City of Madison TMDL 2020 SLAMM Analysis

City of Madison

Madison, Wisconsin

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List of Abbreviations

ADT	Average daily traffic
BMP	Best management practice
cfs	cubic feet per second
City	City of Madison
EPA	Environmental Protection Agency
GIS	Geographical Information System
HTU	High-traffic urban
MDRNA	Medium density residential – no alleys
MMSD	Madison Metropolitan Sewerage District
MS4	Municipal Separate Storm Sewer System
NRCS	Natural Resource Conservation Service
NRCS	Natural Resource Conservation Service
Plan	Stormwater Management Plan
RI	Remedial Investigation
ROW	Right-of-Way
SCM	Stormwater Control Measures
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSS	Total Suspended Solids
USDA	U.S. Department of Agriculture
USGS	Unites States Geological Survey
WAC	Wisconsin Administrative Code
WBIC	Waterbody Identification Code
WDNR	Wisconsin Department of Natural Resources
WinSLAMM	Windows Source Loading and Management Model
WisDOT	Wisconsin Department of Transportation
WLAs	Waste Load Allocations
WPDES	Wisconsin Pollutant Discharge Elimination System

1 Introduction

City of Madison (City) stormwater discharge quality is regulated by a joint Wisconsin Department of Natural Resources (WDNR) Municipal Separate Storm Sewer System (MS4) Permit WI-S058416-4. The most recent permit was issued in 2019. The permit requires the City to conduct various stormwater management programs including reducing stormwater pollution originating from its existing upstream storm sewer system.

In September 2011 the U.S. Environmental Protection Agency (EPA) approved the document: Total Maximum Daily Load and Watershed Management Plan for Total Phosphorus (TP) and Total Suspended Solids (TSS) in the Rock River Basin (WDNR 2012). The Rock River total maximum daily load (TMDL) report specifies waste load allocations (WLAs) for each reachshed (i.e. drainage area) within the City. The 2019 MS4 permit specifies a schedule and requirements for the City to meet TMDL pollution reduction targets. The first step to meet permit compliance is to develop an updated citywide stormwater management plan (Plan) that meets MS4 permit Section 1.8 and 3.7 requirements.

In December 2017 the City completed its Modeling Post-Construction Stormwater Management and Treatment NR151, Wisconsin Administrative Code (City of Madison 2017). This plan focused on mainly the City's current progress at meeting the revised Chapter NR 151.13 Wisconsin Administrative Code (WAC) standards and the Rock River TMDL WLAs. The 2017 plan documented the City's stormwater pollution loads and the reduction achieved using the City's current stormwater control measures (SCMs).

This 2020 update builds upon data generated during the 2017 effort and incorporates new guidance and model updates released since that time. The methodology used, analytical approach, and results are described in this Plan, which fulfills TMDL stormwater planning requirements for the City.

1.1 MS4 & NR151 Developed Urban Area Performance Standard for Pollution Reduction

The developed urban area performance standard for MS4 permit holders has been in place since October 2004, when the City acknowledged WAC NR 151 runoff management targets. This standard requires municipalities to reduce pollution from areas within the city developed since October 2004. When this standard was implemented, the City had to meet TSS pollution reductions from a 20 percent no-controls condition by March 31, 2008, and 40 percent no-controls condition by March 31, 2013. The City applied this control level to Madison as a whole.

Per Wisconsin State budget bill 2011 Wisconsin Act 32, two provisions have passed that directly impact WAC NR 151 developed urban area performance standards:

- The March 31, 2013, deadline for the 40 percent TSS reduction target was removed. The 20 percent TSS reduction target and all performance standards that address new construction and redevelopment are still enforced.
- All structural best management practices in place on July 1, 2011, must be maintained to the maximum extent practicable in locations where a permitted municipality achieved reduction above the 20 percent TSS performance standard.

The pollution reduction analysis performed during the 2017 study found that the City had achieved approximately 36 percent reduction of TSS citywide. This means that the City complies with current WAC NR 151.13 targets so long as it continues to maintain these management measures.

Additionally, the City met with the WDNR December 19, 2019 to discuss several questions regarding the modeling conducted for this report. One of the questions included what is required for showing compliance with this standard (the NR151 Developed Urban Area Performance Standard). The WDNR indicated that since the City was almost to 40 percent TSS reduction, the modeling for this standard did not need to be completed for the 2021 Annual Report Submittal. The meeting minutes from the meeting where this is discussed can be found in Appendix E.

Therefore, the remainder of this document focuses on the pollution reduction analysis for meeting the TMDL pollution reduction targets.

1.2 TMDL and Pollution Reduction Targets

WDNR finalized the Rock River TMDL (collectively referred to as simply, TMDL) in July 2011, and EPA approved it in September 2011 (Cadmus 2011). The document specifies pollution reduction targets for TSS and TP from the basin reachsheds (i.e., the watershed to an identified segment of a stream, river, or other water body as defined in the 2011 TMDL document). The City has eight reachsheds within the TMDL project area; thus, the City has sixteen different goals to meet (eight reachsheds, each with one TSS and one TP target), instead of one general goal for the NR 151 target.

The actual reduction targets (relative to no-controls conditions) are greater than those listed in the TMDL. This is because the TMDL baseline conditions assume that the City is achieving minimum NR 151 requirements, equivalent to a 40 percent TSS reduction and 27 percent TP reduction. Table 1-1 provides the published reduction targets relative to the TMDL baseline conditions (relative to 40 percent TSS reduction and 27 percent TP reduction from no controls, described above) for each reachshed and required reductions from the no-controls condition. See Figure 1 for graphical images of TMDL reachshed drainage areas. (Figures are included in Appendix A.)

Reachshed	Waterbody Name	Waterbody Extents	Target TP % Reduction		Target TSS % Reduction	
			Baseline	No Controls	Baseline	No Controls
47	Maunesha River	Stony Brook to Mile 13.2	0	27	0	40
62	Pheasant Branch Creek	Mile 1 to 9	70	78	70	82
64	Yahara River, Lake Mendota, Lake Monona	Nine Springs Creek to Spring (Dorn) Creek, Pheasant Branch Creek	47	61	55	73
65	Nine Springs Creek	Mile 0 to 6	49	63	46	68
66	Yahara River, Lake Waubesa, Lake Kegonsa	Mile 16 to Nine Springs Creek, Lake Waubesa	37	54	37	62

Table 1-1. Reduction targets relative to the TMDL baseline and required reduction targets from no-controls condition for each reachshed.

This document describes the City's progress towards meeting the pollution reduction targets as specified by the TMDL.

1.3 Summary of Past Reports

Since the City began tracking its pollution reduction efforts for purposes of MS4 permit compliance, the City has submitted five reports. The section documents the names of the reports and the calculated pollution reductions at that time.

In December 2017 the City released Modeling Post-Construction Stormwater Management and Treatment. This report documented the City's stormwater pollution loads for each reachshed (i.e., drainage area) within the City and the reduction achieved using the City's current stormwater control measures. The results of that analysis were a TSS reduction by 35.9% and a TP reduction by 27.1%.

In March 2011, the City released a stormwater management treatment report. The results, using a model called P8, found a TSS reduction by 40.55% on a Citywide Basins for the NR151 Developed Urban Area Performance Standard. TP was not analyzed as the TMDL requirements had not gone into effect yet.

In 2007 the City completed a WinSLAMM analysis looking at TSS and TP reductions. That analysis was completed via a spreadsheet analysis. The results of that analysis were reductions of TSS by 29.6% and TP by 38.6%.

Prior SLAMM (DOS version) analyses were completed in 1997 and again in approximately 2001 with results reported to the WDNR. At this time those results are only available in paper copy and are not readily accessible.

2 Study Area

2.1 Permitted Area

The City's MS4 permit covers all areas under the ownership, control, or jurisdiction of the "permittee" (the City) contributing to discharges from an MS4. The MS4 regulated areas are further defined as meeting any one of the following conditions:

- An urbanized area, adjacent developing areas, and areas where runoff connects (or will connect) to a MS4 regulated per WAC NR 216, subchapter I
- An area associated with a municipal population of 10,000 or more and a population density of 1,000 or more per square mile, adjacent developing areas, and areas where runoff connects (or will connect) to an MS4 regulated per WAC NR 216, subchapter I
- An area draining to an MS4 that is designated for permit coverage pursuant to WAC NR 216.02(2) or 216.025

As of October 2004, to comply with NR 151.13, the project area comprises all developed lands (October 2004 is when the developed urban area standard was put in place). The project area for Rock River TMDL compliance includes urban developed (non-agricultural) land only, and encompasses all area within the City of Madison that drains to the Rock River (areas draining to Badger Mill Creek are not included). For purposes of this project, the City of Madison used land use files dated to Jan 2020.

WDNR issued a policy memorandum in November 2010 to guide performing the municipal-wide analysis and comply with NR 151. A subsequent WDNR policy memorandum was issued in October 2014 to clarify how municipalities should conduct these TMDL analyses. See Appendix B for both policy memoranda.

Permitted municipalities are responsible for any municipal urban stormwater pollution that discharges from their MS4s. The area the City is responsible for within its municipal boundary is referred to as its "analyzed area."

