding if not maintained properly, if local owner does not maintain any debris blockage.</li> <li>• Even though it does not belong to MMSD, have cleaned culvert twice at National Ave.</li> </ul>

## 5. SEWRPC FLOOD DAMAGES ASSESSMENT

MMSD's goal is to protect structures that are within the 1-percent probability floodplain (100-year recurrence interval). There are an estimated 14 structures within the 1-percent probability floodplain in the Root River watershed. MMSD assesses the conditions of the watersheds under its jurisdiction on a routine basis.

To provide a more accurate assessment of the overall asset capacity, structure flooding must be evaluated for more frequent storm events than the 1-percent probability storm event. Subwatersheds that contain structures that flood more frequently have a higher likelihood of failure and a greater impact on safety and fiscal responsibility. Table 4 provides estimates from the Southeastern Wisconsin Regional Planning Commission (SEWRPC) on the number of structures with damages and the cost of those damages.

Table 4: Estimated total damages to structures during selected annual probability flood events [TO BE DETERMINED BY SEWRPC AT A FUTURE DATE \*]

Subwatershed	25-year RI		50-year RI		100-year RI	
	# of structures with damages	Total estimated damages	# of structures with damages	Total estimated damages	# of structures with damages	Total estimated damages
Crayfish Creek	TBD	TBD	TBD	TBD	TBD	TBD
Hale Creek	TBD	TBD	TBD	TBD	TBD	TBD
Lower Crayfish Creek	TBD	TBD	TBD	TBD	TBD	TBD
Root River, 104th St. branch	TBD	TBD	TBD	TBD	TBD	TBD
Root River, north branch	TBD	TBD	TBD	TBD	TBD	TBD
Root River, west branch	TBD	TBD	TBD	TBD	TBD	TBD
Root River, east branch	TBD	TBD	TBD	TBD	TBD	TBD
Tess Corners Creek	TBD	TBD	TBD	TBD	TBD	TBD
Whitnall Park Creek	TBD	TBD	TBD	TBD	TBD	TBD
Total	TBD	TBD	TBD	TBD	TBD	TBD

\* Per SEWRPC, the MCAMLIS Root River efforts are ongoing, with an update to the watershed hydrologic (HSPF) model anticipated to be completed in 2019. Draft floodplain mapping updates will follow stream by stream over the next 5 +/- years.

**APPENDIX 5C-7: WCFM Risk Register -**

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MMSD 2050 Facilities Plan  
Watercourse and Flood Management Asset System Risk Register

Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W001	Structure Flooding (Fish Creek)	LAKE MICHIGAN	<ul style="list-style-type: none"> <li>Seven structures flood during 100-year event due to overbank flooding at confluence within current MMSD jurisdiction.</li> <li>Update with SEWRPC July 2016 floodplain for mainstem and tributary.</li> </ul>	Fish Creek is a natural alluvial conveyance channel. Flood management structures include culverts, railroad and highway embankments. The channels are not stable but eroding.	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W002	Potential negative public perception, political pressure due to Western Milwaukee Phase 2B project delay	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Numerous structures within floodplain and hydraulic shadow without completion of W20029, Phase 2B and with Phase 1 and 2A complete.</li> <li>FEMA LOMR for Menomonee River from Hart Park to Western Milwaukee cannot be approved until this project is completed.</li> </ul>	Phase 1 and 2A complete, a 60% design exists for Phase 2B and plans are in place to complete.	Low	<ul style="list-style-type: none"> <li>1% probability event</li> <li>Phase 2B project is not completed.</li> </ul>	High	<ul style="list-style-type: none"> <li>Issues raised by single public official/commissioner</li> <li>Moderate loss of reputation or long term goodwill with customers, residents and stakeholders</li> </ul>	Low	Level of Service	Customer Service, Communication and Employee Development
W003	Increased cost to MMSD if fail to effectively pursue and maximize opportunities for cost sharing on projects (Multiple)	Multiple	<ul style="list-style-type: none"> <li>Opportunity for 50-65% USACE cost sharing on feasibility, design and construction projects</li> <li>WDNR, private, and other grants</li> <li>MMSD has no dedicated staff to write grants. PMs do not have much time to conduct this work and it is beyond their job description.</li> <li>City of Milwaukee bridges and culvert work improvements</li> <li>Milwaukee County conducting storage and channel work improvements in parks.</li> </ul>	<ul style="list-style-type: none"> <li>Proactive and timely submittals of letter requests to USACE</li> <li>Tracking of USACE stages of planning or design for channel projects</li> </ul>	Very Low	Proactively submitting letter request	High	\$1,000,000 - \$10,000,000 total financial impact	Low	Economic	Fiscal Responsibility
W004	Failure to establish or maintain native vegetation reduces aesthetics, can cause public perception issues and lead to higher maintenance costs (Multiple - unknown locations)	Multiple	<ul style="list-style-type: none"> <li>Loss of native plantings</li> <li>Diminished aesthetics</li> <li>Higher maintenance costs</li> <li>Complaints from neighbors</li> <li>Invasive species take over</li> <li>Potential increase in erosion if we lose native plantings</li> <li>Decreased bank/slope stability</li> </ul>	Vegetation maintenance contracts	High	Critical timeframe for natives to establish is 1-5 years	High	Moderate loss of reputation or long term goodwill with customers, residents and stakeholders	Moderate	Level of Service	Customer Service, Communication and Employee Development
W005	Increased maintenance cost and potential decrease in water quality benefits due to use of turf grass vs. native vegetation	Multiple	<ul style="list-style-type: none"> <li>Mowing frequency/cost is higher than native vegetation.</li> <li>Projects such as W33002 N. Branch Root River WC Mgmt, W34001 W. Branch Root River, and W35002 Lower Whitnall Park Creek FM deconstruct structures in the floodplain and restore the turf grass. The turf grass on these properties now must be maintained by MMSD.</li> </ul>	Vegetation maintenance contracts	High	<ul style="list-style-type: none"> <li>Preliminary tech memo states a 36 to 72 percent reduction in annual vegetation maintenance costs when native vegetation is used instead of turf grass.</li> <li>Triple bottom line benefits of native vegetation shown in memo.</li> </ul>	High	Regional (multiple watersheds) erosion and/or negative impact to water quality	Moderate	Economic	Fiscal Responsibility
W006	Loss of reputation and negative news coverage due to failure to maintain MMSD owned riparian land (Multiple)	Multiple	Not maintaining riparian land (floodplain fringe, green space where properties purchased, etc.)	<ul style="list-style-type: none"> <li>Vegetation maintenance contracts</li> <li>Post-project vegetation maintenance</li> <li>O&amp;M</li> </ul>	Low	MMSD follows their O&M schedules	High	<ul style="list-style-type: none"> <li>Negative coverage at state or local (TV and/or newspaper) level</li> <li>Issues raised by single public official/commissioner</li> <li>Regional (multiple watersheds) erosion and/or negative impact to water quality</li> <li>Angry calls from nearby homeowners. Negative MMSD-brand experiences erode the public's goodwill and willingness to partner with MMSD in the future.</li> </ul>	Low	Level of Service	Customer Service, Communication and Employee Development
W007	Increased flood risk if designed conveyance capacity of rehabilitated channels not maintained (Multiple locations, MMSD installed)	Multiple	<ul style="list-style-type: none"> <li>Not maintaining designed conveyance capacity increases the risk of flooding, specifically, approximately 3 miles of rehabilitated channels where MMSD has recently removed concrete. Approximately 16 miles of MMSD owned concrete channel exist and many will likely be removed in future, increasing this risk.</li> <li>Future flow rates will increase and may exceed original channel capacity (i.e. atmospheric changes and redevelopment driven).</li> </ul>	<ul style="list-style-type: none"> <li>Vegetation maintenance contracts</li> <li>Post-project vegetation maintenance</li> <li>Bedrock, bioengineered, concrete, gabion, natural alluvial, or riprap channels</li> </ul>	High	<ul style="list-style-type: none"> <li>2-yr storms will likely exceed the flow duration that the low flow channel was designed for (excluding concrete).</li> <li>More extreme events may cause structure flooding.</li> </ul>	High	<ul style="list-style-type: none"> <li>Negative coverage at state or local (TV and/or newspaper) level</li> <li>Issues raised by single public official/commissioner</li> <li>Regional (multiple watersheds) erosion and/or negative impact to water quality</li> </ul>	Moderate	Capacity	Customer Service, Communication and Employee Development
W008	Increased cost to MMSD if fail to meet ICA, MOU, and grant requirements	Multiple	<ul style="list-style-type: none"> <li>ICU, MOU, and grant agreements not followed and/or not up-to-date, could result in unexpected costs incurred by MMSD.</li> <li>Past examples include W20021 Menomonee River Stream Management and W20025 Removal of Five Low Head Barriers in the Menomonee River</li> </ul>	MMSD has list of agreements (it is assumed a more recent list exists and the date needs to be updated by MMSD).	Very High	Current list of items dated January 18, 2012	Very Low	Violation of municipal/state ICA/MOU/permit identified internally	Minimal	Economic	Fiscal Responsibility
W009	Risk of flooding if Milwaukee County Grounds dam fails	MENOMONEE RIVER	Dam breach during design event would result in 15 structures within the hydraulic shadow upon completion of Western Milwaukee Phase 2B. Currently, 79 structures are within the hydraulic shadow.	<ul style="list-style-type: none"> <li>Emergency Action Plan (EAP)</li> <li>Milwaukee County Grounds Inspection, Operation and Maintenance Plan (MCG IOM Plan)</li> </ul>	Very Low	MCG design report, i.e. extremely unlikely to happen.	Very High	<ul style="list-style-type: none"> <li>Permanent disability or potential fatality,</li> <li>\$1,000,000 - \$10,000,000 total financial impact</li> <li>Widespread flooding with impacts to 10-100 buildings</li> </ul>	Moderate	Physical Mortality	Safety
W010	Risk of flooding due to inlet/outlet blockage/failure if not properly maintained along Honey Creek (MMSD owned, Honey Creek Reach 3)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Risk of upstream flooding if not maintained properly.</li> <li>Inlets along Honey Creek between State Fair and Lincoln Ave need to have proper O&amp;M (property access unknown)</li> </ul>	O&M	Very Low	MMSD follows their O&M schedules	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact</li> <li>Widespread flooding with impacts to 10-100 buildings</li> </ul>	Moderate	Capacity	Safety

Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W011	Risk of legal action due to failure to meet Wisconsin State Standards for MMSD structures that are classified as bridges (Trans 212)	Multiple	<ul style="list-style-type: none"> <li>According to Trans 212, MMSD must inspect structures classified as bridges (openings &gt; 200 feet) every other year. Some MMSD "culverts" are "bridges."</li> <li>Other entities sometimes inspect bridges for MMSD, but MMSD must make sure that the inspections are occurring every other year.</li> <li>In addition to legal issues, there have been some potential issues with Swan Blvd bridge at Milwaukee County Grounds flood management facility regarding public perception issues, structural and surface condition and safety if not maintained properly.</li> </ul>	O&M (mainly inspection every other year)	Very Low	No MMSD "bridge" appears to have an active issue.	High	Significant adverse impact to arterial streets and/or multiple community or industrial buildings, or widespread residential buildings	Low	Economic	Permit Requirements
W012	Risk of flooding if stormwater pump station fails (MMSD Owned, N 42nd Street and Mt Vernon)	MENOMONEE RIVER	Risk of flooding if not maintained properly.	O&M	Low	MMSD follows their O&M schedules	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact</li> <li>Widespread flooding with impacts to 10-100 buildings</li> </ul>	Moderate	Physical Mortality	Safety
W013	Increased flood risk due to trash rack clogging/failure (MMSD Owned, McCarty Park, Honey Creek Reach 4)	MENOMONEE RIVER	High risk of flooding if not maintained properly.	O&M	Low	<ul style="list-style-type: none"> <li>MMSD follows their O&amp;M schedules.</li> <li>Trash racks will clog and need to be inspected upon floods and maintenance performed.</li> </ul>	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact</li> <li>Widespread flooding with impacts to 10-100 buildings</li> </ul>	Moderate	Capacity	Safety
W014	Increased safety risk from erosion and potential sinkhole formation due to failure of corrugated metal pipe culvert at State Fair (Honey Creek Reach 2)	MENOMONEE RIVER	Corrugated metal pipe culvert is rusting out and failing, causing ground to erode, creating sinkholes on a major road. Condition is not known for all parts of the CMP.	When sinkhole occurred in 2009 or 2010, a patch was placed at the downstream end of the center infield culverts and the upstream end of the north infield culverts. The patches are in very good condition and the construction methods used for these patches should be used for any future patches.	Very High	Failure occurring now in Asset 70245 (most eastern Center Infield culvert).	High	State Fair Park is a high profile area. Could lead to significant loss of reputation and local/state news coverage if there is an injury involved or hydraulic/flooding issues as a result of the failure.	High	Physical Mortality	Safety
W015	Increased safety risk from erosion and potential sinkhole formation due to failure of corrugated metal pipe culvert at 43rd and Lincoln (43rd St Ditch)	KINNICKINNIC RIVER	Corrugated metal pipe culvert is rusting out and failing, causing ground to erode, creating sinkholes.	None	Very High	Failure occurring now	Very High	Injury requiring medical treatment or possibly death	High	Physical Mortality	Safety
W016	Unforeseen emergency situations caused by a lack of a Watercourse Asset Management Program.	Multiple	<p>There is no Watercourse Asset Management Program that proactively inspects and maintains MMSD Watercourse assets. An Asset Management Analyst is needed to continually monitor the watercourse system. Included in this would be:</p> <ul style="list-style-type: none"> <li>Concrete channel assessments: MMSD owns approximately 16 miles of concrete built in the 1950's - 1980's. Although summer interns perform annual channel inspections, there has not been a comprehensive condition assessment. Obvious issues are known, but engineers are not performing inspections that would possibly identify hidden conditions behind the concrete channel lining. Inspections performed by the same person on a regular basis will also reveal issues.</li> <li>Culverts (CMP and other materials): Videos are taken by conveyance monitoring field personnel but need to be watched and the pipe evaluated.</li> <li>Native plantings should be checked for invasives and other issues after maintenance contracts expire.</li> <li>Flood control basins should be monitored for capacity.</li> <li>Caps need to be monitored.</li> </ul>	Channel inspections are done each summer by two watercourse interns. Watercourse SPMS inspect watercourses when issues arise from the public.	Very High	Failures in many areas are unknown until an emergency occurs.	High	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of flooding for 10-100 structures and have a total financial impact of \$1M-\$10M.	High	Level of Service	Management Effectiveness
W017	Increased cost to MMSD if fail to effectively pursue and maximize opportunities for cost sharing on Underwood Creek projects - high priority (Underwood Reach 2)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Opportunity for 50-65% USACE cost sharing on feasibility, design and construction projects</li> <li>WDNR, private, and other grants</li> <li>MMSD has no dedicated staff to write grants and PMs have limited time to conduct this work. Need someone who can more efficiently and effectively write grants (Writer vs. Engineer).</li> <li>MMSD to develop and utilize habitat unit assessment to justify projects for USACE funding.</li> </ul>	<ul style="list-style-type: none"> <li>Proactive and timely submittals of letter requests to USACE</li> <li>Tracking of USACE stages of planning or design for channel projects</li> </ul>	High	Feasibility study pending	High	\$1,000,000 - \$10,000,000 total financial impact	Moderate	Economic	Fiscal Responsibility
W018	Increased cost to MMSD if fail to effectively pursue and maximize opportunities for cost sharing on Kinnickinnic projects - high priority (Kinnickinnic, multiple)	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Opportunity for 50-65% USACE cost sharing on feasibility, design and construction projects</li> <li>WDNR, private, and other grants</li> <li>MMSD has no dedicated staff to write grants and PMs have limited time to conduct this work. Need someone who can more efficiently and effectively write grants (English major vs. engineer).</li> <li>MMSD to develop and utilize habitat unit assessment to justify projects for USACE funding.</li> </ul>	<ul style="list-style-type: none"> <li>Proactive and timely submittals of letter requests to USACE</li> <li>Tracking of USACE stages of planning or design for channel projects</li> </ul>	High	Feasibility study pending	High	\$1,000,000 - \$10,000,000 total financial impact	Moderate	Economic	Fiscal Responsibility

Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W019	Structure Flooding (Milwaukee River Reach 2)	MILWAUKEE RIVER	Flood risk for 389 homes - mostly in Glendale	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Medium	1% probability event/2% probability event (many structures are in both floodplains) Some structures in 4% probability event.	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W020	Structure Flooding (Beaver Creek)	MILWAUKEE RIVER	Flood risk for 13 structures at confluence with Milwaukee River.	None	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W021	Potential water quality impacts (PCB contamination) from the Estabrook Dam removal	MILWAUKEE RIVER	Risk of unearthing PCB contamination that may be against dam face or hidden in areas that were not able to be remediated when PCB clean-up project was accomplished. PCB project was done to face of dam, so it is thought that what PCBs are left are minimal.	It has been said that PCBs that were not able to be removed were covered.	Low	PCBs were removed to the extent practicable so there should be little left in the area of the dam.	Medium	Any PCBs that are found will need to be removed using approved methods of retrieval and disposal to prevent further contamination of the area.	Minimal	Level of Service	Permit Requirements
W022	Structure Flooding (Lincoln Creek)	MILWAUKEE RIVER	Recurring property damage from limited stormwater conveyance capacity. This is flooding due to inadequate stormwater drainage, not riverine flooding.	Undersized conveyance system (combined sewer)	High	Frequent stormwater issues in the 30th Street Corridor.	High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Customer Service, Communication and Employee Development
W023	Increased flood risk if capacity of the Lincoln Creek 30th Street Corridor Basins (flood management facilities) are not maintained	MILWAUKEE RIVER	If flood management facilities are not maintained, storage capacity is reduced and flooding can occur.	<ul style="list-style-type: none"> <li>Vegetation maintenance contracts</li> <li>Post project vegetation maintenance</li> <li>Bedrock, bio, concrete, gabion, natural alluvial, or riprap channels</li> </ul>	Medium	<ul style="list-style-type: none"> <li>2-yr storms will likely exceed the flow duration that the low flow channel was designed for (excluding concrete)</li> <li>More extreme events may cause structure flooding</li> </ul>	High	<ul style="list-style-type: none"> <li>Negative coverage at state or local (TV and/or newspaper) level</li> <li>Issues raised by single public official/commissioner</li> <li>Regional (multiple watersheds) erosion and/or negative impact to water quality</li> </ul>	Moderate	Capacity	Customer Service, Communication and Employee Development
W024	Risk of flooding if stormwater pump station fails (MMSD Owned, 30th Street Corridor)	MILWAUKEE RIVER	Risk of flooding if not maintained properly	O&M	Low	MMSD follows O&M schedules	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact</li> <li>Widespread flooding with impacts to 10-100 buildings</li> </ul>	Moderate	Physical Mortality	Safety
W025	Increased flood risk and loss of vegetation due to sediment deposition (Indian Creek)	MILWAUKEE RIVER	Sediment deposition is occurring in Indian Creek near N Manor Lane (Fox Point)	None	Very High	Active sediment deposition	Low	Sediment deposition reduces the capacity of the channel, and can, over time, lead to increased flooding of the surrounding area. It can also choke the vegetation that was added by MMSD downstream for W13001.	Low	Capacity	Environmental Improvements
W026	Structure Flooding (Menomonee River, Hart Park area, Wauwatosa)	MENOMONEE RIVER	Floodproofing of Muellner building in Wauwatosa (commercial property).	Risk has been lowered by other projects in the Menomonee River. However, the Muellner building is still at risk.	High	Building is close to the stream and in the regulatory floodplain (1% probability event).	High	Commercial building and contents could result in heavy financial losses if building is flooded.	Moderate	Level of Service	Safety
W027	Structure Flooding (Menomonee River, Concordia Avenue)	MENOMONEE RIVER	Risk of flooding for 11 structures in the vicinity of Menomonee River Parkway and W Concordia Avenue.	Risk has been lowered by other projects in the Menomonee River. However, these structures are still at risk.	Medium	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W028	Failure to establish or maintain native vegetation reduces aesthetics, can cause public perception issues and lead to higher maintenance costs (Menomonee River Lower Reach)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Loss of native plantings; diminished aesthetics; higher maintenance costs; complaints from neighbors; invasive species takeover; potential increase in erosion if we lose native plantings; decreased bank/slope stability.</li> <li>Invasives can be a problem.</li> </ul>	Vegetation maintenance contracts	Medium	Critical timeframe for natives to establish is 1-5 years	Medium	Moderate loss of reputation or long term good will with customers, residents and stakeholders	Low	Level of Service	Customer Service, Communication and Employee Development
W029	Increased flood risk if designed conveyance capacity of rehabilitated channel not maintained (Menomonee Lower Reach)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Not maintaining designed conveyance capacity increases the risk of flooding. Specifically, rehabilitated channels where MMSD has removed concrete.</li> <li>Future flow rates will increase and eventually exceed original channel capacity (i.e., atmospheric changes and redevelopment driven)</li> </ul>	<ul style="list-style-type: none"> <li>Vegetation maintenance contracts</li> <li>Post project vegetation maintenance</li> <li>Helping keep floodplain mapping up-to-date and staying aware of changes.</li> </ul>	Medium	<ul style="list-style-type: none"> <li>2-yr storms will likely exceed the flow duration that the low flow channel was designed for (excluding concrete)</li> <li>More extreme events may cause structure flooding</li> </ul>	Medium	<ul style="list-style-type: none"> <li>Negative coverage at state or local (TV and/or newspaper) level</li> <li>Issues raised by single public official/commissioner</li> <li>Regional (multiple watersheds) erosion and/or negative impact to water quality</li> </ul>	Low	Capacity	Customer Service, Communication and Employee Development
W030	Structure Flooding (Western Milwaukee)	MENOMONEE RIVER	Risk of flooding for approximately 62 structures along the Menomonee River between N 63rd Street and W Monarch Place	Risk has been lowered by other projects in the Menomonee River. However, these structures are still at risk. Additional controls include: <ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Medium	1% probability event	Very High	potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety



Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W031	Structure Flooding (Menomonee River Estuary)	MENOMONEE RIVER	Risk of flooding for approximately 24 structures along the Menomonee River between S 29th Street and W Canal Street. Updated SEWRPC flooding mapping (due to new climatological data) has preliminarily identified these structures within the floodplain.	This area has some of the following controls, but will probably need more due to the increased floodplain area: • Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.). • Water surface elevation monitoring.	Medium	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W032	Failure to establish or maintain native vegetation reduces aesthetics, can cause public perception issues and lead to higher maintenance costs (Underwood Creek Reach 1)	MENOMONEE RIVER	• Loss of native plantings; diminished aesthetics; higher maintenance costs; complaints from neighbors; invasive species takeover; potential increase in erosion if we lose native plantings; decreased bank/slope stability. • Invasives have been a problem in this reach.	Vegetation maintenance contracts (10-year)	High	Critical timeframe for natives to establish is 1-5 years	Medium	Moderate loss of reputation or long term good will with customers, residents and stakeholders	Low	Level of Service	Customer Service, Communication and Employee Development
W033	Increased flood risk if designed conveyance capacity of rehabilitated channel on Underwood Creek not maintained (MMSD installed)	MENOMONEE RIVER	• Not maintaining designed conveyance capacity increases the risk of flooding. Specifically, rehabilitated channels where MMSD has removed concrete. • Future flow rates will increase and eventually exceed original channel capacity (i.e., atmospheric changes and redevelopment driven)	• Vegetation maintenance contracts • Post project vegetation maintenance • Helping keep floodplain mapping up-to-date and staying aware of changes.	High	• 2-yr storms will likely exceed the flow duration that the low flow channel was designed for (excluding concrete) • More extreme events may cause structure flooding	High	• Negative coverage at state or local (TV and/or newspaper) level • Issues raised by single public official/commissioner • Regional (multiple watersheds) erosion and/or negative impact to water quality	Moderate	Capacity	Customer Service, Communication and Employee Development
W034	Increased erosion, reduced aesthetics and increased safety risk due to deterioration of concrete-lined channels (Underwood Creek Reach 1)	MENOMONEE RIVER	Concrete channels are beyond their design life and are deteriorating leading to erosion and unsafe conditions Concrete condition assessment: Moderate	• Concrete removal typically occurs as a result of channel rehabilitation efforts for flood management projects. • Two interns are tasked with inspecting the jurisdictional every summer.	Medium	Concrete-lined channels in the jurisdictional watercourses are failing now.	Medium	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of local flooding with impacts to 1-10 buildings.	Low	Physical Mortality	Safety
W035	Increased erosion, reduced aesthetics and increased safety risk due to deterioration of concrete-lined channels (Underwood Creek Reach 2)	MENOMONEE RIVER	Concrete channels are beyond their design life and are deteriorating leading to erosion and unsafe conditions Concrete condition assessment: Moderate	• Concrete removal typically occurs as a result of channel rehabilitation efforts for flood management projects. • Two interns are tasked with inspecting the jurisdictional every summer.	Medium	Concrete-lined channels in the jurisdictional watercourses are failing now.	Medium	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of local flooding with impacts to 1-10 buildings.	Low	Physical Mortality	Safety
W036	Increased erosion, reduced aesthetics and increased safety risk due to deterioration of concrete-lined channels (South Branch Underwood Creek)	MENOMONEE RIVER	Concrete channel is beyond their design life and are deteriorating leading to erosion and unsafe conditions (5,700 feet) Concrete condition assessment: Moderate	• Concrete removal typically occurs as a result of channel rehabilitation efforts for flood management projects. • Two interns are tasked with inspecting the jurisdictional every summer.	Medium	Concrete-lined channels in the jurisdictional watercourses are failing now.	Medium	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of local flooding with impacts to 1-10 buildings.	Low	Physical Mortality	Safety
W037	Increased risk of drowning due to high velocities and steep, slippery slopes in concrete-lined channels (Underwood Creek Reach 2)	MENOMONEE RIVER	High velocities and steep, slippery concrete side slopes make concrete-lined channels difficult to escape from during high flows.	Concrete removal projects, typically in conjunction with channel rehabilitation efforts for flood management projects.	Medium	No known deaths in this channel (according to newspaper research), but the potential is still there due to high velocities, especially during flood events.	Very High	Permanent disability or potential fatality.	Moderate	Level of Service	Safety
W038	Failure to improve habitat if fish passage barriers not removed from Underwood Creek Reach 1	MENOMONEE RIVER	• Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. • Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds. • 5 drop structures located between confluence with the Menomonee River and I-41 (Reach 1).	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	• Erosion and negative impact to water quality or environmentally sensitive areas (wetland). • Fish populations decrease when they do not have the ability to access upstream spawning locations.	Low	Level of Service	Environmental Improvements
W039	Failure to improve habitat if fish passage barriers not removed from Underwood Creek Reach 2	MENOMONEE RIVER	• Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. • Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds. • 3 drop structures located along Underwood Creek between Watertown Plank Road and N 115th St (Reach 2).	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	• Erosion and negative impact to water quality or environmentally sensitive areas (wetland). • Fish populations decrease when they do not have the ability to access upstream spawning locations.	Low	Level of Service	Environmental Improvements
W040	Failure to improve habitat if fish passage barriers not removed from South Branch Underwood Creek Reach 1	MENOMONEE RIVER	• Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 1 has concrete channel that makes it difficult for fish to access headwater areas for spawning. • Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	• Erosion and negative impact to water quality or environmentally sensitive areas (wetland). • Fish populations decrease when they do not have the ability to access upstream spawning locations.	Low	Level of Service	Environmental Improvements
W041	Failure to improve habitat if fish passage barriers not removed from South Branch Underwood Creek Reach 2	MENOMONEE RIVER	• Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 2 an enclosed channel that makes it difficult for fish to access headwater areas for spawning. • Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	• Erosion and negative impact to water quality or environmentally sensitive areas (wetland). • Fish populations decrease when they do not have the ability to access upstream spawning locations.	Low	Level of Service	Environmental Improvements



Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W042	Structure Flooding (Honey Creek Reach 6)	MENOMONEE RIVER	Risk of flooding of approximately 2 structures between W Howard Avenue and 43	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W043	Increased erosion, reduced aesthetics and increased safety risk due to deterioration of concrete-lined channels (Honey Creek Reach 6)	MENOMONEE RIVER	Concrete channels are beyond their design life and are deteriorated leading to erosion and unsafe conditions Concrete condition assessment: Good	<ul style="list-style-type: none"> <li>Concrete removal typically occurs as a result of channel rehabilitation efforts for flood management projects.</li> <li>Two interns are tasked with inspecting the jurisdictional every summer.</li> </ul>	Low	Concrete-lined channels in the jurisdictional watercourses are failing now.	Medium	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of local flooding with impacts to 1-10 buildings.	Minimal	Physical Mortality	Safety
W044	Structure Flooding (Honey Creek Reach 5)	MENOMONEE RIVER	Risk of flooding of approximately 18 structures from W Oklahoma Avenue upstream to W Howard Avenue. This is new flooding (SEWRPC floodplains) that was identified between Euclid and Ohio Avenues.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W045	Increased erosion, reduced aesthetics and increased safety risk due to deterioration of concrete-lined channels (Honey Creek Reach 5)	MENOMONEE RIVER	Concrete channels are beyond their design life and are deteriorated leading to erosion and unsafe conditions Concrete condition assessment: Good	<ul style="list-style-type: none"> <li>Concrete removal typically occurs as a result of channel rehabilitation efforts for flood management projects.</li> <li>Two interns are tasked with inspecting the jurisdictional every summer.</li> </ul>	Low	Concrete-lined channels in the jurisdictional watercourses are failing now.	Medium	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of local flooding with impacts to 1-10 buildings.	Minimal	Physical Mortality	Safety
W046	Structure Flooding (Honey Creek Reach 4)	MENOMONEE RIVER	Risk of flooding of approximately 4 structures from W Arthur Avenue upstream to W Oklahoma Avenue	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W047	Increased erosion, reduced aesthetics and increased safety risk due to deterioration of concrete-lined channels (Honey Creek Reach 4)	MENOMONEE RIVER	Concrete channels are beyond their design life and are deteriorated leading to erosion and unsafe conditions Concrete condition assessment: Bed/Bank: Good, Overbank: Poor	<ul style="list-style-type: none"> <li>Concrete removal typically occurs as a result of channel rehabilitation efforts for flood management projects.</li> <li>Two interns are tasked with inspecting the jurisdictional every summer.</li> </ul>	High	Concrete-lined channels in the jurisdictional watercourses are failing now.	Medium	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of local flooding with impacts to 1-10 buildings.	Low	Physical Mortality	Safety
W048	Structure Flooding due to revised SEWRPC Floodplain Maps (Honey Creek)	MENOMONEE RIVER	SEWRPC has updated the effective floodplain maps to incorporate climatological changes. These maps have increased the floodplain in many areas, either adding structures to the floodplain or increasing flood depths at structures already in the floodplain.	Honey Creek has an existing planning study that addresses risks.	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W049	Increased cost to MMSD if fail to effectively pursue and maximize opportunities for cost sharing on Honey Creek projects (Honey Creek Reach 1)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Opportunity for 50-65% USACE cost sharing on feasibility, design and construction projects</li> <li>WDNR, private, and other grants</li> <li>MMSD has no dedicated staff to write grants and PMs have limited time to conduct this work. Need someone who can more efficiently and effectively write grants (English major vs. engineer).</li> <li>MMSD to develop and utilize habitat unit assessment to justify projects for USACE funding.</li> </ul>	<ul style="list-style-type: none"> <li>Proactive and timely submittals of letter requests to USACE</li> <li>Tracking of USACE stages of planning or design for channel projects</li> </ul>	High	Feasibility study pending	High	\$1,000,000 - \$10,000,000 total financial impact	Moderate	Economic	Fiscal Responsibility
W050	Increased erosion, reduced aesthetics and increased safety risk due to deterioration of concrete-lined channels (Honey Creek Reach 1)	MENOMONEE RIVER	Concrete channels are beyond their design life and are deteriorated leading to erosion and unsafe conditions Concrete condition assessment: Good - Moderate	<ul style="list-style-type: none"> <li>Concrete removal typically occurs as a result of channel rehabilitation efforts for flood management projects.</li> <li>Two interns are tasked with inspecting the jurisdictional every summer.</li> </ul>	Medium	Concrete-lined channels in the jurisdictional watercourses are failing now.	Medium	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of local flooding with impacts to 1-10 buildings.	Low	Physical Mortality	Safety
W051	Failure to improve habitat if fish passage barriers not removed from Honey Creek Reach 6	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 1 has concrete channel that makes it difficult for fish to access headwater areas for spawning.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W052	Failure to improve habitat if fish passage barriers not removed from Honey Creek Reach 5	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 1 has concrete channel that makes it difficult for fish to access headwater areas for spawning.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements

Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W053	Failure to improve habitat if fish passage barriers not removed from Honey Creek Reach 4	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 1 has concrete channel that makes it difficult for fish to access headwater areas for spawning.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W054	Failure to improve habitat if fish passage barriers not removed from Honey Creek Reach 1	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 1 has concrete channel that makes it difficult for fish to access headwater areas for spawning.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W055	Downstream MMSD assets (stream restoration projects, conveyance system, WRFs) adversely impacted by non-MMSD entities not following Chapter 13 Stormwater Rule.	Multiple	<ul style="list-style-type: none"> <li>Failure to comply with the MMSD Chapter 13 Rule adds more stormwater to the system, whether it be directly or indirectly. This can happen when others construct/alter channels, culverts, bridges, and/or increase peak flows and volume of water. Others can be public or private owners of culverts, channels, and/or bridges.</li> <li>Additional flow in streams can raise water surface elevations putting more structures at risk for flooding and can lead to bank erosion that can also put structures at risk.</li> <li>An example of this risk is the failure of WisDOT to comply with Chapter 13 for the Zoo Interchange Project. Highway expansion projects will impact the streams that they cross, in this case, Honey Creek.</li> </ul>	MMSD Chapter 13	Very High	WisDOT's Zoo Interchange project did not follow Chapter 13. There is a concern about five more mega projects are proposed through year 2030.	High	Potential impacts to MMSD facilities from increased runoff; water quality issues	High	Level of Service	Permit Requirements
W056	Structure Flooding (Schoonmaker Creek)	MENOMONEE RIVER	Economic and public safety impact of major flooding events to residences and roadways within the Schoonmaker Creek Watershed	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W057	Structure Flooding (North Branch Root River)	ROOT RIVER	<ul style="list-style-type: none"> <li>Risk of flooding of an undetermined number of structures in the Upper Reach of the North Branch Root River Watershed. Update with SEWRPC July 2016 floodplain for all jurisdictional streams anticipated to increase structure flooding.</li> <li>Street Flooding at Root River Parkway adjacent/downstream of National Ave along N Branch Root River.</li> <li>New SEWRPC flows should show new flooding along S. 119th St between Oklahoma and Morgan Ave along N Branch Root River.</li> </ul>	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Low	1% probability event	High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Low	Level of Service	Safety
W058	Structure Flooding (Lower Whitnall Park Creek)	ROOT RIVER	<ul style="list-style-type: none"> <li>Risk of flooding of an undetermined number of structures in the Lower Whitnall Park Creek Watershed. Update with SEWRPC July 2016 floodplain for all jurisdictional streams anticipated to increase structure flooding.</li> <li>Flooding u/s of Janesville Rd along Whitnall Park Creek.</li> </ul>	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Low	1% probability event	High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Low	Level of Service	Safety
W059	Structure Flooding (KK Reach 2)	KINNICKINNIC RIVER	Risk of flooding of more than 300 residential and commercial structures between S 6th and S 16th Streets.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Medium	1% probability event/2% probability event (many structures are in both floodplains) Some structures in 10% probability event.	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W060	Increased erosion, reduced aesthetics and increased safety risk due to deterioration of concrete-lined channels (KK River Reach 2)	KINNICKINNIC RIVER	<p>Concrete channels are beyond their design life and are deteriorated leading to erosion and unsafe conditions (12,000 linear feet)</p> <p>Concrete condition assessment: Poor - Moderate</p>	<ul style="list-style-type: none"> <li>Concrete removal typically occurs as a result of channel rehabilitation efforts for flood management projects.</li> <li>Two interns are tasked with inspecting the jurisdictional every summer.</li> </ul>	High	Concrete-lined channels in the jurisdictional watercourses are failing now.	Medium	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of local flooding with impacts to 1-10 buildings.	Low	Physical Mortality	Safety
W061	Failure to improve habitat if fish passage barriers not removed from KK River Reach 2	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Drop Structures along KK mainstem between 6th and 20th are failing.</li> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Medium	<ul style="list-style-type: none"> <li>This reach's fish passage barriers make it very difficult or impossible for salmon and other fish to move upstream.</li> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Moderate	Level of Service	Environmental Improvements
W062	Increased erosion, reduced aesthetics and increased safety risk due to deterioration of concrete-lined channels (KK River Reach 3)	KINNICKINNIC RIVER	<p>Concrete channels are beyond their design life and are deteriorated leading to erosion and unsafe conditions (5,800 linear feet)</p> <p>Concrete condition assessment: Poor</p>	<ul style="list-style-type: none"> <li>Concrete removal typically occurs as a result of channel rehabilitation efforts for flood management projects.</li> <li>Two interns are tasked with inspecting the jurisdictional every summer.</li> </ul>	High	The concrete lining is approximately 50 years old and has reached the end of its useful life.	Medium	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of local flooding with impacts to 1-10 buildings.	Low	Physical Mortality	Safety

Risk Identification				Risk Analysis							
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W063	Failure to improve habitat if fish passage barriers not removed from KK River Reach 4	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects because MMSD does not have authority to use their own funds for certain types of projects. (For this project, the District will partner with USACE who will finance 65% of the project costs, up to \$10,000,000.)</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W064	Failure to establish or maintain native vegetation reduces aesthetics, can cause public perception issues and lead to higher maintenance costs (KK Reach 1)	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Loss of native plantings</li> <li>Diminished aesthetics</li> <li>Higher maintenance costs</li> <li>Complaints from neighbors</li> <li>Invasive species take over</li> <li>Potential increase in erosion if we lose native plantings</li> <li>Decreased bank/slope stability</li> </ul>	Vegetation maintenance contracts (5-year)	Medium	Critical timeframe for natives to establish is 1-5 years	Medium	Moderate loss of reputation or long-term goodwill with customers, residents and stakeholders	Low	Level of Service	Customer Service, Communication and Employee Development
W065	Increased erosion, reduced aesthetics and increased safety risk due to deterioration of concrete-lined channels (KK River Reach 4)	KINNICKINNIC RIVER	<p>Concrete channels are beyond their design life and are deteriorated leading to erosion and unsafe conditions (700 linear feet)</p> <p>Concrete condition assessment: Poor - Very poor</p>	<ul style="list-style-type: none"> <li>Concrete removal typically occurs as a result of channel rehabilitation efforts for flood management projects.</li> <li>Two interns are tasked with inspecting the jurisdictional every summer.</li> </ul>	Very High	Concrete-lined channels in the jurisdictional watercourses are failing now.	Medium	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of local flooding with impacts to 1-10 buildings.	Moderate	Physical Mortality	Safety
W066	Failure to improve habitat if fish passage barriers not removed from KK River Reach 4	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Drop Structure on KK mainstem at confluence with 43rd St Ditch failing.</li> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds. (For this project, the District will partner with USACE who will finance 65% of the project costs, up to \$10,000,000.)</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W067	Risk of upstream flooding due to inadequate hydraulic capacity and debris blockage of 43rd St bridge over the KK River (MMSD owned, KK River Reach 4)	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>High risk of upstream flooding even when maintained properly.</li> <li>Bridge on KK River at 43rd Street is undersized.</li> </ul>	O&M	Medium	<ul style="list-style-type: none"> <li>Culvert is undersized.</li> <li>There are issues even when maintained.</li> </ul>	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact</li> <li>Flooding</li> </ul>	Moderate	Capacity	Safety
W068	Risk of upstream flooding due to inadequate hydraulic capacity and debris blockage of culvert (four circular openings) in Jackson Park just downstream of confluence with 43rd St Ditch (MMSD owned, KK River Reach 4)	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Risk of upstream flooding if not maintained properly.</li> <li>Culvert in poor condition in KK just d/s of confluence with 43rd St Ditch (4-circular culverts).</li> </ul>	O&M	Medium	Culverts are blocked often and may be undersized.	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact (could impact RR)</li> <li>Flooding</li> </ul>	Moderate	Capacity	Safety
W069	Risk of upstream flooding due to inadequate hydraulic capacity and debris blockage of railroad culvert on 43rd St Ditch (MMSD owned)	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>High risk of upstream flooding even when maintained properly.</li> <li>Culvert under RR on 43rd Street Ditch just upstream of KK River confluence is undersized.</li> </ul>	O&M	Medium	<ul style="list-style-type: none"> <li>Culvert is undersized.</li> <li>There are issues even when maintained.</li> </ul>	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact</li> <li>Widespread flooding with impacts to 10-100 buildings</li> </ul>	Moderate	Capacity	Safety
W070	Impaired water quality and habitat due to contaminated sediment and other issues (KK River Reach 1)	KINNICKINNIC RIVER	The area of the KK River between the 1,200 linear feet of channel reconstruction in Reach 1 and a Great Lakes Legacy Act remediation project that removed contaminated sediments from the Lake Estuary has contaminated sediments that have led to impaired habitat. DO Sag is also a problem. The impaired reach starts at the downstream end of Reach 1 on the upstream end and includes the entire River Estuary.	Permitting requirements to discharge to channels have put an end to high PAH loadings from coal tar sealants. However, the contaminants do not go away on their own. They must be removed.	High	Contaminants are already in the stream and are having an adverse effect on aquatic species.	Medium	Contamination this far downstream in the river will prevent fish movement upstream in areas where fish passage barriers are being removed.	Low	Level of Service	Environmental Improvements
W071	Impaired water quality and habitat due to contaminated sediment and other issues (KK River Estuary)	KINNICKINNIC RIVER	The area of the KK River between the 1,200 linear feet of channel reconstruction in Reach 1 and a Great Lakes Legacy Act remediation project that removed contaminated sediments from the Lake Estuary has contaminated sediments that have led to impaired habitat. DO Sag is also a problem. The impaired reach starts at the downstream end of Reach 1 on the upstream end and includes the entire River Estuary.	Permitting requirements to discharge to channels have put an end to high PAH loadings from coal tar sealants. However, the contaminants do not go away on their own. They must be removed.	High	Contaminants are already in the stream and are having an adverse effect on aquatic species.	Medium	Contamination this far downstream in the river will prevent fish movement upstream in areas where fish passage barriers are being removed.	Low	Level of Service	Environmental Improvements
W072	Structure Flooding (Lyons Park Creek)	KINNICKINNIC RIVER	Risk of flooding of approximately 66 structures	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Medium	1% probability event/2% probability event (many structures are in both floodplains) 10% probability event comes close to structures.	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety

Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W073	Failure to improve habitat if fish passage barriers not removed from Lyons Park Creek	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Drop structures owned by the City of Milwaukee are in bad shape.</li> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 1 has concrete channel that makes it difficult for fish to access headwater areas for spawning.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds. (For this project, the District will partner with USACE who will finance 65% of the project costs, up to \$10,000,000.)</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W074	Structure Flooding (43rd Street Ditch)	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Risk of flooding of approximately 9 structures, primarily located along the enclosed section of the ditch under S 43rd Street.</li> <li>Roadway flooding at Lincoln and 43rd Street.</li> </ul>	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W075	Failure to improve habitat if fish passage barriers not removed from 43rd Street Ditch Reach 1	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 1 has concrete channel that makes it difficult for fish to access upstream.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed. Here it is a large lengths of culverted pipe connected with concrete channel.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W076	Risk of upstream flooding due to inadequate hydraulic capacity and debris blockage of culverts at W Colony Dr. and beneath hotel at S 27th St. (non-MMSD owned, Villa Mann Creek Tributary)	KINNICKINNIC RIVER	Culvert beneath hotel at S 27th St undersized causing hotel to flood.	O&M conducted by non-MMSD owner	Medium	Assumption is based on confidence level in other owners to perform maintenance.	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact</li> <li>Widespread flooding with impacts to 10-100 buildings</li> </ul>	Moderate	Capacity	Safety
W077	Structure Flooding (Villa Mann Creek Tributary)	KINNICKINNIC RIVER	Risk of flooding of approximately 9 structures, primarily located northwest of the I-43/894 and S 27th Street interchange.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Low	1% probability event/2% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W078	Structure Flooding (Wilson Park Creek Reach 3)	KINNICKINNIC RIVER	Risk of flooding for over 50 residential and commercial structures in the vicinity of S 6th Street and W Armour Avenue.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Low	1% probability event/2% probability event (many structures are in both floodplains)	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W079	Increased erosion, reduced aesthetics and increased safety risk due to deterioration of concrete-lined channels (43rd Street Ditch)	KINNICKINNIC RIVER	Concrete channels are beyond their design life and are deteriorated leading to erosion and unsafe conditions. Concrete condition assessment: Moderate	<ul style="list-style-type: none"> <li>Concrete removal typically occurs as a result of channel rehabilitation efforts for flood management projects.</li> <li>Two interns are tasked with inspecting the jurisdictional every summer.</li> </ul>	Medium	Concrete-lined channels in the jurisdictional watercourses are failing now.	Medium	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of local flooding with impacts to 1-10 buildings.	Low	Physical Mortality	Safety
W080	Increased erosion, reduced aesthetics and increased safety risk due to deterioration of concrete-lined channels (Wilson Park Creek Reach 3)	KINNICKINNIC RIVER	Concrete channels are beyond their design life and are deteriorated leading to erosion and unsafe conditions. Concrete condition assessment: Moderate	<ul style="list-style-type: none"> <li>Concrete removal typically occurs as a result of channel rehabilitation efforts for flood management projects.</li> <li>Two interns are tasked with inspecting the jurisdictional every summer.</li> </ul>	Medium	The concrete channel lining is a District asset that was installed in the 1960s and is reaching the end of its useful life.	Medium	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of local flooding with impacts to 1-10 buildings.	Low	Physical Mortality	Safety
W081	Increased risk of drowning due to high velocities and steep, slippery slopes in concrete-lined channels (Wilson Park Creek Reach 3)	KINNICKINNIC RIVER	High velocities and steep, slippery concrete side slopes make concrete-lined channels difficult to escape from during high flows.	Concrete removal projects, typically in conjunction with channel rehabilitation efforts for flood management projects.	Very Low	No mention of drownings in Wilson Park Creek in the research.	Very High	Permanent disability or potential fatality.	Moderate	Level of Service	Safety
W082	Risk of upstream flooding due to inadequate hydraulic capacity and debris blockage of culverts on Wilson Park Creek, Reach 2 (MMSD owned, Wilson Park Creek Reach 2)	KINNICKINNIC RIVER	Risk of upstream flooding if culverts not maintained properly: three culverts under the Point Loomis shopping center between W Morgan Avenue and S 27th Street and one under W Lakefield Avenue at W Howard Avenue.	O&M	Low	MMSD follows their O&M schedules but inspection after floods and preceding a flood are not instantaneous.	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact</li> <li>Flooding</li> </ul>	Moderate	Capacity	Safety
W083	Increased erosion, reduced aesthetics and increased safety risk due to deterioration of concrete-lined channels (Wilson Park Creek Reach 2)	KINNICKINNIC RIVER	Concrete channels are beyond their design life and are deteriorated leading to erosion and unsafe conditions. Concrete condition assessment: Good	<ul style="list-style-type: none"> <li>Concrete removal typically occurs as a result of channel rehabilitation efforts for flood management projects.</li> <li>Two interns are tasked with inspecting the jurisdictional every summer.</li> </ul>	Low	The concrete channel lining is a District asset that was installed in the 1980s and is reaching the end of its useful life.	Medium	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of local flooding with impacts to 1-10 buildings.	Minimal	Physical Mortality	Safety



Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W084	Increased risk of drowning due to high velocities and steep, slippery slopes in concrete-lined channels (Wilson Park Creek Reach 2)	KINNICKINNIC RIVER	High velocities and steep, slippery concrete side slopes make concrete-lined channels difficult to escape from during high flows.	Concrete removal projects, typically in conjunction with channel rehabilitation efforts for flood management projects.	Very Low	No mention of drownings in Wilson Park Creek in the research.	Very High	Permanent disability or potential fatality.	Moderate	Level of Service	Safety
W085	Structure Flooding (Wilson Park Creek Reach 2)	KINNICKINNIC RIVER	Risk of flooding more than 90 structures.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Low	1% probability event/2% probability event (many structures are in both floodplains)	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W086	Increased erosion, reduced aesthetics and increased safety risk due to deterioration of concrete-lined channels (Wilson Park Creek Reach 4, GMIA)	KINNICKINNIC RIVER	Concrete channels are beyond their design life and are deteriorated leading to erosion and unsafe conditions. Concrete condition assessment: Moderate - Good	<ul style="list-style-type: none"> <li>Concrete removal typically occurs as a result of channel rehabilitation efforts for flood management projects.</li> <li>Two interns are tasked with inspecting the jurisdictional every summer.</li> </ul>	Low	Concrete-lined channels in the jurisdictional watercourses are failing now.	Medium	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of local flooding with impacts to 1-10 buildings.	Minimal	Physical Mortality	Safety
W087	Increased risk of drowning due to high velocities and steep, slippery slopes in concrete-lined channels (Wilson Park Creek Reach 4, GMIA)	KINNICKINNIC RIVER	High velocities and steep, slippery concrete side slopes make concrete-lined channels difficult to escape from during high flows.	Concrete removal projects, typically in conjunction with channel rehabilitation efforts for flood management projects.	Very Low	No mention of drownings in Wilson Park Creek in the research. Even less likely on GMIA property due to airport security.	Very High	Permanent disability or potential fatality.	Moderate	Level of Service	Safety
W088	Structure Flooding (Wilson Park Creek Reach 4, GMIA)	KINNICKINNIC RIVER	Risk of flooding of a underdetermined number of structures. Some structures flood during higher frequency storm events.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Low	1% probability event/2% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W089	Structure Flooding (North Branch Oak Creek)	OAK CREEK	<ul style="list-style-type: none"> <li>Flood damage to 15 structures in current 1%, 7 in 2%, and 2 in 4% probability floodplains (per SEWRPC data).</li> <li>Hotel flooded at/near College and S 13th St</li> <li>Little slope on culvert under S 13th St just north of the intersection of S 13th St &amp; W Granada St. There are three culverts at this location. Center culvert causes some nearby flooding.</li> </ul>	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Medium	Damages in 4% probability event (SEWRPC data)	High	Potential fatality, widespread flooding with impacts to 10-100 buildings, \$1M-\$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W090	Structure Flooding (Oak Creek)	OAK CREEK	<ul style="list-style-type: none"> <li>Flood damage to 9 structures in current 1%, 5 in 2% and 4 in 4% probability floodplains (per SEWRPC data). Flooding between Southland Dr and Ryan Road; could add structures in other locations as well.</li> <li>Flooded structures south of Ryan Road.</li> </ul>	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Medium	Damages in 4% probability event (SEWRPC data)	High	Potential fatality, property damage, potential increase in SSOs, Local flooding with impacts to 1-10 buildings impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W091	Failure to improve habitat if fish passage barriers not removed from Wilson Park Creek Reach 1	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Culvert beneath St. Luke's Hospital eliminates passage upstream to Creek and tributaries.</li> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds</li> </ul>	<ul style="list-style-type: none"> <li>USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications.</li> <li>Open channels (bedrock, natural, bio, concrete, gabion, riprap)</li> </ul>	Very High	Concrete culverts, especially ones as long as this one, are known to be fish barriers for both native and non-native migrating fish throughout the watershed.	Low	Erosion and negative impact to water quality or environmentally sensitive areas (wetland).	Low	Level of Service	Environmental Improvements
W092	Increased flood risk if designed conveyance capacity of the North Branch Oak Creek Reach 1 not maintained by removing cattails and other nuisance vegetation (MMSD installed, North Branch Oak Creek)	OAK CREEK	North Branch Oak Creek often clogged often with cattails.	<ul style="list-style-type: none"> <li>Vegetation maintenance contracts</li> <li>Post-project vegetation maintenance</li> <li>Bedrock, bio, concrete, gabion, natural alluvial, or riprap channels</li> </ul>	High	<ul style="list-style-type: none"> <li>2-yr storms will likely exceed the flow duration that the low flow channel was designed for (excluding concrete).</li> <li>More extreme events may cause structure flooding.</li> </ul>	High	<ul style="list-style-type: none"> <li>Negative coverage at state or local (TV and/or newspaper) level</li> <li>Issues raised by single public official/commissioner</li> <li>Regional (multiple watersheds) erosion and/or negative impact to water quality</li> </ul>	Moderate	Capacity	Customer Service, Communication and Employee Development
W093	Risk of upstream flooding due to inadequate hydraulic capacity and debris blockage of culvert under 13th St (MMSD owned, North Branch Oak Creek)	OAK CREEK	<ul style="list-style-type: none"> <li>Risk of upstream flooding if not maintained properly.</li> <li>Little slope on culvert under S 13th Street just North of the intersection of S 13th St &amp; W Granada St. There are three culverts at this location. Blockage increases nearby flooding. Culvert is filled with sediment and cattails.</li> </ul>	O&M	Medium	MMSD follows their O&M schedules but inspection after floods and preceding a flood are not instantaneous.	Very High	Potential fatality, \$10M financial impact	Moderate	Capacity	Safety
W094	Risk of upstream flooding due to inadequate hydraulic capacity and debris blockage of culvert just south of College Ave. (non-MMSD owned, North Branch Oak Creek)	OAK CREEK	<ul style="list-style-type: none"> <li>Risk of upstream flooding if not maintained properly, if local owner does not maintain any debris blockage.</li> <li>RR culvert just south of College is not kept clean which aggravates upstream flooding issue. Culvert is filled with sediment and cattails.</li> </ul>	O&M conducted by non-MMSD owner	Medium	Assumption is based on confidence level in other owners to perform maintenance.	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact (could impact RR)</li> <li>Flooding</li> </ul>	Moderate	Capacity	Safety

Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W095	Risk of upstream flooding due to inadequate hydraulic capacity and debris blockage of railroad, 5th St and 6th St bridges (non-MMSD owned, Wilson Park Creek Reach 3)	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Risk of upstream flooding if not maintained properly, if local owner does not maintain any debris blockage.</li> <li>Railroad bridge and 5th and 6th St bridges are undersized.</li> </ul>	O&M conducted by non-MMSD owner	Medium	Assumption is based on confidence level in other owners to perform maintenance.	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact (could impact RR)</li> <li>Widespread flooding with impacts to 10-100 buildings</li> </ul>	Moderate	Capacity	Safety
W096	Increased safety risk from erosion and potential sinkhole formation due to failure of corrugated metal pipe culvert between Morgan Ave. and Loomis Rd. (MMSD owned, Wilson Park Creek Reach 2)	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>CMP culverts between Morgan Ave and Loomis Road in poor shape (likelihood of failure higher than normal and COF high).</li> <li>CMP culverts are owned by MMSD, while the concrete culverts under Morgan and Loomis are not.</li> </ul>	O&M	Low	Assumption is based on confidence level in other owners to perform maintenance and the fact that CMPs are failing throughout the service area. Videos from 2013 show small splits in the pipe but nothing serious.	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact</li> <li>Widespread flooding with impacts to 10-100 buildings</li> </ul>	Moderate	Physical Mortality	Safety
W097	Risk of upstream flooding due to inadequate hydraulic capacity and debris blockage of culvert at National Ave. (non-MMSD owned, North Branch Root River Upper Reach)	ROOT RIVER	<ul style="list-style-type: none"> <li>Risk of upstream flooding if not maintained properly, if local owner does not maintain any debris blockage.</li> <li>Even though it does not belong to MMSD, have cleaned culvert twice at National Ave.</li> </ul>	O&M conducted by non-MMSD owner	Medium	Assumption is based on confidence level in other owners to perform maintenance.	High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact (could impact RR)</li> <li>Flooding</li> </ul>	Moderate	Capacity	Safety
W098	Structure Flooding (Fish Creek Tributary)	LAKE MICHIGAN	<ul style="list-style-type: none"> <li>One structure floods during 100-year event due to overbank flooding at confluence within current MMSD jurisdiction.</li> <li>Update with SEWRPC July 2016 floodplain for mainstem and tributary.</li> </ul>	Fish Creek Tributary is a natural alluvial conveyance channel. Flood management structures include culverts, railroad and highway embankments. The channels are not stable but eroding.	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W099	Contaminated sediment cleanup/cap in Burnham Canal may not occur if federal funding is not obtained.	LAKE MICHIGAN	Miller Compressing is required to resolve environmental issues within the canal. Through a public-private partnership, MMSD is able to help them improve water quality in the canal. Risks involve not obtaining funding from sources such as USACE, NOAA, Fund for Lake Michigan, and other sources who are interested in wetland restoration and creation. Contamination has been there for many years. No new immediate threat has been identified.	Miller Compressing has instituted guidelines to prevent future contamination and are working with EPA and MMSD to remediate.	High	Contaminants are already in the stream and are having an adverse effect on aquatic species.	High	The site is not listed on the National Priorities List (NPL) but is considered to be a NPL-caliber site and is being addressed through the Superfund Alternative Approach.	Moderate	Economic	Environmental Improvements
W100	Structure Flooding (Milwaukee River Estuary)	LAKE MICHIGAN	MMSD took over jurisdiction for the estuary. There are an undetermined number of structures prone to flooding.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W101	Structure Flooding (KK River Estuary)	KINNICKINNIC RIVER	MMSD took over jurisdiction for the estuary. There are 33 structures prone to flooding.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W102	Failure to improve habitat if fish passage barriers not removed from Milwaukee River Reach 2	MILWAUKEE RIVER	<ul style="list-style-type: none"> <li>Dam in Kletzsch Park is in poor condition and blocks low flow fish passage.</li> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	Dam blocks low flow fish passage.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W103	Failure to improve habitat if fish passage barriers not removed from Oak Creek (outside service area)	OAK CREEK	<ul style="list-style-type: none"> <li>Outside MMSD jurisdiction there is a dam in South Mke along Oak Creek preventing all fish passage.</li> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds. For this specific barrier, the dam is outside of MMSD jurisdiction, so removal is near impossible.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	All fish passage from Lake Michigan to the jurisdictional reaches of Oak Creek is cut off by the dam in South Milwaukee.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W104	Failure to improve habitat if fish passage barriers not removed from Milwaukee River Reach 1	MILWAUKEE RIVER	<ul style="list-style-type: none"> <li>Estabrook dam prevents fish passage.</li> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	Dam prevents fish passage.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements



Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W105	Risk of upstream flooding due to inadequate hydraulic capacity and debris blockage of multiple culverts on Lincoln Creek Reach 6 (non-MMSD owned, Lincoln Creek Reach 6)	MILWAUKEE RIVER	<ul style="list-style-type: none"> <li>Risk of upstream flooding if not maintained properly, if local owner does not maintain any debris blockage.</li> <li>Some culverts MMSD cannot inspect since they cannot visually see during a watercourse channel inspection which pose a risk to whether or not the owner (such as a RR) is performing O&amp;M.</li> <li>Bridges located along Reach 6 of Lincoln Creek.</li> </ul>	O&M conducted by non-MMSD owner	Medium	Assumption based on confidence level in other owners to perform maintenance.	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact</li> <li>Widespread flooding with impacts to 10-100 buildings</li> </ul>	Moderate	Capacity	Safety
W106	Increased safety risk due to metal cage from gabion/revetment fraying, leading to sharp edges poking out (Lincoln Creek Reach 1)	MILWAUKEE RIVER	<ul style="list-style-type: none"> <li>Metal caging is fraying, leading to sharp edges sticking up, causing a hazard located in areas where public has access. Many children play in and around the creek in this area.</li> <li>MMSD mows vegetation and the mower blade will catch on the frayed metal and can rip it off and propel the sharp metal – another hazard.</li> </ul>	Watercourse monitors and calls for maintenance including trimming and tying back of metal caging, as needed.	Low	MMSD Watercourse Staff has inspected this reach and it appears to be in stable condition currently.	High	Potentially very serious injury requiring medical treatment, very likely to child(ren).	Low	Physical Mortality	Safety
W107	Increased safety risk due to metal cage from gabion/revetment fraying, leading to sharp edges poking out (Lincoln Creek Reach 2)	MILWAUKEE RIVER	<ul style="list-style-type: none"> <li>Metal caging is fraying, leading to sharp edges sticking up, causing a hazard located in areas where public has access. Many children play in and around the creek in this area.</li> <li>MMSD mows vegetation and the mower blade will catch on the frayed metal and can rip it off and propel the sharp metal – another hazard.</li> </ul>	Watercourse monitors and calls for maintenance including trimming and tying back of metal caging, as needed.	Medium	MMSD Watercourse Staff has inspected this reach, and found that the left (west) bank south of Hampton has some exposed revetment/rock. The area is currently stable and mowing stops before the revetment treatment which protects them from being unraveled. Long stretches of the banks are covered in revetment in this area, so this reach should be inspected on a regular basis and mowing should remain outside of this areas with revetment treatment.	High	Potentially very serious injury requiring medical treatment, very likely to child(ren).	Moderate	Physical Mortality	Safety
W108	Increased safety risk due to metal cage from gabion/revetment fraying, leading to sharp edges poking out (Lincoln Creek Reach 3)	MILWAUKEE RIVER	<ul style="list-style-type: none"> <li>Metal caging is fraying, leading to sharp edges sticking up, causing a hazard located in areas where public has access. Many children play in and around the creek in this area.</li> <li>MMSD mows vegetation and the mower blade will catch on the frayed metal and can rip it off and propel the sharp metal – another hazard.</li> </ul>	Watercourse monitors and calls for maintenance including trimming and tying back of metal caging, as needed.	Low	MMSD Watercourse Staff has inspected this reach and it appears to be in stable condition currently.	High	Potentially very serious injury requiring medical treatment, very likely to child(ren).	Low	Physical Mortality	Safety
W109	Increased safety risk due to metal cage from gabion/revetment fraying, leading to sharp edges poking out (Lincoln Creek Reach 4)	MILWAUKEE RIVER	<ul style="list-style-type: none"> <li>Metal caging is fraying, leading to sharp edges sticking up, causing a hazard located in areas where public has access. Many children play in and around the creek in this area.</li> <li>MMSD mows vegetation and the mower blade will catch on the frayed metal and can rip it off and propel the sharp metal – another hazard.</li> </ul>	Watercourse monitors and calls for maintenance including trimming and tying back of metal caging, as needed.	Very High	MMSD Watercourse Staff has inspected this reach and has identified that some areas where this method was used are failing. Gabion baskets at outfall at the corner of Congress and 47th are eroding away.	High	Potentially very serious injury requiring medical treatment, very likely to child(ren).	High	Physical Mortality	Safety
W110	Increased safety risk due to metal cage from gabion/revetment fraying, leading to sharp edges poking out (Lincoln Creek Reach 5)	MILWAUKEE RIVER	<ul style="list-style-type: none"> <li>Metal caging is fraying, leading to sharp edges sticking up, causing a hazard located in areas where public has access. Many children play in and around the creek in this area.</li> <li>MMSD mows vegetation and the mower blade will catch on the frayed metal and can rip it off and propel the sharp metal – another hazard.</li> </ul>	Watercourse monitors and calls for maintenance including trimming and tying back of metal caging, as needed.	Very High	MMSD Watercourse Staff has inspected this reach and has identified that some areas where this method was used are failing. Revetments on the north side of the stream just upstream of the outfall at 47th and Congress are fraying significantly and need to be addressed in a more sustainable way. There is also some limited exposure of the wire just downstream of Hampton at the upstream end of this reach.	High	Potentially very serious injury requiring medical treatment, very likely to child(ren).	High	Physical Mortality	Safety
W111	Increased safety risk due to metal cage from gabion/revetment fraying, leading to sharp edges poking out (Lincoln Creek Reach 7)	MILWAUKEE RIVER	<ul style="list-style-type: none"> <li>Metal caging is fraying, leading to sharp edges sticking up, causing a hazard located in areas where public has access. Many children play in and around the creek in this area. Growing Power is located here.</li> <li>MMSD mows vegetation and the mower blade will catch on the frayed metal and can rip it off and propel the sharp metal – another hazard.</li> <li>Metal caging downstream of Silver Spring is different from</li> </ul>	Watercourse monitors and calls for maintenance including trimming and tying back of metal caging, as needed.	High	MMSD Watercourse Staff has inspected this reach and has identified that areas upstream (north) of Silver Spring have some exposed revetment materials. The area appears to currently be stable but should continue to be monitored.	High	Potentially very serious injury requiring medical treatment, very likely to child(ren).	Moderate	Physical Mortality	Safety
W112	Potential damage to structures, property loss and water quality impacts due to increased streambank erosion (non-MMSD owned, Honey Creek Reach 1)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Erosion is a riparian land owner or local issue and MMSD is not required to repair erosion problems due to maintenance unless MMSD owns the land. High velocities and culvert modifications by others can cause this erosion, which alters the flow rates through the channel.</li> <li>Major erosion from Honey Creek Parkway to Menomonee River, in the Hart Park area. Erosion area is downstream of concrete channel and is the responsibility of Milwaukee County Parks.</li> </ul>	<ul style="list-style-type: none"> <li>Natural alluvial conveyance channel and several non-MMSD owned culverts, including the County, Railroad, and WisDOT.</li> <li>Natural vegetation on streambanks where erosion has not occurred.</li> <li>MMSD Chapter 13.</li> </ul>	High	2-10 year velocities approach 6 ft/s in some areas; this is the average threshold for natural vegetation on steeper slopes	Medium	\$250k financial Impact, issues raised by numerous residents, local erosion and negative water quality impacts.	Low	Physical Mortality	Environmental Improvements

Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W113	Failure to establish or maintain native vegetation reduces aesthetics, can cause public perception issues and lead to higher maintenance costs (MCG Basins)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Loss of native plantings; diminished aesthetics; higher maintenance costs; complaints from neighbors; invasive species takeover; potential increase in erosion if we lose native plantings; decreased bank/slope stability.</li> <li>Invasives, particularly crown vetch, are a problem in the Milwaukee County Grounds basins. Crown vetch is susceptible to mass die-outs and the root structure does not offer good soil stabilization. It spreads incredibly quickly, crowding out native species.</li> </ul>	Vegetation maintenance contracts	Very High	Crown vetch has begun to take over parts of the MCG Basins. It spreads very fast.	Medium	Moderate loss of reputation or long-term goodwill with customers, residents and stakeholders	Moderate	Level of Service	Customer Service, Communication and Employee Development
W114	Risk of flooding if floodwall fails (MMSD owned, Lincoln Creek Reach 4)	MILWAUKEE RIVER	<ul style="list-style-type: none"> <li>Risk of flooding if not maintained properly</li> <li>Floodwalls along Lincoln Creek Reach 4 are critical to prevent flooding.</li> </ul>	O&M	Very Low	MMSD follows their O&M schedules	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact</li> <li>Widespread flooding with impacts to 10-100 buildings</li> </ul>	Moderate	Physical Mortality	Safety
W115	Risk of flooding if floodwall fails (MMSD owned, Menomonee River Lower Reach)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Risk of flooding if not maintained properly</li> <li>Valley Park Floodwalls are critical to prevent flooding.</li> </ul>	O&M	Very Low	MMSD follows their O&M schedules	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact</li> <li>Widespread flooding with impacts to 10-100 buildings</li> </ul>	Moderate	Physical Mortality	Safety
W116	Risk of flooding if floodwall/retaining wall fails (WPA wall, 16th Street, KK River Reach 2)	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Risk of flooding if not maintained properly</li> <li>WPA wall holding up 16th St along KK Mainstem in poor condition.</li> </ul>	O&M by responsible party	Medium	MMSD does not own this wall and it is in poor condition	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact</li> <li>Widespread flooding with impacts to 10-100 buildings</li> </ul>	Moderate	Physical Mortality	Safety
W117	Risk of flooding if floodwall/berm fails (Hart Park, Western Milwaukee, Menomonee River Lower Reach)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Risk of flooding if not maintained properly</li> <li>Western Milwaukee levees will work in conjunction with the Hart Park berm to provide flood protection. Currently, the full protection is not realized because the Western Milwaukee project (2B) has not been built.</li> </ul>	O&M	Medium	Although MMSD follows their O&M schedules, the full system has not yet been built.	Very High	<ul style="list-style-type: none"> <li>Potential fatality, \$10M financial impact</li> <li>Widespread flooding with impacts to 10-100 buildings</li> </ul>	Moderate	Physical Mortality	Safety
W118	Failure of instream habitat feature if not maintained resulting in loss of habitat (MMSD owned, Underwood Creek Reach 1)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Loss of biohabitat and fish passage. Includes pools, riffles, boulders, drowned logs, etc.</li> <li>Maintaining instream habitat is important to meeting designated use for streams, which can help with meeting TMDLs for the region.</li> <li>Reach 1, Phase 1 is complete and instream habitat must be maintained. Reach 1, Phase 2 will be completed in the next year and instream habitat will also need to be maintained.</li> </ul>	O&M	Very Low	MMSD follows their O&M schedules	High	Project was designed for instream habitat	Low	Level of Service	Environmental Improvements
W119	Failure of instream habitat feature if not maintained resulting in loss of habitat (MMSD owned, KK River Reach 1)	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Loss of biohabitat and fish passage. Includes pools, riffles, boulders, drowned logs, etc.</li> <li>Maintaining instream habitat is important to meeting designated use for streams, which can help with meeting TMDLs for the region.</li> <li>KK River from 6th Street to Chase</li> </ul>	O&M	Very Low	MMSD follows their O&M schedules	High	Project was designed for instream habitat	Low	Level of Service	Environmental Improvements
W120	Failure of instream habitat feature if not maintained resulting in loss of habitat (MMSD owned, Lincoln Creek)	MILWAUKEE RIVER	<ul style="list-style-type: none"> <li>Loss of biohabitat and fish passage. Includes pools, riffles, boulders, drowned logs, etc.</li> <li>Maintaining instream habitat is important to meeting designated use for streams, which can help with meeting TMDLs for the region.</li> </ul>	O&M	Very Low	MMSD follows their O&M schedules	High	Project was designed for instream habitat	Low	Level of Service	Environmental Improvements
W121	Failure of instream habitat feature if not maintained resulting in loss of habitat (MMSD owned, Menomonee River)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Loss of biohabitat and fish passage. Includes pools, riffles, boulders, drowned logs, etc.</li> <li>Maintaining instream habitat is important to meeting designated use for streams, which can help with meeting TMDLs for the region.</li> </ul>	O&M	Very Low	MMSD follows their O&M schedules	High	Project was designed for instream habitat	Low	Level of Service	Environmental Improvements
W122	Damage to alley, potential damage to structures and water quality impacts due to increased streambank erosion on Lyons Park Creek (Reach 2)	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Erosion is an MMSD issue if MMSD owns the land, and they are required to repair erosion problems. High velocities and culvert modifications by others can cause this erosion, which alters the flow rates through the channel. Erosion causes water quality problems and continues downcutting and potential building/private property loss, expansion of floodplain, and therefore this is a risk associated with MMSD Watercourse policy. Considered to have Regional (multiple watersheds) erosion and/or negative impact to water quality or environmentally sensitive areas (wetland).</li> </ul>	<ul style="list-style-type: none"> <li>Natural vegetation on streambanks where erosion has not occurred.</li> <li>MMSD Chapter 13.</li> </ul>	High	Already occurring at this location.	Medium	Erosion that is occurring is undercutting the end of an alley between W Nebraska and W Forest Home Avenues. COF could go up if the erosion gets closer to the homes in this area (upstream end of Reach 2 where channel is more channelized).	Low	Physical Mortality	Customer Service, Communication and Employee Development
W123	Structure flooding (Mitchell Field Ditch)	OAK CREEK	<ul style="list-style-type: none"> <li>Flood damage to 2 structures in current 1%, 2 in 2% and 1 in 4% probability floodplains (per SEWRPC data).</li> </ul>	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Medium	Damages in 4% probability event (SEWRPC data)	High	Potential fatality, property damage, potential increase in SSOs, Local flooding with impacts to 1-10 buildings impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety

**APPENDIX 5C-8: WCFM Risk Register – COF Definitions -**

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Ranking	Permit / Legal Requirements	Environmental Improvements (non regulatory, resource recovery)	Energy	Customer Service, Community Economic Development and Organizational Reputation	Safety	Fiscal Responsibility	Management and Operational Effectiveness
<b>Watercourse and Flood Management</b>							
<b>Very High</b>	NA	NA	NA	<ul style="list-style-type: none"> <li>Significant adverse impact to freeways, hospitals, schools, numerous community buildings, major industry, or highly visible public areas</li> <li>Constrains regional economic development                             <ul style="list-style-type: none"> <li>Negative coverage at national level</li> </ul> </li> <li>Issues raised by State Government and/or multiple public officials/commissioners</li> </ul>	<ul style="list-style-type: none"> <li>Permanent disability or potential fatality</li> <li>Regional flooding with impacts to &gt;100 buildings</li> </ul>	> \$10,000,000 total financial impact	<ul style="list-style-type: none"> <li>Major critical systems, facilities, or equipment unavailable for &gt; 1 month</li> <li>High turnover of critical staff - organization-wide impact</li> </ul>
<b>High</b>	NA	Regional (multiple watersheds) erosion and/or negative impact to water quality	NA	<ul style="list-style-type: none"> <li>Significant adverse impact to arterial streets and/or multiple community or industrial buildings, or widespread residential buildings</li> <li>Constrains localized economic development, and/or widespread decrease in property values</li> <li>Significant loss of reputation or long term good will with customers, residents and stakeholders</li> <li>Negative coverage at state or local (TV and/or newspaper) level                             <ul style="list-style-type: none"> <li>Issues raised by single public official/commissioner</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Permanent disability or potential fatality</li> <li>Temporary disability or serious illness</li> <li>Widespread flooding with impacts to 10-100 buildings</li> </ul>	\$1,000,000 - \$10,000,000 total financial impact	<ul style="list-style-type: none"> <li>Major critical systems, facilities, or equipment unavailable for &lt; 1 month</li> <li>Extensive or prolonged adverse reaction - company-wide disengagement                             <ul style="list-style-type: none"> <li>Loss of key staff - impacts multiple locations/departments</li> </ul> </li> <li>Significant impact on operational efficiency, &gt;50% impact on operational KPI's</li> </ul>
<b>Medium</b>	Violation of municipal/state ICA/MOU/permit identified by stakeholder	<ul style="list-style-type: none"> <li>Widespread local (single watershed-wide) erosion and/or negative impact to water quality</li> <li>Significant failure to meet annual internal targets (&lt;50% of goals achieved) for GI capacity, Greenseams acres or river buffer acres</li> <li>Significant or newsworthy negative impact on biodiversity, fish habitat, access to green space, education, or other environmental aesthetics</li> </ul>	Significant failure to meet annual internal targets (<50% of goals achieved) for carbon footprint sequestered through green space addition	<ul style="list-style-type: none"> <li>Adverse impact to collector streets and numerous residential buildings                             <ul style="list-style-type: none"> <li>Local decrease in property values</li> </ul> </li> <li>Moderate loss of reputation or long term good will with customers, residents and stakeholders</li> <li>Issues raised by numerous residents</li> </ul>	<ul style="list-style-type: none"> <li>Injury or illness requiring medical treatment</li> <li>Local flooding with impacts to 1-10 buildings</li> </ul>	\$250,000 - \$1,000,000 total financial impact	<ul style="list-style-type: none"> <li>Employee disengagement among business area or geographic location                             <ul style="list-style-type: none"> <li>Loss of key staff in single location or department</li> </ul> </li> <li>Moderate impact on operational efficiency, 25-50% impact on operational KPI's</li> </ul>
<b>Low</b>	Violation of municipal/state ICA/MOU/permit identified internally	<ul style="list-style-type: none"> <li>Limited local (sub-watershed) erosion and/or negative impact to water quality</li> <li>Moderate failure to meet annual internal targets (50-75% of goals achieved) for GI capacity, Greenseams acres or river buffer acres                             <ul style="list-style-type: none"> <li>Organization cannot demonstrate commitment to biodiversity, fish habitat, access to green space, education, or other environmental aesthetics</li> </ul> </li> </ul>	Moderate failure to meet annual internal targets (50-75% of goals achieved) for carbon footprint sequestered through green space addition	<ul style="list-style-type: none"> <li>Adverse impact to isolated residential street or residential buildings                             <ul style="list-style-type: none"> <li>Isolated decrease in property values</li> </ul> </li> <li>Minimal loss of reputation or long term good will with customers, residents and stakeholders</li> <li>Issues raised by isolated residents</li> </ul>	<ul style="list-style-type: none"> <li>Injuries requiring first aid treatment</li> <li>Isolated flooding with no impacts to any buildings</li> </ul>	\$50,000 - \$250,000 total financial impact	<ul style="list-style-type: none"> <li>Non-critical systems, facilities, or equipment unavailable for &gt; 1 month</li> <li>Localized adverse impact on employee morale - single departmental location                             <ul style="list-style-type: none"> <li>Loss of non-critical staff in single department or location</li> </ul> </li> <li>Minimal impact on operational efficiency, &lt;25% impact on operational KPI's</li> </ul>
<b>Very Low</b>	NA	<ul style="list-style-type: none"> <li>Isolated (single point location) erosion and/or negative impact to water quality</li> <li>Minimal failure to meet annual internal targets (76-99% of goals achieved) for GI capacity, Greenseams acres or river buffer acres</li> </ul>	Minimal failure to meet annual internal targets (76-99% of goals achieved) for carbon footprint sequestered through green space addition	<ul style="list-style-type: none"> <li>Negative response internally</li> </ul>	<ul style="list-style-type: none"> <li>Possible minor injury</li> <li>Isolated flooding of local areas with no impact to buildings</li> </ul>	0 - \$50,000 total financial impact	<ul style="list-style-type: none"> <li>Non-critical systems, facilities, or equipment unavailable for &lt; 1 month</li> <li>Isolated adverse impact on employee morale - single employees</li> <li>Loss of non-critical staff - single employees</li> </ul>

**APPENDIX 5C-9: WCFM Risk Register – LOS Risks -**

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MMSD 2050 Facilities Plan  
Watercourse and Flood Management Asset System  
Risk Register - Level of Service Risks

Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W001	Structure Flooding (Fish Creek)	LAKE MICHIGAN	<ul style="list-style-type: none"> <li>Seven structures flood during 100-year event due to overbank flooding at confluence within current MMSD jurisdiction.</li> <li>Update with SEWRPC July 2016 floodplain for mainstem and tributary.</li> </ul>	Fish Creek is a natural alluvial conveyance channel. Flood management structures include culverts, railroad and highway embankments. The channels are not stable but eroding.	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W002	Potential negative public perception, political pressure due to Western Milwaukee Phase 2B project delay	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Numerous structures within floodplain and hydraulic shadow without completion of W20029, Phase 2B and with Phase 1 and 2A complete.</li> <li>FEMA LOMR for Menomonee River from Hart Park to Western Milwaukee cannot be approved until this project is completed.</li> </ul>	Phase 1 and 2A complete, a 60% design exists for Phase 2B and plans are in place to complete.	Low	<ul style="list-style-type: none"> <li>1% probability event</li> <li>Phase 2B project is not completed.</li> </ul>	High	<ul style="list-style-type: none"> <li>Issues raised by single public official/commissioner</li> <li>Moderate loss of reputation or long term goodwill with customers, residents and stakeholders</li> </ul>	Low	Level of Service	Customer Service, Communication and Employee Development
W004	Failure to establish or maintain native vegetation reduces aesthetics, can cause public perception issues and lead to higher maintenance costs (Multiple - unknown locations)	Multiple	<ul style="list-style-type: none"> <li>Loss of native plantings</li> <li>Diminished aesthetics</li> <li>Higher maintenance costs</li> <li>Complaints from neighbors</li> <li>Invasive species take over</li> <li>Potential increase in erosion if we lose native plantings</li> <li>Decreased bank/slope stability</li> </ul>	Vegetation maintenance contracts	High	Critical timeframe for natives to establish is 1-5 years	High	Moderate loss of reputation or long term goodwill with customers, residents and stakeholders	Moderate	Level of Service	Customer Service, Communication and Employee Development
W006	Loss of reputation and negative news coverage due to failure to maintain MMSD owned riparian land (Multiple)	Multiple	Not maintaining riparian land (floodplain fringe, green space where properties purchased, etc.)	<ul style="list-style-type: none"> <li>Vegetation maintenance contracts</li> <li>Post-project vegetation maintenance</li> <li>O&amp;M</li> </ul>	Low	MMSD follows their O&M schedules	High	<ul style="list-style-type: none"> <li>Negative coverage at state or local (TV and/or newspaper) level</li> <li>Issues raised by single public official/commissioner</li> <li>Regional (multiple watersheds) erosion and/or negative impact to water quality</li> <li>Angry calls from nearby homeowners. Negative MMSD-brand experiences erode the public's goodwill and willingness to partner with MMSD in the future.</li> </ul>	Low	Level of Service	Customer Service, Communication and Employee Development
W016	Unforeseen emergency situations caused by a lack of a Watercourse Asset Management Program.	Multiple	<p>There is no Watercourse Asset Management Program that proactively inspects and maintains MMSD Watercourse assets. An Asset Management Analyst is needed to continually monitor the watercourse system. Included in this would be:</p> <ul style="list-style-type: none"> <li>Concrete channel assessments: MMSD owns approximately 16 miles of concrete built in the 1950's - 1980's. Although summer interns perform annual channel inspections, there has not been a comprehensive condition assessment. Obvious issues are known, but engineers are not performing inspections that would possibly identify hidden conditions behind the concrete channel lining. Inspections performed by the same person on a regular basis will also reveal issues.</li> <li>Culverts (CMP and other materials): Videos are taken by conveyance monitoring field personnel but need to be watched and the pipe evaluated.</li> <li>Native plantings should be checked for invasives and other issues after maintenance contracts expire.</li> <li>Flood control basins should be monitored for capacity.</li> <li>Caps need to be monitored.</li> </ul>	Channel inspections are done each summer by two watercourse interns. Watercourse SPMs inspect watercourses when issues arise from the public.	Very High	Failures in many areas are unknown until an emergency occurs.	High	Depending on severity of the failure, reduced hydraulic capacity in certain areas could increase risk of flooding for 10-100 structures and have a total financial impact of \$1M-\$10M.	High	Level of Service	Management Effectiveness
W019	Structure Flooding (Milwaukee River Reach 2)	MILWAUKEE RIVER	Flood risk for 389 homes - mostly in Glendale	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Medium	1% probability event/2% probability event (many structures are in both floodplains) Some structures in 4% probability event.	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W020	Structure Flooding (Beaver Creek)	MILWAUKEE RIVER	Flood risk for 13 structures at confluence with Milwaukee River.	None	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W021	Potential water quality impacts (PCB contamination) from the Estabrook Dam removal	MILWAUKEE RIVER	Risk of unearthing PCB contamination that may be against dam face or hidden in areas that were not able to be remediated when PCB clean-up project was accomplished. PCB project was done to face of dam, so it is thought that what PCBs are left are minimal.	It has been said that PCBs that were not able to be removed were covered.	Low	PCBs were removed to the extent practicable so there should be little left in the area of the dam.	Medium	Any PCBs that are found will need to be removed using approved methods of retrieval and disposal to prevent further contamination of the area.	Minimal	Level of Service	Permit Requirements
W022	Structure Flooding (Lincoln Creek)	MILWAUKEE RIVER	Recurring property damage from limited stormwater conveyance capacity. This is flooding due to inadequate stormwater drainage, not riverine flooding.	Undersized conveyance system (combined sewer)	High	Frequent stormwater issues in the 30th Street Corridor.	High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Customer Service, Communication and Employee Development

Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W026	Structure Flooding (Menomonee River, Hart Park area, Wauwatosa)	MENOMONEE RIVER	Floodproofing of Muellner building in Wauwatosa (commercial property).	Risk has been lowered by other projects in the Menomonee River. However, the Muellner building is still at risk.	High	Building is close to the stream and in the regulatory floodplain (1% probability event).	High	Commercial building and contents could result in heavy financial losses if building is flooded.	Moderate	Level of Service	Safety
W027	Structure Flooding (Menomonee River, Concordia Avenue)	MENOMONEE RIVER	Risk of flooding for 11 structures in the vicinity of Menomonee River Parkway and W Concordia Avenue.	Risk has been lowered by other projects in the Menomonee River. However, these structures are still at risk.	Medium	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W028	Failure to establish or maintain native vegetation reduces aesthetics, can cause public perception issues and lead to higher maintenance costs (Menomonee River Lower Reach)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Loss of native plantings; diminished aesthetics; higher maintenance costs; complaints from neighbors; invasive species takeover; potential increase in erosion if we lose native plantings; decreased bank/slope stability.</li> <li>Invasives can be a problem.</li> </ul>	Vegetation maintenance contracts	Medium	Critical timeframe for natives to establish is 1-5 years	Medium	Moderate loss of reputation or long term good will with customers, residents and stakeholders	Low	Level of Service	Customer Service, Communication and Employee Development
W030	Structure Flooding (Western Milwaukee)	MENOMONEE RIVER	Risk of flooding for approximately 62 structures along the Menomonee River between N 63rd Street and W Monarch Place	Risk has been lowered by other projects in the Menomonee River. However, these structures are still at risk. Additional controls include: <ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Medium	1% probability event	Very High	potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W031	Structure Flooding (Menomonee River Estuary)	MENOMONEE RIVER	Risk of flooding for approximately 24 structures along the Menomonee River between S 29th Street and W Canal Street. Updated SEWRPC flooding mapping (due to new climatological data) has preliminarily identified these structures within the floodplain.	This area has some of the following controls, but will probably need more due to the increased floodplain area: <ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Medium	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W032	Failure to establish or maintain native vegetation reduces aesthetics, can cause public perception issues and lead to higher maintenance costs (Underwood Creek Reach 1)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Loss of native plantings; diminished aesthetics; higher maintenance costs; complaints from neighbors; invasive species takeover; potential increase in erosion if we lose native plantings; decreased bank/slope stability.</li> <li>Invasives have been a problem in this reach.</li> </ul>	Vegetation maintenance contracts (10-year)	High	Critical timeframe for natives to establish is 1-5 years	Medium	Moderate loss of reputation or long term good will with customers, residents and stakeholders	Low	Level of Service	Customer Service, Communication and Employee Development
W037	Increased risk of drowning due to high velocities and steep, slippery slopes in concrete-lined channels (Underwood Creek Reach 2)	MENOMONEE RIVER	High velocities and steep, slippery concrete side slopes make concrete-lined channels difficult to escape from during high flows.	Concrete removal projects, typically in conjunction with channel rehabilitation efforts for flood management projects.	Medium	No known deaths in this channel (according to newspaper research), but the potential is still there due to high velocities, especially during flood events.	Very High	Permanent disability or potential fatality.	Moderate	Level of Service	Safety
W038	Failure to improve habitat if fish passage barriers not removed from Underwood Creek Reach 1	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.</li> <li>5 drop structures located between confluence with the Menomonee River and I-41 (Reach 1).</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W039	Failure to improve habitat if fish passage barriers not removed from Underwood Creek Reach 2	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.</li> <li>3 drop structures located along Underwood Creek between Watertown Plank Road and N 115th St (Reach 2).</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W040	Failure to improve habitat if fish passage barriers not removed from South Branch Underwood Creek Reach 1	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 1 has concrete channel that makes it difficult for fish to access headwater areas for spawning.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements

Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W041	Failure to improve habitat if fish passage barriers not removed from South Branch Underwood Creek Reach 2	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 2 an enclosed channel that makes it difficult for fish to access headwater areas for spawning.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W042	Structure Flooding (Honey Creek Reach 6)	MENOMONEE RIVER	Risk of flooding of approximately 2 structures between W Howard Avenue and 43	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W044	Structure Flooding (Honey Creek Reach 5)	MENOMONEE RIVER	Risk of flooding of approximately 18 structures from W Oklahoma Avenue upstream to W Howard Avenue. This is new flooding (SEWRPC floodplains) that was identified between Euclid and Ohio Avenues.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W046	Structure Flooding (Honey Creek Reach 4)	MENOMONEE RIVER	Risk of flooding of approximately 4 structures from W Arthur Avenue upstream to W Oklahoma Avenue	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W048	Structure Flooding due to revised SEWRPC Floodplain Maps (Honey Creek)	MENOMONEE RIVER	SEWRPC has updated the effective floodplain maps to incorporate climatological changes. These maps have increased the floodplain in many areas, either adding structures to the floodplain or increasing flood depths at structures already in the floodplain.	Honey Creek has an existing planning study that addresses risks.	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W051	Failure to improve habitat if fish passage barriers not removed from Honey Creek Reach 6	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 1 has concrete channel that makes it difficult for fish to access headwater areas for spawning.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W052	Failure to improve habitat if fish passage barriers not removed from Honey Creek Reach 5	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 1 has concrete channel that makes it difficult for fish to access headwater areas for spawning.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W053	Failure to improve habitat if fish passage barriers not removed from Honey Creek Reach 4	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 1 has concrete channel that makes it difficult for fish to access headwater areas for spawning.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W054	Failure to improve habitat if fish passage barriers not removed from Honey Creek Reach 1	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 1 has concrete channel that makes it difficult for fish to access headwater areas for spawning.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W055	Downstream MMSD assets (stream restoration projects, conveyance system, WRFs) adversely impacted by non-MMSD entities not following Chapter 13 Stormwater Rule.	Multiple	<ul style="list-style-type: none"> <li>Failure to comply with the MMSD Chapter 13 Rule adds more stormwater to the system, whether it be directly or indirectly. This can happen when others construct/alter channels, culverts, bridges, and/or increase peak flows and volume of water. Others can be public or private owners of culverts, channels, and/or bridges.</li> <li>Additional flow in streams can raise water surface elevations putting more structures at risk for flooding and can lead to bank erosion that can also put structures at risk.</li> <li>An example of this risk is the failure of WisDOT to comply with Chapter 13 for the Zoo Interchange Project. Highway expansion projects will impact the streams that they cross, in this case, Honey Creek.</li> </ul>	MMSD Chapter 13	Very High	WisDOT's Zoo Interchange project did not follow Chapter 13. There is a concern about five more mega projects are proposed through year 2030.	High	Potential impacts to MMSD facilities from increased runoff; water quality issues	High	Level of Service	Permit Requirements

Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W056	Structure Flooding (Schoonmaker Creek)	MENOMONEE RIVER	Economic and public safety impact of major flooding events to residences and roadways within the Schoonmaker Creek Watershed	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W057	Structure Flooding (North Branch Root River)	ROOT RIVER	<ul style="list-style-type: none"> <li>Risk of flooding of an undetermined number of structures in the Upper Reach of the North Branch Root River Watershed. Update with SEWRPC July 2016 floodplain for all jurisdictional streams anticipated to increase structure flooding.</li> <li>Street Flooding at Root River Parkway adjacent/downstream of National Ave along N Branch Root River.</li> <li>New SEWRPC flows should show new flooding along S. 119th St between Oklahoma and Morgan Ave along N Branch Root River.</li> </ul>	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Low	1% probability event	High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Low	Level of Service	Safety
W058	Structure Flooding (Lower Whitnall Park Creek)	ROOT RIVER	<ul style="list-style-type: none"> <li>Risk of flooding of an undetermined number of structures in the Lower Whitnall Park Creek Watershed. Update with SEWRPC July 2016 floodplain for all jurisdictional streams anticipated to increase structure flooding.</li> <li>Flooding u/s of Janesville Rd along Whitnall Park Creek.</li> </ul>	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Low	1% probability event	High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Low	Level of Service	Safety
W059	Structure Flooding (KK Reach 2)	KINNICKINNIC RIVER	Risk of flooding of more than 300 residential and commercial structures between S 6th and S 16th Streets.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Medium	1% probability event/2% probability event (many structures are in both floodplains) Some structures in 10% probability event.	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W061	Failure to improve habitat if fish passage barriers not removed from KK River Reach 2	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Drop Structures along KK mainstem between 6th and 20th are failing.</li> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Medium	<ul style="list-style-type: none"> <li>This reach's fish passage barriers make it very difficult or impossible for salmon and other fish to move upstream.</li> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Moderate	Level of Service	Environmental Improvements
W063	Failure to improve habitat if fish passage barriers not removed from KK River Reach 4	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects because MMSD does not have authority to use their own funds for certain types of projects. (For this project, the District will partner with USACE who will finance 65% of the project costs, up to \$10,000,000.)</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W064	Failure to establish or maintain native vegetation reduces aesthetics, can cause public perception issues and lead to higher maintenance costs (KK Reach 1)	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Loss of native plantings</li> <li>Diminished aesthetics</li> <li>Higher maintenance costs</li> <li>Complaints from neighbors</li> <li>Invasive species take over</li> <li>Potential increase in erosion if we lose native plantings</li> <li>Decreased bank/slope stability</li> </ul>	Vegetation maintenance contracts (5-year)	Medium	Critical timeframe for natives to establish is 1-5 years	Medium	Moderate loss of reputation or long-term goodwill with customers, residents and stakeholders	Low	Level of Service	Customer Service, Communication and Employee Development
W066	Failure to improve habitat if fish passage barriers not removed from KK River Reach 4	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Drop Structure on KK mainstem at confluence with 43rd St Ditch failing.</li> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds. (For this project, the District will partner with USACE who will finance 65% of the project costs, up to \$10,000,000.)</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W070	Impaired water quality and habitat due to contaminated sediment and other issues (KK River Reach 1)	KINNICKINNIC RIVER	The area of the KK River between the 1,200 linear feet of channel reconstruction in Reach 1 and a Great Lakes Legacy Act remediation project that removed contaminated sediments from the Lake Estuary has contaminated sediments that have led to impaired habitat. DO Sag is also a problem. The impaired reach starts at the downstream end of Reach 1 on the upstream end and includes the entire River Estuary.	Permitting requirements to discharge to channels have put an end to high PAH loadings from coal tar sealants. However, the contaminants do not go away on their own. They must be removed.	High	Contaminants are already in the stream and are having an adverse effect on aquatic species.	Medium	Contamination this far downstream in the river will prevent fish movement upstream in areas where fish passage barriers are being removed.	Low	Level of Service	Environmental Improvements



Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W071	Impaired water quality and habitat due to contaminated sediment and other issues (KK River Estuary)	KINNICKINNIC RIVER	The area of the KK River between the 1,200 linear feet of channel reconstruction in Reach 1 and a Great Lakes Legacy Act remediation project that removed contaminated sediments from the Lake Estuary has contaminated sediments that have led to impaired habitat. DO Sag is also a problem. The impaired reach starts at the downstream end of Reach 1 on the upstream end and includes the entire River Estuary.	Permitting requirements to discharge to channels have put an end to high PAH loadings from coal tar sealants. However, the contaminants do not go away on their own. They must be removed.	High	Contaminants are already in the stream and are having an adverse effect on aquatic species.	Medium	Contamination this far downstream in the river will prevent fish movement upstream in areas where fish passage barriers are being removed.	Low	Level of Service	Environmental Improvements
W072	Structure Flooding (Lyons Park Creek)	KINNICKINNIC RIVER	Risk of flooding of approximately 66 structures	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Medium	1% probability event/2% probability event (many structures are in both floodplains) 10% probability event comes close to structures.	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W073	Failure to improve habitat if fish passage barriers not removed from Lyons Park Creek	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Drop structures owned by the City of Milwaukee are in bad shape.</li> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 1 has concrete channel that makes it difficult for fish to access headwater areas for spawning.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds. (For this project, the District will partner with USACE who will finance 65% of the project costs, up to \$10,000,000.)</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W074	Structure Flooding (43rd Street Ditch)	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Risk of flooding of approximately 9 structures, primarily located along the enclosed section of the ditch under S 43rd Street.</li> <li>Roadway flooding at Lincoln and 43rd Street.</li> </ul>	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W075	Failure to improve habitat if fish passage barriers not removed from 43rd Street Ditch Reach 1	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems. Reach 1 has concrete channel that makes it difficult for fish to access upstream.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	There are known areas to have fish barriers for both native and non-native migrating fish throughout the watershed. Here it is a large lengths of culverted pipe connected with concrete channel.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W077	Structure Flooding (Villa Mann Creek Tributary)	KINNICKINNIC RIVER	Risk of flooding of approximately 9 structures, primarily located northwest of the I-43/894 and S 27th Street interchange.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Low	1% probability event/2% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W078	Structure Flooding (Wilson Park Creek Reach 3)	KINNICKINNIC RIVER	Risk of flooding for over 50 residential and commercial structures in the vicinity of S 6th Street and W Armour Avenue.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Low	1% probability event/2% probability event (many structures are in both floodplains)	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W081	Increased risk of drowning due to high velocities and steep, slippery slopes in concrete-lined channels (Wilson Park Creek Reach 3)	KINNICKINNIC RIVER	High velocities and steep, slippery concrete side slopes make concrete-lined channels difficult to escape from during high flows.	Concrete removal projects, typically in conjunction with channel rehabilitation efforts for flood management projects.	Very Low	No mention of drownings in Wilson Park Creek in the research.	Very High	Permanent disability or potential fatality.	Moderate	Level of Service	Safety
W084	Increased risk of drowning due to high velocities and steep, slippery slopes in concrete-lined channels (Wilson Park Creek Reach 2)	KINNICKINNIC RIVER	High velocities and steep, slippery concrete side slopes make concrete-lined channels difficult to escape from during high flows.	Concrete removal projects, typically in conjunction with channel rehabilitation efforts for flood management projects.	Very Low	No mention of drownings in Wilson Park Creek in the research.	Very High	Permanent disability or potential fatality.	Moderate	Level of Service	Safety
W085	Structure Flooding (Wilson Park Creek Reach 2)	KINNICKINNIC RIVER	Risk of flooding more than 90 structures.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Low	1% probability event/2% probability event (many structures are in both floodplains)	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W087	Increased risk of drowning due to high velocities and steep, slippery slopes in concrete-lined channels (Wilson Park Creek Reach 4, GMIA)	KINNICKINNIC RIVER	High velocities and steep, slippery concrete side slopes make concrete-lined channels difficult to escape from during high flows.	Concrete removal projects, typically in conjunction with channel rehabilitation efforts for flood management projects.	Very Low	No mention of drownings in Wilson Park Creek in the research. Even less likely on GMIA property due to airport security.	Very High	Permanent disability or potential fatality.	Moderate	Level of Service	Safety



Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W088	Structure Flooding (Wilson Park Creek Reach 4, GMIA)	KINNICKINNIC RIVER	Risk of flooding of a underdetermined number of structures. Some structures flood during higher frequency storm events.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Low	1% probability event/2% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W089	Structure Flooding (North Branch Oak Creek)	OAK CREEK	<ul style="list-style-type: none"> <li>Flood damage to 15 structures in current 1%, 7 in 2%, and 2 in 4% probability floodplains (per SEWRPC data).</li> <li>Hotel flooded at/near College and S 13th St</li> <li>Little slope on culvert under S 13th St just north of the intersection of S 13th St &amp; W Granada St. There are three culverts at this location. Center culvert causes some nearby flooding.</li> </ul>	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Medium	Damages in 4% probability event (SEWRPC data)	High	Potential fatality, widespread flooding with impacts to 10-100 buildings, \$1M-\$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W090	Structure Flooding (Oak Creek)	OAK CREEK	<ul style="list-style-type: none"> <li>Flood damage to 9 structures in current 1%, 5 in 2% and 4 in 4% probability floodplains (per SEWRPC data). Flooding between Southland Dr and Ryan Road; could add structures in other locations as well.</li> <li>Flooded structures south of Ryan Road.</li> </ul>	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Medium	Damages in 4% probability event (SEWRPC data)	High	Potential fatality, property damage, potential increase in SSOs, Local flooding with impacts to 1-10 buildings impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W091	Failure to improve habitat if fish passage barriers not removed from Wilson Park Creek Reach 1	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Culvert beneath St. Luke's Hospital eliminates passage upstream to Creek and tributaries.</li> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds</li> </ul>	<ul style="list-style-type: none"> <li>USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications.</li> <li>Open channels (bedrock, natural, bio, concrete, gabion, riprap)</li> </ul>	Very High	Concrete culverts, especially ones as long as this one, are known to be fish barriers for both native and non-native migrating fish throughout the watershed.	Low	Erosion and negative impact to water quality or environmentally sensitive areas (wetland).	Low	Level of Service	Environmental Improvements
W098	Structure Flooding (Fish Creek Tributary)	LAKE MICHIGAN	<ul style="list-style-type: none"> <li>One structure floods during 100-year event due to overbank flooding at confluence within current MMSD jurisdiction.</li> <li>Update with SEWRPC July 2016 floodplain for mainstem and tributary.</li> </ul>	Fish Creek Tributary is a natural alluvial conveyance channel. Flood management structures include culverts, railroad and highway embankments. The channels are not stable but eroding.	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W100	Structure Flooding (Milwaukee River Estuary)	LAKE MICHIGAN	MMSD took over jurisdiction for the estuary. There are an underdetermined number of structures prone to flooding.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W101	Structure Flooding (KK River Estuary)	KINNICKINNIC RIVER	MMSD took over jurisdiction for the estuary. There are 33 structures prone to flooding.	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Very Low	1% probability event	Very High	Potential fatality, \$10M financial impact, property damage, potential increase in SSOs, impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety
W102	Failure to improve habitat if fish passage barriers not removed from Milwaukee River Reach 2	MILWAUKEE RIVER	<ul style="list-style-type: none"> <li>Dam in Kletzsch Park is in poor condition and blocks low flow fish passage.</li> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	Dam blocks low flow fish passage.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W103	Failure to improve habitat if fish passage barriers not removed from Oak Creek (outside service area)	OAK CREEK	<ul style="list-style-type: none"> <li>Outside MMSD jurisdiction there is a dam in South Mke along Oak Creek preventing all fish passage.</li> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds. For this specific barrier, the dam is outside of MMSD jurisdiction, so removal is near impossible.</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	All fish passage from Lake Michigan to the jurisdictional reaches of Oak Creek is cut off by the dam in South Milwaukee.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W104	Failure to improve habitat if fish passage barriers not removed from Milwaukee River Reach 1	MILWAUKEE RIVER	<ul style="list-style-type: none"> <li>Estabrook dam prevents fish passage.</li> <li>Fish barriers such as drop structures, dams, concrete channels, or other barriers that prevent fish from migrating up and downstream of rivers, including perennial and intermittent systems.</li> <li>Risk includes not obtaining grants for these types of projects since MMSD does not have authority to use their own funds</li> </ul>	USACE, WDNR, SEWRPC, MMSD, i.e. stakeholders requiring permits and/or having a stake in activities that involve channel modifications to prevent construction of these barriers in the future.	Very High	Dam prevents fish passage.	Low	<ul style="list-style-type: none"> <li>Erosion and negative impact to water quality or environmentally sensitive areas (wetland).</li> <li>Fish populations decrease when they do not have the ability to access upstream spawning locations.</li> </ul>	Low	Level of Service	Environmental Improvements
W113	Failure to establish or maintain native vegetation reduces aesthetics, can cause public perception issues and lead to higher maintenance costs (MCG Basins)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Loss of native plantings; diminished aesthetics; higher maintenance costs; complaints from neighbors; invasive species takeover; potential increase in erosion if we lose native plantings; decreased bank/slope stability.</li> <li>Invasives, particularly crown vetch, are a problem in the Milwaukee County Grounds basins. Crown vetch is susceptible to mass die-outs and the root structure does not offer good soil stabilization. It spreads incredibly quickly, crowding out native species.</li> </ul>	Vegetation maintenance contracts	Very High	Crown vetch has begun to take over parts of the MCG Basins. It spreads very fast.	Medium	Moderate loss of reputation or long-term goodwill with customers, residents and stakeholders	Moderate	Level of Service	Customer Service, Communication and Employee Development

Risk Identification				Risk Analysis							
Risk ID	Risk Title	Level 2 - Watershed	Risk Description	Existing Controls to Manage the Risk	Likelihood of Failure	Justification of Likelihood Score	Consequence of Failure	Justification of Consequence Score	Risk Level	Failure Mode	LOS Category
W118	Failure of instream habitat feature if not maintained resulting in loss of habitat (MMSD owned, Underwood Creek Reach 1)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Loss of biohabitat and fish passage. Includes pools, riffles, boulders, drowned logs, etc.</li> <li>Maintaining instream habitat is important to meeting designated use for streams, which can help with meeting TMDLs for the region.</li> <li>Reach 1, Phase 1 is complete and instream habitat must be maintained. Reach 1, Phase 2 will be completed in the next year and instream habitat will also need to be maintained.</li> </ul>	O&M	Very Low	MMSD follows their O&M schedules	High	Project was designed for instream habitat	Low	Level of Service	Environmental Improvements
W119	Failure of instream habitat feature if not maintained resulting in loss of habitat (MMSD owned, KK River Reach 1)	KINNICKINNIC RIVER	<ul style="list-style-type: none"> <li>Loss of biohabitat and fish passage. Includes pools, riffles, boulders, drowned logs, etc.</li> <li>Maintaining instream habitat is important to meeting designated use for streams, which can help with meeting TMDLs for the region.</li> <li>KK River from 6th Street to Chase</li> </ul>	O&M	Very Low	MMSD follows their O&M schedules	High	Project was designed for instream habitat	Low	Level of Service	Environmental Improvements
W120	Failure of instream habitat feature if not maintained resulting in loss of habitat (MMSD owned, Lincoln Creek)	MILWAUKEE RIVER	<ul style="list-style-type: none"> <li>Loss of biohabitat and fish passage. Includes pools, riffles, boulders, drowned logs, etc.</li> <li>Maintaining instream habitat is important to meeting designated use for streams, which can help with meeting TMDLs for the region.</li> </ul>	O&M	Very Low	MMSD follows their O&M schedules	High	Project was designed for instream habitat	Low	Level of Service	Environmental Improvements
W121	Failure of instream habitat feature if not maintained resulting in loss of habitat (MMSD owned, Menomonee River)	MENOMONEE RIVER	<ul style="list-style-type: none"> <li>Loss of biohabitat and fish passage. Includes pools, riffles, boulders, drowned logs, etc.</li> <li>Maintaining instream habitat is important to meeting designated use for streams, which can help with meeting TMDLs for the region.</li> </ul>	O&M	Very Low	MMSD follows their O&M schedules	High	Project was designed for instream habitat	Low	Level of Service	Environmental Improvements
W123	Structure flooding (Mitchell Field Ditch)	OAK CREEK	<ul style="list-style-type: none"> <li>Flood damage to 2 structures in current 1%, 2 in 2% and 1 in 4% probability floodplains (per SEWRPC data).</li> </ul>	<ul style="list-style-type: none"> <li>Flood management structures/strategies (culverts, levees, detention basins, floodwalls, conveyance channels, floodproofing, acquisitions, etc.).</li> <li>Water surface elevation monitoring.</li> </ul>	Medium	Damages in 4% probability event (SEWRPC data)	High	Potential fatality, property damage, potential increase in SSOs, Local flooding with impacts to 1-10 buildings impact to emergency traffic, health and safety including possible death.	Moderate	Level of Service	Safety