Within a municipal boundary some areas may discharge to the MS4; however, the municipality is not responsible for, for example, industrial areas under a separate industrial stormwater permit. There are also areas within the municipal boundary that do not enter the MS4 before discharging to state waters; those that may be excluded from NR 151.13 are:

- Agricultural lands
- Tier 1 and Tier 2 Industrial areas
- WisDOT right-of-ways (ROW)
- Riparian areas
- University of Wisconsin-Madison
- Lands owned by Dane County discharging to a Dane County MS4

The modeled areas in each reach shed are a shown in Table 2-1. This table lists the watershed area, City of Madison acreage in each watershed, city modeled area in each watershed, and the areas omitted (shown in Figure 2).

Reachshed	Omitted Area (ac)[1]	Modeled Area with Pollutants Stripped (ac)[2]	City of Madison Modeled Area (ac)
47	0	226	216
62	0	559	2740
64	6182	3158	22178
65	2811	1026	1346
66	3024	1371	5175
City-wide Total	**12017**	**6340**	**31655**

[1]Omitted areas are areas listed as "excluded" above that do not drain to a City of Madison SCM.
[2]Modeled areas with pollutants stripped are areas listed as "excluded" above that do drain to a City of Madison SCM. Hydrologic loading to Madison SCM is accounted for by removing pollutants and routing to the appropriate SCM.

Table 2-1. Area, City acreage, modeled area, and omitted area for each watershed.

2.2 Watershed/Reachsheds

Madison is located within the Lower Rock Basin. Water resources directly impacted by the City's MS4 system are the Maunesha River, Pheasant Branch Creek, Spring (Dorn) Creek, Nine Springs Creek, Yahara River, Lake Mendota, Lake Monona, Lake Waubesa, and Lake Kegonsa. Several minor, un-named waterways also exist within the project area.

Each water resource is described briefly below; these descriptions are from WDNR's "Explore Wisconsin's Waters" website (WDNR 2020). WDNR includes a Waterbody Identification Code (WBIC) within each stream name for reference purposes.

2.2.1 Maunesha River (WBIC 888100)

This large stream drains parts of Columbia, Dane, Jefferson, and Dodge Counties, and empties into the Crawfish River in Dodge County. Much of the watershed in Dane County is ditched and drained wetland. A large percentage is in cropland and soil loss is high. Deansville Marsh is a large, slightly disturbed wetland adjoining the river. The Department of Natural Resources owns 1,459 acres in the marsh, including 4 miles of frontage on the river. This area provides hunting for pheasants, waterfowl, small game, and deer. Impoundments are found above the Villages of Marshall and Waterloo (Jefferson County). Siltation and agricultural runoff are problems above the Marshall Millpond but water quality is good. Below the Village of Marshall water quality is poor due to the fact that the Marshall wastewater treatment plant is presently overloaded. A new plant is scheduled for completion In June 1983.

The river has been chemically treated to remove rough fish several times in the past and largemouth bass, northern pike, channel catfish, and walleye were restocked. The bass and northern pike have some good survival and growth rates, but information on the catfish and walleye has been unattainable. Carp, bullheads, panfish, and forage species are also present. The possibility of developing a smallmouth bass fishery above Marshall Millpond has been suggested but is not likely. Access is available at numerous road crossings, at one county park which has a boat ramp, and through the public lands in the Deansville Marsh. The Deansville Marsh is a popular hunting area for deer, rabbits, and pheasants.

2.2.2 Pheasant Branch Creek (WBIC 805900)

Pheasant Branch Creek is 7-mile-long stream that drains 22.7 square miles of west-central Dane County. Pheasant Branch Creek begins in the glacial moraine area of the Town of Springfield (T8N, R8E, Sec. 34) and flows south and east through the City of Middleton, entering Lake Mendota on its western lobe. A south branch, mostly ditched and draining an urban area, forms Pleasant Branch above Highway 12. Much of the creek has been straightened and most adjacent wetlands have been drained for agricultural and residential development. One important wetland that remains largely intact is the 311-acre Pheasant Branch Marsh. Located near the mouth of the creek, it offers spawning habitat for northern pike.

The worst problem facing Pheasant Branch Creek is a poor base flow and excessive peak runoff that created a high sediment load which threatens the marsh and contributes to lake sediments. The main source of sediment is the erosion of unconsolidated, unstable glacial deposits at the headwaters. This natural erosion is exacerbated by local land development and could be slowed through improved soil conservation measures. Many farmers owning land along the banks have cooperated in innovative soil and water conservation programs.

Other water quality problems include moderately high alkalinity and fertility in addition to unusually high levels of chloride for a creek that receives no municipal or industrial discharges. However, it does collect urban runoff as it flows through Middleton. The natural, steep-sided configuration of the creek channel and its watershed are conducive to spring flooding. The creek has a low base flow in its upper portions where it supports forage fish. A diverse warm water fishery is found downstream where the creek joins Lake Mendota. Waterfowl use the Pheasant Branch Marsh for nesting, and as a wintering area.

2.2.3 Spring (Dorn) Creek (WBIC 805600)

Spring (Dorn) Creek Six-mile-long Dorn Creek originates in the town of Springfield (T8N, R8E, S13) and flows southeast through agricultural lands and Governor Nelson State Park before meeting Six Mile Creek. The stream drains 12.7 square miles that are 78 percent agricultural and 16 percent wetland. Wetlands adjacent to the creek provide wildlife habitat and spawning for northern pike. The creek supports a mainly tolerant warm water forage fishery. Two intolerant species are also known to inhabit the creek--the Northern Redbelly Dace and Pearl Dace.

Spring Creek is a tributary to Six Mile Creek that drains 12.7 square miles in the southwestern portion of Westport Township. This area includes approximately 325 acres of shallow marsh and sedge meadow located near the mouth of the creek and extending upstream (Dane Cty. Reg. Plann. Comm. 1979a). The areas have remained relatively undisturbed and the state has acquired some of these lands for protection as spawning areas for northern pike and panfish. The fresh meadow and wetlands provide habitat for waterfowl, pheasants, rabbits, deer, and furbearers. The waters of Spring Creek are moderately high in chloride, indicating a pollution source, most likely livestock- related. The creek has a high sediment load, causing heavy silting problems in many areas. The fishery is limited to forage species, panfish, and spawning northern pike. Diversity could be increased by improving soil conservation practices within the watershed.

2.2.4 Nine Springs Creek (WBIC 804200)

Nine Springs Creek is six-miles long and is intermittent until just east of Fish Hatchery Road where it picks up flow from the springs that give the stream its name. It empties into the Yahara River just above Upper Mud Lake. Portions of the stream have been ditched and straightened, and the stream runs through an urbanizing area. Channelization has increased summer water temperatures, reduced habitat, and increased sedimentation and excessive growth of aquatic plants.

Sediment is delivered to the stream from farm fields to the south and from construction sites in the cities of Fitchburg and Madison and their sub-watersheds. The creek's heavy sediment load results in the lower portion occasionally requiring dredging. Urban storm water from the cities of Fitchburg and Madison also deliver pollutants to the creek. As the upper portions of the sub-watershed continue to be developed, this problem is expected to increase. These factors, plus its low gradient, cause “fair” water quality, with channel straightening having a devastating effect on water quality and habitat.

Detectable levels of mercury have been found in low concentrations in Nine Springs sediment taken at Moorland Road. The Madison Metropolitan Sewerage District (MMSD) sludge lagoons are adjacent to the stream, including a Superfund site. The possibility of mercury and other substances moving from the lagoon was evaluated in the Remedial Investigation (RI) conducted as part of the Superfund evaluations for the lagoon site. The RI report concluded that no sludge constituents are migrating through the lagoon dike walls; no patterns between sludge and sediment constituents were found to indicate possible migration; the peat acts as a capture zone that restricts migration of sludge constituents to the aquifer beneath the lagoons; and groundwater is not affected by the lagoon sludge constituents (MMSD).

2.2.5 Yahara River (WBIC 798300)

The Yahara River is a large tributary to the Rock River, draining over 1/3 of Dane County. The river is nearly 40 miles in length with 23 miles in the Yahara-Kegonsa watershed. The stretch of the Yahara River in this watershed flows from the dam at Lake Waubesa and ends at the river's confluence with the Rock River. The river is slow-moving in most areas with an average gradient of 3.6 feet/mile and a baseflow of 68.8 cfs as it passes through the largely agricultural landscape. The Yahara River has undergone only limited channelization projects, but its flow has been interrupted at many points by dams and locks built for navigation.

Although there is some point source pollution to the river, the greatest water quality problem in this stretch of the Yahara is from urban and rural non-point source pollution. Urban stormwater run-off carries sediment and pollutants to area surface waters. Rural sources of non-point pollution come from cropland erosion, pesticides, and runoff from barnyards and cattle exercise lots.

The section of the Yahara that flows south from Lake Kegonsa was added to the 303(d) list in 1996. The 303(d) listed waters are those waters, which have impairment that prohibit them from meeting their potential use. Environmental problems have impacted the level of flow, habitat, fish migration, turbidity, dissolved oxygen, and sedimentation on the Yahara River. Efforts have been made over the past 20 years to reduce non-point and point source pollution. Despite these efforts, however, the Yahara River continues to be on the 303 (d) list of impaired waters. Fishkills, usually due to low dissolved oxygen, also continue to be a problem in the Yahara River below Lake Monona.

Since the majority of Dane County s population resides within the Yahara River Valley, development pressure on the Yahara system has been and continues to be intense.

2.2.6 Lake Mendota (WBIC 805400)

At 9,842 acres, Lake Mendota is the largest of the Yahara lakes and almost three times larger than Lake Monona, with only a slightly greater depth. The lake's potential for diverse habitat in and near its bays and shallows is great. But the lake's wide littoral zone, combined with urban development in the immediate basin and agriculture throughout the watershed, has resulted in channels and embayments filling in and subsequent public requests for dredging for recreational motor craft access. Further, about 50 percent of original wetlands in the lake's watershed (which includes Six Mile and Pheasant Branch Creeks Watershed) have been drained or filled (WDNR 1997).

The lake's two watersheds include the urban areas of Middleton, Maple Bluff, Shorewood Hills, Waunakee, DeForest and large portions of Madison. Lathrop (1989b) observed that agricultural runoff is a much larger source of phosphorous to Lake Mendota than to the other Yahara Lakes because its drainage area is 4 to 5 times larger than the drainage area to the three other lakes. Due to the rapid urbanization of land in the lake's watershed, a number of structural and nonstructural nutrient and sediment reduction and retention projects have been started.

In-lake recreation on Mendota is high and includes use of its warm water fishery, sailing, boating, jet skiing, sail boarding, and swimming. Use of Mendota and adjacent wetlands for aesthetic, shoreline and research activities is also popular. The waterbody is one of the most extensively-researched lakes in the United States. Water quality has improved in Lake Mendota during the last 25 years with reduced phosphorous loads resulting in improved water clarity.

2.2.7 Lake Monona (WBIC 804600)

Lake Monona drains a highly urbanized area and much of its shoreline has been developed. Water quality of this large drainage lake is affected by urban polluted runoff as well as the nutrient loading from Lake Mendota and its watershed. Recreational use of Lake Monona is intense, with boaters, water skiers, sail boaters, wind surfers, anglers and swimmers taking advantage of the lake's attributes. The lake has a diverse fishery of perch, panfish, largemouth bass, northern pike, walleye and muskellunge. However, a fish consumption advisory exists for certain fish in the lake.

Algae blooms and excessive plant growth were reported as early as 1888. Abundant rooted aquatic plant growth has historically occurred in Lake Monona, particularly in Monona Bay and Turville Bay. Because the lake's sediment contains large quantities of nutrients, milfoil and curly leaf pondweed growth will likely continue to be a problem, particularly if water clarity continues to improve.

Chloride levels in the lake have slowly increased since the 1960s. Chloride levels in Monona are higher than in Lake Mendota, reflecting the greater proportion of urban runoff received by Monona. Sodium levels have been relatively steady over the last 25 years. Continued increases of sodium and chloride levels could change the species of algae and aquatic plants found in the lake and is a concern.

Portions of the lake have been filled with sediment in the past. Some of this fill material may include toxic substances. Due to elevated levels of mercury in walleye samples, a fish consumption advisory exists. The city of Madison Public Health Department identified Starkweather Creek as one source of mercury contamination in the lake. Recent core samples show decreasing mercury deposition over time. These decreasing concentrations indicate the possibility of reduced bioaccumulation in fish.

2.2.8 Lake Waubesa (WBIC 803700)

The Yahara River flows unimpeded from the Mendota Locks through Lake Monona and Lake Waubesa. The Lake Waubesa Dam, popularly known as the Babcock Park Lock and Dam, is located at the outlet of Lake Waubesa in the Town of Dunn. Dane County constructed the 10 foot dam in 1938 to control lake levels and aid navigation. The dam holds a very small hydraulic head, often less than a foot and dam is often open during the year because the water level is held up by the channel constriction downstream of the dam. The County passes 50 cfs between April 1 and May 15 to aid the spawning of walleye and other fish downstream of the dam. Walleye prefer to spawn in flowing water over gravel substrate. At all other times, a minimum discharge of at least 10 cfs is maintained.

Water quality of the lake has improved since MMSD diverted its treated wastewater effluent away from the lake. The lake still receives large nutrient loads primarily from upstream. The lake also continues to exhibit effects from past nutrient loading. Dissolved reactive phosphorus and total phosphorus levels in the lake have, however, declined, which may be attributed to reduced direct loadings from its watershed and indirect loads from upstream lakes. Lake sediments also contain high concentrations of phosphorus and will continue to affect water quality in the years to come.

Rooted aquatic plant growth, particularly Eurasian water milfoil, has been resurgent in the lake, corresponding to improved water clarity. A fish consumption advisory exists for walleye. Elevated levels of mercury were found in some fish samples taken by WDNR. WDNR is investigating a connection between red sore disease and pseudomonas bacteria. Red sore tends to occur in fish under some stress, and occurs more frequently in the lower Yahara lakes.

More than 500 acres of wetlands exist in the Lake Waubesa watershed. The lake's southern wetlands provide excellent habitat for fish spawning, migratory waterfowl and other wildlife and has a diversity of plant communities. Much of the wetland is in public ownership. A number of springs in and around the wetland provide a constant source of clean water. The primary threats are from alterations of some of the springs, agricultural polluted runoff, and local development and construction. The lake's 139-acre southeast wetland was identified by the 1990 UW-Madison Water Resources Monitoring Workshop as having significant aesthetic and recreational qualities.

2.2.9 Lake Kegonsa (WBIC 802600)

The Yahara River flows into Lake Kegonsa, a large, highly eutrophic, moderately shallow drainage lake. Lake Kegonsa was formed as glacial deposits dammed the Yahara River. It is the furthest downstream of all of the Yahara River lakes and has a surface area of 3,209 acres and a maximum depth of 31 feet. The Kegonsa dam maintains water levels between 843.0 and 843.5 based upon the 1929 datum. Lake Kegonsa is located outside of the central urban area and it is surrounded primarily by agricultural land with the shoreline dominated by seasonal cottages and year-round homes.

Water quality has improved over the last 40 years since the Madison Metropolitan Sewerage District diverted wastewater from the area's lakes. Yet, excess sediment, nutrient and chloride loads from upstream lakes, from the Yahara River, Door Creek and surrounding agricultural land continue to affect the lake's water quality. Despite overall reductions in nutrient loads, severe blue-green algae blooms still occur during summer, restricting beneficial aquatic plant growth. The health of the lake is also affected by the growth of undesirable, non-native, macrophyte plant growth.

The lake is highly turbid, but modest improvements in water clarity would allow limited growth of aquatic plants, benefiting the lake's fishery. Fish kills have occurred in the past, some attributable to natural causes while the cause of others remains undetermined. Fish sampling in Lake Kegonsa has detected toxic contaminants, but at levels below health concern standards.

2.3 Subbasin/Treatment Area Delineation

Figure 1 (see Appendix A) shows maps of the reachsheds, watersheds, and subbasins in the study area.

The subbasins used for this analysis effort differ significantly from those submitted with the City 2017 report. Changes made to the subbasins were made to increase the accuracy of the subbasin delineations. The subbasin boundaries submitted with the 2017 report were based heavily on City-wide delineations completed in 1993. Since that time, the City of Madison has undergone significant development, changing the boundaries of the subbasins, and in some cases, the watersheds. In addition, more accurate Lidar data has refined staff’s understanding of the topography and the drainage patterns within the City. As a result of these changes, City staff decided that fully re-delineating subbasins within the City would be the best approach to this modeling effort.

Additionally, 2019 marked the beginning of the City’s watershed study program. As part of that program, subbasins in all watersheds studied up to this date have been delineated to a very precise level of detail. In all watersheds that had previously been studied, City staff used the delineations from those studies to construct the subbasins used for the TMDL modeling.

In addition to re-delineating watersheds through the City for this TMDL modeling effort, City staff also chose to delineate subbasins differently than was done previously. The subbasins used in the 2017 modeling effort were delineated to each 36" pipe, and were assigned alpha numeric codes detailing the watershed, major basin, a unique identifier and whether or not treatment was received. Those names were consistent with Dane Country naming convention. However, for the current TMDL modeling effort, the City elected to delineate subbasins to the first downstream treatment device, thus consolidating some of the previous subbasins and sub-dividing others.

This was done due to WinSLAMM program limitations. In the 2017 modeling effort, City staff found that the WinSLAMM program struggled to run large models. Consolidating subbasins based on the treatment device decreased model size without sacrificing accuracy, which allowed City staff to more efficiently construct WinSLAMM models for the City.

2.4 Precipitation

The City used precipitation data as a parameter in WinSLAMM. When modeling stormwater pollution loadings, cumulative runoff and pollution loads from the more frequent "normal" rain events (i.e., 0.25- to 1.5-inch [in.] rains) are more important than pollution from the less frequent "larger" rain events. This is because the normal events (more frequent) generate most urban stormwater runoff volume in any given year. Modeling simulations are performed with rainfall records for a representative time frame per WDNR.

Current WDNR guidance stipulates that rainfall records for a 5-year period should be used during modeling if street sweeping is used as a BMP. Rainfall input files were developed for several locations throughout Wisconsin, and WDNR specified that the file location closest to the project area must be used for the analysis. Thus, the City used the Madison 5-year rainfall file for rain events between 1980 and 1984 for stormwater pollution modeling.

2.5 Soils

Soil properties influence the volume and runoff rates generated from rainfall events. Soils that allow rainfall to freely infiltrate the ground (i.e., sandy soils) result in lower runoff rates and volumes. Soils that restrict rainfall infiltration (i.e., clayey soils) cause higher runoff rates and volumes. The U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) classifies soils based on runoff potential into Hydrologic Groups A, B, C, or D. Soils in Hydrologic Group A have a high infiltration capacity and low runoff potential (generally sandy or gravelly soils). Conversely, Group D soils have a low infiltration capacity and a high runoff potential (generally soils with high clay content).

Per the NRCS Soil Survey, the most predominant soil group within Madison is Group B soils, followed by Group D, then Group C, and the smallest being soil Group A. NRCS Soil Survey (developed to provide general soil characteristics on a regional basis) information shows that these soils exhibit a wide range of properties and infiltration ability. Actual soil conditions for a specific location can vary from the general (i.e., mapped) condition.

WinSLAMM requires inputs that characterize the soil type for the study area. Allowable inputs in the WinSLAMM model are terms like: "Sandy," "Silty," or "Clayey." For this analysis, soils in Hydrologic Group A are "Sandy," soils in Hydrologic Group B are "Silty," and soils in Hydrologic Group C or D are

“Clayey.” Table 2-2 summarizes the extent of soil hydrologic groups within the project area. Figure 3 (see Appendix A) displays the soil group distributions within the city.

Hydrologic Soil Group (USDA/NRCS)	**Texture**	**Project Area Percent Coverage (%)**
A	Sandy	0.80
B	Silty	54.73
C or D	Clayey	44.47

Table 2-2. Project Area Soil Hydrologic Groups

2.6 Land Use

This section provides general background details, data sources, and methods the City used to create the land use data for this study.

2.6.1 General Background

The type and distribution of land use has a major impact on the hydrology and urban stormwater pollution within a watershed. The volume and rate of stormwater runoff increases as the percentage of impervious surfaces (streets, parking lots, roofs, etc.) in an area increases. The amount of impervious surface, in turn, is related to land use. As development occurs, the impervious area generally increases, significantly. Land use also plays an important role in determining the types and amounts of pollutants that are carried by runoff.

Highly urbanized commercial and industrial areas contain a generally high percentage of impervious area and generate high amounts of pollutants. These pollutants include sediment, nutrients, bacteria, metals, and toxic substances. Less-intensive development, such as low- to medium-density residential lands, may contain a lower amount of impervious area and generate lower levels of most pollutants.

2.6.2 Data Sources and Methods

To create the land use categories for this TMDL analysis, the City analyzed land use data collected up to January 2020 by the City of Madison Assessor, and compared that data to the land use information used in the previous plan (2017), the most recent aerial photograph, development data, and the municipal boundary. Each parcel within City boundaries was assigned a WinSLAMM-compatible standard land use based on the above data sources. Areas outside the City of Madison municipal boundary but within the drainage area of a City of Madison SCM were assigned a WinSLAMM-compatible standard land use based on Dane County land use information from 2015. Land use conditions for the TMDL analyzed area include land developed until and including January 2020.

Figure 4 (see Appendix A) shows the land use categories used for the pollution analyses. Table 2-3 summarizes land use coverage for the City’s MS4 for the TMDL. Table 2-3 also shows land use categories that match Windows Source Loading and Management Model (WinSLAMM) categories, and only in the respective analyzed areas.

Land Use	Acres Analyzed	Percentage of City Area (%)
Cemetery	168	0.5%
Downtown	193	0.6%
Duplex	710	2.3%
High-density residential (no alleys)	1405	4.5%
High-density residential (with alleys)	110	0.4%
High rise residential	154	0.5%
Hospital	234	0.7%
Institutional	608	1.9%
Light industrial	1110	3.5%
Low-density residential	606	1.9%
Medium-density residential (no alleys)	6203	19.8%
Medium-density residential (with alleys)	30	0.1%
Medium industrial	1375	4.4%
Mobile home	111	0.4%
Multi-family residential	1922	6.1%
Office park	1557	5.0%
Open space	2971	9.5%
Park	3725	11.9%
School	707	2.3%
Shopping center	931	3.0%
Street (High-Traffic Urban)	441	1.4%
Street (not High-Traffic)	4758	15.2%
Strip mall	1067	3.4%
Suburban	252	0.8%
Total	31349	100.0%

Table 2-3. Land use coverage for the City.

3 Methodology and Results

This section documents the City's study methodology and current progress toward meeting its stormwater pollution reduction goals.

3.1 Methodology

To calculate urban stormwater pollutant loads and reductions due to SCMs within the City, City staff used WinSLAMM Version 10.4.1, WinSLAMM Version 10.4.225 and WinSLAMM Version 10.5.037. WinSLAMM Versions 10.4.225 and 10.5.037 are non-commercially available "beta" versions of the WinSLAMM program, developed by PV Associates for the City under contract between the City and PV Associates. WinSLAMM Version 10.4.225 was developed to include a copy-paste function for control practices between different WinSLAMM models, and after the de-bugging process is completed will be issued widely as WinSLAMM Version 10.4.2. WinSLAMM Version 10.5.037 was developed to allow inter-model linking of hydrographs and pollutographs, as further described in Section 3.3, and after the de-bugging process is completed will be issued widely as WinSLAMM Version 10.5.1. All WinSLAMM results presented in this report have been generated using WinSLAMM 10.5.037. WinSLAMM is the most widely used small-storm urban pollutant loading and reduction model in Wisconsin.

The City delineated the project area, as described in Section 2, based on WDNR guidelines to meet TMDL compliance targets for the Rock River TMDL. To conduct these analysis in compliance with WDNR guidelines and define the no-controls and with controls conditions, the City created a geographical information system (GIS) database containing information about stormwater pollution and SCMs in the City, including:

- Hydrologic units/subbasins
- Soil types and classifications
- Land use, as of January 7, 2020 (as collected for the City of Madison Assessor's office database)
- Road meeting the High-Traffic Urban (HTU) definition
- Permitted entities within the municipal boundary (regulated Tier 1 and Tier 2 permitted industrial properties, WisDOT ROWs, Dane County MS4s, and the University of Wisconsin – Madison)
- Permitted entities outside the City of Madison municipal boundary that drain to a City structural SCM
- Existing street cleaning program
- Existing catchbasin/proprietary device/Coanda screen structure cleaning program
- Existing leaf management program
- Private stormwater treatment practices permitted by the City of Madison
- Existing structural SCMs under the City's jurisdiction

WinSLAMM requires input files that describe soil, land cover, drainage system, and precipitation characteristics, and other factors composing the project area. The model uses a 5-year rainfall record to calculate runoff and pollution loads. The City of Madison used the 1980-1985 rainfall data for Madison for this application (entered in WinSLAMM as the "WisReg – Madison Five Year Rainfall.ran" file).

WinSLAMM also requires support files. The United States Geological Survey (USGS) and WDNR developed versions of these files for use in Wisconsin, which are based on extensive field monitoring and calibration. The latest versions of these WinSLAMM files provided by the USGS with the WinSLAMM program and used for this project are listed in Table 3-1.

Parameter		Input File
Rain File		WisReg – Madison Five Year Rainfall.RAN
Pollutant Probability Distribution File		C:\WinSLAMM Files\WI_GEO03.ppdx
Runoff Coefficient File		C:\WinSLAMM Files\WI_SL06 Dec06.rsvx
Particulate Solids Concentration File		C:\WinSLAMM Files\v10.1 WI_AVG01.pscx
Street Delivery File	Residential LU	C:\WinSLAMM Files\WI_Res and Other Urban Dec06.std
	Institutional LU	C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
	Commercial LU	C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
	Industrial LU	C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
	Other Urban LU	C:\WinSLAMM Files\WI_Res and Other Urban Dec06.std
	Freeways	C:\WinSLAMM Files\Freeway Dec06.std
Source Area PSD and Peak to Average Flow Ratio File		C:\WinSLAMM Files\NURP Source Area PSD Files.csv
Source Area Particle Size Distribution File		C:\WinSLAMM Files\NURP.cpz

Table 3-1. WinSLAMM support files provided by USGS.

3.2 Results: No-controls

The City evaluated pollution loads for the Rock River TMDL area within the City boundary. This section presents the pollution load without SCMs implemented (the no-controls condition).

The City calculated the pollution loading (assuming no controls are implemented) for the City's jurisdictional area. Per the TMDL, the City must target pollution reduction down to the WLA for each reachshed (47, 62, 64, 65, 66) within the City proper. Table 3-2 shows the average annual no-controls pollution results for the City and Table 3-2 shows the results by reachshed.

Rock River TMDL Reachshed ID	No Controls Annual TSS Load (lbs/yr)	No Controls Annual TP Load (lbs/yr)
47	50,991	172
62	675,103	2,247
64	6,930,111	21,706
65	434,983	1,268
66	1,497,920	4,446
City-wide Total	**9,589,108**	**29,839**

Table 3-22. Average annual no-controls pollution results for the City.

Rock River TMDL Reachshed ID	No Controls Annual TSS Load (lbs/yr)	No Controls Annual TP Load (lbs/yr)
47	50,991	172
62	675,103	2,247
64	6,930,111	21,706
65	434,983	1,268
66	1,497,920	4,446
City-wide Total	**9,589,108**	**29,839**

Table 3-2. Average annual no-controls load per reachshed.

The TMDL baseline condition assumes that municipalities have achieved a 40 percent TSS reduction; however, for this analysis the City calculated the pollution loads for each reachshed during a no-controls condition (i.e. the same conditions as the developed urban area standard no-controls conditions).

3.3 Results: Existing Management Conditions

Once the no-controls condition load was established, the City evaluated the City's current SCMs. As defined in the scope of work for this project, the existing practices the City analyzed were:

- Street cleaning
- Catch basin and proprietary device cleaning
- Coanda screen structures
- Leaf management
- Private stormwater treatment practices
- Existing structural SCMs
    - Wet ponds
    - Dry ponds
    - Infiltration basins
    - Large bioretention basins

The City calculated the pollution control effectiveness of these SCMs to determine the level of TSS and TP control to achieve targeted WLAs.

The current WinSLAMM version can route by hydrographs and pollutographs through multiple SCMs within a watershed. This feature prevents "double-counting" pollution control from runoff treated through more than one practice (e.g., street sweeping in a watershed draining to a stormwater pond). Because of this feature, the pollution load reduction from a specific control practice within a watershed cannot be easily reported; therefore, the results in this section will vary based on the types of treatment levels within various watersheds.

For example, street cleaning is included in every watershed because all streets are cleaned by the City. Where additional SCMs exist in a watershed, the pollution load will be reported for the entire watershed reduction (accounting for routing the hydrographs and pollutographs for all types of SCMs). The results for a single SCM will be reported only if there are no other SCMs in the watershed.

While running large models in WinSLAMM, City staff noticed frequent memory errors when the five-year rainfall file was run, two pollutants (TSS and TP) were tracked, and/or street cleaning was included throughout the model as a source-area control practice. To allow these large models to be split but still route the hydrograph and pollutograph correctly through each modeled watershed, the City contracted with PV Associates to modify the WinSLAMM model to allow for the export of a hydrograph and pollutograph from one model and their import into a second model. The City utilized beta version 10.5.037 for all final modeling described in this report; after de-bugging is completed, it will be widely issued as WinSLAMM Version 10.5.1.

3.3.1 Street cleaning

The City performs street cleaning on a regular basis throughout the non-winter season. Through most of the City jurisdictional area, the City sweeps all city streets with curb and gutter drainage once per month throughout the non-winter season. In the City's designated Snow Emergency Area, the City performs street cleaning once per week during the non-winter season. These street cleaning areas are included with this report as Figure 5 (see Appendix A).

In the Snow Emergency Area, which is densely populated, the parking density in WinSLAMM is defined as "Extensive (Short Term)." In all other areas, the parking density in WinSLAMM is defined as "Light." Because the City street cleaners can generally reach the curb when cleaning, parking controls are imposed throughout the City.

The City uses seven mechanical broom sweepers and one vacuum-assisted sweeper. In the Snow Emergency Area, only a mechanical broom sweeper is used. In all other parts of the City, sweeping equipment is rotated. To account for this variability in WinSLAMM, the City designated approximately 1/8 of monthly-swept area in each TMDL reachshed to be swept using the vacuum-assisted sweeper. All other areas were assigned mechanical broom sweeping.

WinSLAMM models can now analyze streets that are considered high-traffic urban. Recent studies reveal that street cleaning is more effective on high-traffic urban streets. For a street to be considered high-traffic urban it must have the following characteristics:

- Average daily traffic (ADT) rate greater than 6,000 vehicles per day
- Posted speed limit is 30 miles per hour or faster
- No parking
- Constructed with the curb and gutter in good condition

Figure 5 shows the high-traffic urban street locations and cleaning frequency throughout the City. Street cleaning is accounted for on a citywide basis and is included in reductions for regional structural SCMs. Table 3-6 lists the TSS reduction results from street cleaning for each reachshed.

3.3.2 Leaf Management

On October 5, 2017, the WDNR released its "Interim Municipal Phosphorus Reduction Credit for Leaf Management Programs." This guidance outlined the WDNR's preliminary approach to quantifying TP reduction credit for municipalities with fall leaf management programs. The City has a robust fall street leaf collection program in place, and is actively partnering with the USGS in Middleton, WI on its leaf study, which aims to provide further data on how leaf management affects dissolved phosphorus in runoff, both overall and seasonally. The City provided comment to the WDNR on the draft guidance on November 9, 2017. The draft guidance is included with this report with Appendix E.

The draft guidance states that municipalities may assume 17% TP reduction in areas where the following conditions are met:

1. Medium Density (2-6 units/acre) Residential (Single-family) land use without alleys. Medium density Residential with alleys land use may be included if the alleys receive the same level of leaf collection and street cleaning as the streets.
2. Curb and gutter with storm sewer drainage systems.
3. A tree cover defined as an average of one or more mature trees between the sidewalk and the curb for every 80 linear feet of curb. Where sidewalk is not present, trees within 10 feet of the curb may be counted toward tree cover. Generally, this equates to a tree canopy over

the street of 17% or greater. Field investigations or aerial photography may be used to document the tree cover.

4. The municipality has an ordinance prohibiting residents from placement of leaves in the street and a policy stating that residents may place leaves on the terrace in bags or piles for collection.
5. Municipal leaf collection provided at least 4 times spaced throughout the months of October and November. Leaves may be pushed, vacuumed, or manually loaded into a garbage vehicles. No leaf piles are left in the street overnight.
6. Within 24 hours of leaf collection, remaining leaf litter in the street must be collected using street cleaning machines, such as a mechanical broom or vacuum assisted street cleaner. A brush attachment on a skid steer is not an acceptable equivalent.

The draft guidance states that "further evaluation is required to determine how leaf collection methods may reduce loading to structural best management practices (BMPs) such as ponds. Therefore, this credit may not be taken in addition to phosphorus reductions from other BMPs in the drainage area at this time." However, due to complexities of isolating medium density residential – no alleys (MDRNA) land uses from other land uses for each subwatershed, calculating a 17% reduction for just those areas where the canopy cover requirement above is met, and comparing that number to the TP reductions from the use of traditional treatment practices, the City chose to work with the WDNR to develop an acceptable method of calculating a TP reduction credit after modeling was completed.

The Madison USGS leaf study (Selbig 2016) has demonstrated that the leaf leaching contribution to the phosphorus content of runoff water is nearly entirely dissolved phosphorus; as ponds, catchbasins and other traditional treatment practices target particulate phosphorus, the USGS study would suggest that leaf management and traditional treatment devices target phosphorus in separate phases and, thus, are unlikely to overlap in their effect. Additionally, the same study showed that on average, the TP content of runoff is approximately 50% dissolved phosphorus and 50% particulate phosphorus. Therefore, City staff estimated that an assumption of 8.5% TP removal (half of the 17% TP removal allowed in the draft guidance) due to leaf management, applied in addition to TP removals from traditional stormwater practices (calculated in WinSLAMM), for MDRNA land uses that meet the canopy cover requirements outlined in the draft guidance, would be a conservative and scientifically sound value. City staff discussed this methodology with WDNR staff, who approved their approach.

City staff used ArcGIS to isolate MDRNA parcels and intersect those parcels with watershed boundaries to calculate total MDRNA acreage in each watershed. City staff then added the City of Madison Forestry Division tree inventory layer and the City of Madison street centerline layers and cropped them by proximity to MDRNA areas in each watershed, giving a total street length and tree count in MDRNA areas within each watershed. The tree inventory was then limited to trees 10" in diameter and greater to ensure that only trees with significant canopy cover were included in calculations. Finally, the street distance was multiplied by two (to account for two curb lines/street) and divided by the number of trees to obtain the curb length per tree in each watershed. This value was then divided by 80 to obtain an estimate of the percentage of roads, and MDRNA area, in each watershed that meet the draft guidance requirements.

After calculating the applicable area, City staff built a "control" model with one land use (MDRNA, 100 acres) and no controls. This model was used to obtain the "no controls" TP loading for 100 acres of MDRNA, which was calculated to be 96.79 lbs/year. For each watershed, this value was scaled to match the total MDRNA acreage in the watershed, then scaled again to apply only to the calculated applicable area (based on trees/curb length, as discussed in the paragraph above). These calculations resulted in TP loadings for each watershed that the City considered “eligible” for the leaf management TP reduction; for each watershed, the TP reduction due to leaf management efforts was estimated by calculating 8.5% of that eligible TP loading. These leaf management TP reductions are summarized, by reachshed, in Table 3-3 and are shown in Figure 6.

Reachshed	Annual TP Reductions from Leaf Management (lbs)
47	0.0
62	15.4
64	210.1
65	17.0
66	23.9
City-wide Total	**266.4**

Table 3-3. Leaf management TP reductions by reachshed.

3.3.3 Private Stormwater Treatment Practices

The City permits over 500 private stormwater treatment practices within its jurisdictional boundary. During the City’s 2017 MS4 water quality modeling effort, City staff worked with WDNR staff to develop an acceptable methodology to take credit for pollutant reductions from private practices without entering them into the City’s overall WinSLAMM model. The agreed-upon methodology is included as an email in Appendix E.

For the current analysis, the City reviewed the guidance and determined that applying it for all permitted private stormwater treatment practices in the City would require a significant time expenditure, and that private stormwater treatment practices draining to City SCMs would be unlikely to provide significant pollutant reductions as compared to areas with no SCMs. Therefore, the City identified only those private stormwater treatment practices located in areas that do not drain to an SCM. For those practices, City staff pulled site stormwater management plans to quantify No Controls TSS loads, With Controls TSS loads, and TSS Percent Reductions per year.

Some private sites were missing formal stormwater management reports. In those instances, the stormwater permits were examined and the site area, site land use (commercial, multi-family residential, industrial, or other), and TSS reduction required by permit were recorded. For each represented site land use, a representative WinSLAMM file was run to calculate the annual TSS and TP load for 1 ac of that land use. Using those values and site areas, City of Madison staff were able to calculate No Controls TSS loads, With Controls TSS loads, and No Controls TP loads for sites with permits but without stormwater management reports.

City ordinances do not require permittees to report TP loading or reductions in their site stormwater management plans or water quality calculations. To account for TP load reductions, the City first had to calculate No Controls TP load, which was done using each site’s area and land use type and the representative WinSLAMM 1 ac land uses and TP loads (as described above). To calculate TP reductions and With Controls loads for all sites, City staff assumed that an 80% TSS reduction would provide a 60% TP reduction, and used that relationship to calculate the % TP reduction for each private site. Using the

No Controls TP load and the % TP reduction, City staff were able to calculate a With Controls TP load (a TP load reduction) for each site.

For private sites within subbasins without an SCM but with catchbasins, the percent TSS reduction due to catchbasins was calculated and, as outlined in the appended guidance, subtracted from the percent TSS reduction for each private stormwater treatment practice within that area. The TSS load reductions due to private treatment practices were then adjusted as appropriate. TP load reductions were adjusted for catchbasins using the 80% TSS reduction/60% TP reduction relationship described above.

As the City of Madison does not permit public right-of-way area, it was assumed that street cleaning would not impact the reductions in TSS or TP loading due to private stormwater treatment practices. Therefore private practice values were not adjusted for street cleaning.

TSS and TP pollution reduction effectiveness of private stormwater treatment practices for non-SCM-treated areas are shown in Table 3-4.

Reachshed	Annual TSS Reduction (lbs)	Annual TP Reduction (lbs)
62	814	0.0
64	65,677	285.0
65	52,390	5.1
66	36,159	24.5
City-wide Total	**155,040**	**314.6**

Table 3-4. Private stormwater treatment practice TSS and TP removal, by reachshed (lbs/yr).

3.3.4 Catchbasin and Proprietary Device Cleaning

The City has several hundred catch basins and proprietary hydrodynamic devices installed throughout the City. Each catchbasin and proprietary device is cleaned twice each year – once in the spring, and once in the fall. For the purposes of this analysis, catch basins and proprietary hydrodynamic devices were modeled as catchbasins.

The City's records indicates that the City maintains 307 catch basins and proprietary devices with sump depths greater than or equal to 2.0'. For each catch basin or proprietary hydrodynamic device meeting that criteria within the City, a GIS layer was developed recording the sump depth, the depth from street surface to bottom of sump, and the footprint area. For catch basins or devices without recorded depths from street surface to bottom of sump, the depth was estimated at 4' plus the sump depth. For catchbasins or devices without recorded footprint areas, the area was estimated to be 9 sf.

For entry into WinSLAMM models, catchbasins and proprietary devices were aggregated for each subbasin, yielding a number of catch basins/proprietary devices, an average sump depth, average depth from street surface to bottom of sump, and an average footprint area for each subbasin. Catch basins and proprietary devices were entered, where applicable, just downstream of land uses and upstream of any other treatment devices.

TSS and TP pollution reduction effectiveness of catch basins and proprietary device sumps and cleaning are shown with other SCMs in Table 3-5.

3.3.5 Coanda Screen Structure Cleaning

The City has 22 large structures that contain Coanda screens for stormwater treatment. These screens function as inline stormwater filters, capturing floatables, debris, leaves and large sediment particles in a sump and allowing cleaner stormwater to pass through and enter the storm sewer system. Coanda screen structures, like other catch basins and proprietary devices, are cleaned twice annually in the spring and fall.

The City reached out to the WDNR and requested guidance as to how best to incorporate Coanda screen structures into the City's WinSLAMM model. The WDNR's emailed guidance, dated 10/16/20 and included in Appendix E, stated that screen structures should be modeled as catch basins using the appropriate sump depth, depth from street surface to sump bottom, and footprint area. In this analysis Coanda screen structures were entered into WinSLAMM as directed by the WDNR but were not aggregated with other catch basins or proprietary devices as described in section 3.3.4.

TSS and TP pollution reduction effectiveness of Coanda screen structure sumps and cleaning are shown with other SCMs in Table 3-5.

3.3.6 Stormwater SCMs

There are numerous structural SCMs within the City of Madison. In this report, the term "structural SCM" includes biofilters, infiltration basins, dry detention ponds and wet detention ponds. The City evaluated each structural SCM using available data to describe its geometry and drainage area. Figure 5 (see Appendix A) shows these structural SCMs.

The structural SCMs were built to the technical standards applicable at the time of construction; however, some SCMs may not achieve the expected 40 or 80 percent TSS reductions required per current regulatory codes and modeling procedures.

Table 3-5 shows the TSS and TP pollution reduction effectiveness of the existing structural SCMs, catch basin and proprietary device sumps and cleaning, and Coanda screen structure sumps and cleaning. Note that street cleaning is included in all models as a source area treatment practice for street source areas, and pollutant reductions due to street cleaning are not identified separately but included in the overall reachshed-wide reductions.

Control Practice Name	Control Practice Type	Rock River TMDL Reachshed ID	Annual TSS Influent Load (lbs)	Annual TSS Effluent Load (lbs)	Annual TSS Load Reduction (lbs)	Percent TSS Load Reduction (%)
PD 7315-001	Detention Pond	47	37,532	1,686	35,847	95.5%
PD1550-003_Inf	Biofilter	62	259	0	259	100.0%
PD1653-002_Inf	Biofilter	62	1,214	108	1,106	91.1%
PD1753-039_Inf1	Biofilter	62	3,778	3,413	365	9.7%
PD1753-039_Inf2	Biofilter	62	3,413	3,361	52	1.5%
PD2256-007_Inf	Biofilter	62	4,670	1,473	3,197	68.5%
PD2350-020_CB	Catchbasin Cleaning	62	84,046	82,683	1,363	1.6%
PD1550-003_WP	Detention Pond	62	4,763	259	4,504	94.6%
PD1648-047	Detention Pond	62	6,402	1,561	4,842	75.6%
PD1654-002	Detention Pond	62	3,682	1,147	2,536	68.9%
PD1748-035	Detention Pond	62	53,030	12,652	40,377	76.1%
PD1750-028	Detention Pond	62	10,690	3,576	7,114	66.6%
PD1753-039_WP	Detention Pond	62	9,245	3,778	5,467	59.1%
PD1948-022	Detention Pond	62	37,759	21,886	15,873	42.0%
PD2056-030	Detention Pond	62	703	259	444	63.2%
PD2146-005_LS3	Detention Pond	62	281,600	279,600	2,000	0.7%
PD2146-005_LS4	Detention Pond	62	279,600	279,400	200	0.1%
PD2146-005_U_C	Detention Pond	62	340,400	281,600	58,800	17.3%
PD2151-027_WP1	Detention Pond	62	26,755	20,733	6,022	22.5%
PD2151-027_WP2	Detention Pond	62	40,210	26,755	13,455	33.5%
PD2156-048	Detention Pond	62	3,432	1,551	1,881	54.8%
PD2255-025	Detention Pond	62	84,956	54,401	30,555	36.0%
PD2258-002	Detention Pond	62	23,718	17,052	6,666	28.1%
PD2350-020	Detention Pond	62	137,483	127,930	9,553	6.9%
PD2357-007	Detention Pond	62	4,570	3,836	734	16.1%
PD2448-016	Detention Pond	62	211,200	126,990	84,210	39.9%
PD2451-011	Detention Pond	62	399	398	1	0.3%
AC_UWHea_W_D2	Biofilter	64	457	84	373	81.6%

Control Practice Name	Control Practice Type	Rock River TMDL Reachshed ID	Annual TSS Influent Load (lbs)	Annual TSS Effluent Load (lbs)	Annual TSS Load Reduction (lbs)	Percent TSS Load Reduction (%)
AC_UWHea_W_E	Biofilter	64	3,011	457	2,554	84.8%
PD 2955-015_BF	Biofilter	64	27,409	22,079	5,330	19.4%
PD 3346-015	Biofilter	64	1,277	496	780	61.1%
PD 3349-047_BF	Biofilter	64	5,903	5,727	176	3.0%
PD 3449-016_BF	Biofilter	64	1,440	333	1,108	76.9%
PD 6831-055	Biofilter	64	7,903	7,142	762	9.6%
PD 7036-027_Bf	Biofilter	64	2,767	2,657	110	4.0%
NA_MEN_Sw_CB	Catchbasin Cleaning	64	29,315	25,981	3,333	11.4%
NA_MENSH_CB	Catchbasin Cleaning	64	240,400	233,000	7,400	3.1%
NA_MENSM_CB	Catchbasin Cleaning	64	25,613	23,765	1,848	7.2%
NA_MENWC_CB	Catchbasin Cleaning	64	422,000	397,200	24,800	5.9%
NA_MON_CB	Catchbasin Cleaning	64	59,950	57,128	2,822	4.7%
NA_MON_CB	Catchbasin Cleaning	64	98,232	95,432	2,800	2.9%
NA_MON_Sw_CB	Catchbasin Cleaning	64	224,800	210,400	14,400	6.4%
NA_MONMB_Sw_CB	Catchbasin Cleaning	64	186,655	175,435	11,220	6.0%
NA_MONWC_Sw_CB	Catchbasin Cleaning	64	108,573	102,673	5,900	5.4%
NA_SC_CB	Catchbasin Cleaning	64	1,490,400	1,444,000	46,400	3.1%
NA_SC_Sw_CB	Catchbasin Cleaning	64	38,356	35,070	3,286	8.6%
NA_UY_CB	Catchbasin Cleaning	64	60,583	59,153	1,431	2.4%
NA_WI_CB	Catchbasin Cleaning	64	96,015	87,705	8,311	8.7%
NA_WI_Sw_CB	Catchbasin Cleaning	64	65,707	61,903	3,804	5.8%
NA_WINakGC_CB	Catchbasin Cleaning	64	26,525	24,553	1,972	7.4%
NA_YR64_CB	Catchbasin Cleaning	64	240,800	224,600	16,200	6.7%
NA_YR64_Sw_CB	Catchbasin Cleaning	64	186,430	173,778	12,651	6.8%
PD 2756-049_CB	Catchbasin Cleaning	64	220,000	219,200	800	0.4%
PD 4061-006_CB	Catchbasin Cleaning	64	106,232	100,109	6,123	5.8%
PD 5020-054_CB	Catchbasin Cleaning	64	41,860	40,637	1,223	2.9%
PD 5417-009_CB	Catchbasin Cleaning	64	15,295	14,466	829	5.4%

Control Practice Name	Control Practice Type	Rock River TMDL Reachshed ID	Annual TSS Influent Load (lbs)	Annual TSS Effluent Load (lbs)	Annual TSS Load Reduction (lbs)	Percent TSS Load Reduction (%)
PD 6748-011_CB	Catchbasin Cleaning	64	47,763	47,223	539	1.1%
PD 6829-013_CB	Catchbasin Cleaning	64	66,908	64,577	2,331	3.5%
PD2546-021_CB	Catchbasin Cleaning	64	75,817	74,543	1,274	1.7%
PD4664-013_CB	Catchbasin Cleaning	64	56,076	53,156	2,920	5.2%
PD5427-061_CB	Catchbasin Cleaning	64	5,717	4,434	1,283	22.4%
SS 3348-070_CB	Catchbasin Cleaning	64	14,101	13,161	940	6.7%
SS 3348-073_CB	Catchbasin Cleaning	64	176	125	51	29.0%
SS4255-083_CB	Catchbasin Cleaning	64	19,424	17,847	1,578	8.1%
SS4257-098_CB	Catchbasin Cleaning	64	8,498	7,723	776	9.1%
SS5547-017_CB	Catchbasin Cleaning	64	2,609	2,308	301	11.6%
SS5843-072_CB	Catchbasin Cleaning	64	6,539	5,636	903	13.8%
SS5943-065_CB	Catchbasin Cleaning	64	11,294	10,619	675	6.0%
TD 4565-001_CB	Catchbasin Cleaning	64	47,968	46,250	1,718	3.6%
WarnerLgn_CB	Catchbasin Cleaning	64	223,800	215,400	8,400	3.8%
AC_UWHea_E_C	Detention Pond	64	7,679	1,326	6,353	82.7%
AC_UWHea_E_D1	Detention Pond	64	1,326	1,315	10	0.8%
AC_UWHea_N_B	Detention Pond	64	2,084	371	1,714	82.2%
Autumn_Lake	Detention Pond	64	67,845	17,580	50,265	74.1%
ESideWalmart	Detention Pond	64	4,689	1,170	3,519	75.0%
PD 2459-016	Detention Pond	64	31,106	28,934	2,171	7.0%
PD 2756-049_N	Detention Pond	64	120,031	115,320	4,711	3.9%
PD 2756-049_S	Detention Pond	64	248,200	120,031	128,169	51.6%
PD 2952-022_E	Detention Pond	64	9,071	8,931	140	1.5%
PD 2952-022_N	Detention Pond	64	8,931	8,531	400	4.5%
PD 2952-022_W	Detention Pond	64	22,489	9,071	13,418	59.7%
PD 2955-015_WP	Detention Pond	64	52,629	27,409	25,220	47.9%
PD 3158-015	Detention Pond	64	16,028	15,346	683	4.3%
PD 3258-008	Detention Pond	64	32,266	26,530	5,735	17.8%

Control Practice Name	Control Practice Type	Rock River TMDL Reachshed ID	Annual TSS Influent Load (lbs)	Annual TSS Effluent Load (lbs)	Annual TSS Load Reduction (lbs)	Percent TSS Load Reduction (%)
PD 3354-027	Detention Pond	64	38,111	16,074	22,037	57.8%
PD 3356-048	Detention Pond	64	4,004	3,937	67	1.7%
PD 3357-013_N1	Detention Pond	64	15,912	15,726	186	1.2%
PD 3357-013_N2	Detention Pond	64	16,100	15,912	188	1.2%
PD 3357-013_N3	Detention Pond	64	25,119	16,100	9,019	35.9%
PD 3358-013	Detention Pond	64	7,226	7,195	31	0.4%
PD 3362-020	Detention Pond	64	99,928	99,126	802	0.8%
PD 3456-032	Detention Pond	64	5,228	4,807	421	8.0%
PD 3462-001_N1	Detention Pond	64	269,800	112,200	157,600	58.4%
PD 3462-001_N2	Detention Pond	64	112,200	110,036	2,164	1.9%
PD 3564-028	Detention Pond	64	24,147	11,192	12,954	53.6%
PD 4061-006_1	Detention Pond	64	209,600	192,246	17,354	8.3%
PD 4061-006_2	Detention Pond	64	192,246	189,842	2,404	1.3%
PD 4061-006_FB	Detention Pond	64	222,800	209,600	13,200	5.9%
PD 4165-004	Detention Pond	64	13,895	5,642	8,253	59.4%
PD 4264-001_1	Detention Pond	64	30,787	23,971	6,815	22.1%
PD 4264-001_2	Detention Pond	64	23,971	15,397	8,575	35.8%
PD 4564-003	Detention Pond	64	56,802	33,088	23,714	41.7%
PD 5020-054	Detention Pond	64	40,637	13,336	27,301	67.2%
PD 5119-009	Detention Pond	64	20,549	5,072	15,477	75.3%
PD 5219-011	Detention Pond	64	49,839	24,297	25,542	51.2%
PD 5417-009	Detention Pond	64	14,466	7,801	6,665	46.1%
PD 6318-015	Detention Pond	64	3,549	3,506	44	1.2%
PD 6412-023	Detention Pond	64	22,302	21,808	494	2.2%
PD 6416-012	Detention Pond	64	29,069	24,213	4,856	16.7%
PD 6444-019	Detention Pond	64	13,496	3,409	10,087	74.7%
PD 6514-006	Detention Pond	64	19,492	18,946	546	2.8%
PD 6515-001	Detention Pond	64	19,534	14,002	5,532	28.3%

Control Practice Name	Control Practice Type	Rock River TMDL Reachshed ID	Annual TSS Influent Load (lbs)	Annual TSS Effluent Load (lbs)	Annual TSS Load Reduction (lbs)	Percent TSS Load Reduction (%)
PD 6520-001	Detention Pond	64	1,407	747	661	46.9%
PD 6521-013	Detention Pond	64	6,513	1,338	5,176	79.5%
PD 6535-008	Detention Pond	64	16,034	5,893	10,141	63.2%
PD 6546-029	Detention Pond	64	9,835	9,603	232	2.4%
PD 6738-024	Detention Pond	64	65,897	44,311	21,586	32.8%
PD 6748-011	Detention Pond	64	47,223	6,890	40,334	85.4%
PD 6821-006	Detention Pond	64	175,428	70,969	104,459	59.5%
PD 6829-013_Pond	Detention Pond	64	64,577	40,070	24,508	38.0%
PD 6834-021	Detention Pond	64	31,011	22,867	8,144	26.3%
PD 6836-018	Detention Pond	64	31,074	16,705	14,369	46.2%
PD 6914-002	Detention Pond	64	33,986	13,656	20,331	59.8%
PD 6935-077_Dry	Detention Pond	64	3,927	3,204	722	18.4%
PD 6942-013_Dry	Detention Pond	64	3,864	3,844	20	0.5%
PD 7020-084_DS	Detention Pond	64	59,964	59,964	0	0.0%
PD 7020-084_US	Detention Pond	64	60,202	59,964	238	0.4%
PD 7028-006	Detention Pond	64	57,832	28,882	28,950	50.1%
PD 7031-007	Detention Pond	64	5,329	4,109	1,220	22.9%
PD 7032-012	Detention Pond	64	7,863	6,574	1,289	16.4%
PD 7036-027_Wet	Detention Pond	64	6,797	2,767	4,030	59.3%
PD 7143-001	Detention Pond	64	27,572	6,196	21,376	77.5%
PD2546-021	Detention Pond	64	74,543	57,706	16,836	22.6%
PD2847-023	Detention Pond	64	8,385	8,272	113	1.3%
PD3046-006	Detention Pond	64	43,880	25,636	18,244	41.6%
PD3046-028	Detention Pond	64	789	267	522	66.2%
PD3046-029	Detention Pond	64	27,921	26,924	997	3.6%
PD4059-045	Detention Pond	64	58,515	18,332	40,182	68.7%
PD4624-011	Detention Pond	64	37,297	12,249	25,048	67.2%
PD4664-013_FB	Detention Pond	64	54,661	38,023	16,638	30.4%

Control Practice Name	Control Practice Type	Rock River TMDL Reachshed ID	Annual TSS Influent Load (lbs)	Annual TSS Effluent Load (lbs)	Annual TSS Load Reduction (lbs)	Percent TSS Load Reduction (%)
PD4664-013_WP	Detention Pond	64	38,023	26,825	11,198	29.5%
PD4722-014	Detention Pond	64	3,829	3,641	188	4.9%
PD5062-046	Detention Pond	64	1,609	1,448	161	10.0%
PD5362-002	Detention Pond	64	35,492	29,540	5,952	16.8%
PD5427-061_N	Detention Pond	64	4,434	2,769	1,664	37.5%
PD5427-061_S	Detention Pond	64	2,769	2,550	219	7.9%
PD5622-036	Detention Pond	64	17,073	16,874	199	1.2%
PD5730-043	Detention Pond	64	879	864	15	1.7%
PD6034-016	Detention Pond	64	3,440	3,389	51	1.5%
PD6348-037	Detention Pond	64	61,648	54,276	7,372	12.0%
PD6423-015	Detention Pond	64	7,243	4,001	3,243	44.8%
PD6438-016	Detention Pond	64	3,149	1,073	2,076	65.9%
PD6438-017	Detention Pond	64	6,083	5,998	86	1.4%
WarnerLgn	Detention Pond	64	218,000	60,532	157,468	72.2%
SS 3247-020_SS	Screen Structure	64	4,228	3,842	386	9.1%
SS 3348-070_SS	Screen Structure	64	13,161	13,053	108	0.8%
SS 3348-073_SS	Screen Structure	64	125	125	0	0.4%
SS 3349-058_SS	Screen Structure	64	6,441	5,784	657	10.2%
SS 3363-030_SS	Screen Structure	64	16,250	14,881	1,369	8.4%
SS 3862-037_SS	Screen Structure	64	1,734	1,447	287	16.5%
SS 4151-093_SS	Screen Structure	64	11,734	10,819	915	7.8%
SS3246-019	Screen Structure	64	1,453	1,273	180	12.4%
SS4255-083	Screen Structure	64	17,847	17,783	63	0.4%
SS4257-098	Screen Structure	64	7,723	7,486	236	3.1%
SS4455-152	Screen Structure	64	6,955	6,372	583	8.4%
SS4565-037	Screen Structure	64	1,815	1,505	311	17.1%
SS5062-073	Screen Structure	64	1,823	1,586	237	13.0%
SS5159-048	Screen Structure	64	962	761	201	20.9%

Control Practice Name	Control Practice Type	Rock River TMDL Reachshed ID	Annual TSS Influent Load (lbs)	Annual TSS Effluent Load (lbs)	Annual TSS Load Reduction (lbs)	Percent TSS Load Reduction (%)
SS5547-017	Screen Structure	64	2,308	2,225	83	3.6%
SS5843-072	Screen Structure	64	5,636	5,629	6	0.1%
SS5943-065	Screen Structure	64	10,619	10,401	219	2.1%
SS6733-038	Screen Structure	64	4,759	4,186	573	12.0%
SS6733-039	Screen Structure	64	2,389	2,016	373	15.6%
SS7129-021	Screen Structure	64	859	660	199	23.2%
TD 4565-001_SS	Screen Structure	64	46,250	43,008	3,241	7.0%
PD3666-096	Biofilter	65	1,348	154	1,194	88.6%
PD3670-012	Biofilter	65	1,794	625	1,169	65.1%
PD3670-012_CB	Catchbasin Cleaning	65	2,019	1,794	224	11.1%
SS3670-022_CB	Catchbasin Cleaning	65	72,846	69,645	3,201	4.4%
PD 4769-015	Detention Pond	65	44,592	23,826	20,766	46.6%
PD 4970-001	Detention Pond	65	11,518	4,204	7,314	63.5%
PD 5368-018	Detention Pond	65	4,780	3,025	1,755	36.7%
PD 5368-019	Detention Pond	65	1,216	1,210	6	0.5%
PD3770-001	Detention Pond	65	132,768	34,308	98,461	74.2%
SS3670-022	Screen Structure	65	69,645	67,956	1,689	2.4%
PD 6751-024_BF	Biofilter	66	2,478	2,099	378	15.3%
PD 6965-002_inf1	Biofilter	66	1,369	771	598	43.7%
PD 6965-002_inf2	Biofilter	66	771	393	378	49.0%
PD 6966-002_Inf1	Biofilter	66	686	670	17	2.4%
PD 6966-002_Inf2	Biofilter	66	670	66	604	90.2%
PD 6968-017_Inf	Biofilter	66	9,887	6,426	3,461	35.0%
PD 7240-002_Inf	Biofilter	66	1,918	15	1,903	99.2%
PD 7241-030	Biofilter	66	2,164	91	2,073	95.8%
PD 7242-014	Biofilter	66	2,099	145	1,955	93.1%
PD 7366-001_Bf	Biofilter	66	13,380	12,967	414	3.1%
PD 7468-004_Bf	Biofilter	66	5,108	4,611	497	9.7%

Control Practice Name	Control Practice Type	Rock River TMDL Reachshed ID	Annual TSS Influent Load (lbs)	Annual TSS Effluent Load (lbs)	Annual TSS Load Reduction (lbs)	Percent TSS Load Reduction (%)
NA_PE_CB	Catchbasin Cleaning	66	429,800	421,800	8,000	1.9%
PD 6458-002_CB	Catchbasin Cleaning	66	54,581	52,078	2,504	4.6%
PD 6752-004_CB	Catchbasin Cleaning	66	95,615	91,291	4,324	4.5%
PD 7058-001_CB	Catchbasin Cleaning	66	30,451	28,620	1,830	6.0%
PD 6458-002	Detention Pond	66	35,240	15,756	19,484	55.3%
PD 6458-002_FB	Detention Pond	66	52,078	35,240	16,837	32.3%
PD 6751-024_WP	Detention Pond	66	2,099	740	1,359	64.8%
PD 6752-004	Detention Pond	66	91,291	31,782	59,509	65.2%
PD 6761-018	Detention Pond	66	10,506	10,412	94	0.9%
PD 6852-005	Detention Pond	66	22,498	22,284	213	0.9%
PD 6856-001	Detention Pond	66	149,675	42,705	106,969	71.5%
PD 6860-036_Dn	Detention Pond	66	34,441	32,320	2,122	6.2%
PD 6860-036_Up	Detention Pond	66	39,857	34,441	5,416	13.6%
PD 6955-024	Detention Pond	66	11,200	669	10,531	94.0%
PD 6960-006_Pond	Detention Pond	66	18,336	17,979	357	1.9%
PD 6960-006_RB	Detention Pond	66	24,565	18,336	6,229	25.4%
PD 6961-012	Detention Pond	66	2,295	170	2,125	92.6%
PD 6965-001	Detention Pond	66	2,686	1,185	1,501	55.9%
PD 6966-001	Detention Pond	66	724	172	552	76.3%
PD 6967-034	Detention Pond	66	4,860	4,857	3	0.1%
PD 6967-035	Detention Pond	66	4,451	4,283	168	3.8%
PD 6968-017_Ret	Detention Pond	66	10,883	9,887	996	9.2%
PD 7058-001_Pond	Detention Pond	66	28,620	5,290	23,330	81.5%
PD 7065-029_Pond1	Detention Pond	66	7,122	7,106	16	0.2%
PD 7065-029_Pond2	Detention Pond	66	19,031	7,122	11,910	62.6%
PD 7067-014	Detention Pond	66	3,808	1,003	2,805	73.7%
PD 7068-001	Detention Pond	66	467	155	312	66.8%
PD 7069-001	Detention Pond	66	1,994	478	1,516	76.0%

Control Practice Name	Control Practice Type	Rock River TMDL Reachshed ID	Annual TSS Influent Load (lbs)	Annual TSS Effluent Load (lbs)	Annual TSS Load Reduction (lbs)	Percent TSS Load Reduction (%)
PD 7153-056	Detention Pond	66	102,372	28,630	73,742	72.0%
PD 7164-034	Detention Pond	66	9,122	890	8,231	90.2%
PD 7168-035	Detention Pond	66	1,395	1,246	149	10.7%
PD 7169-044	Detention Pond	66	17,210	4,950	12,260	71.2%
PD 7240-002_WP	Detention Pond	66	5,684	1,918	3,766	66.3%
PD 7249-010	Detention Pond	66	18,567	6,346	12,221	65.8%
PD 7263-002	Detention Pond	66	6,530	1,317	5,213	79.8%
PD 7340-001	Detention Pond	66	12,519	7,542	4,977	39.8%
PD 7341-001_PD 7342-003	Detention Pond	66	35,476	9,372	26,104	73.6%
PD 7347-018	Detention Pond	66	8,850	8,211	639	7.2%
PD 7366-001_Wet	Detention Pond	66	23,674	13,380	10,293	43.5%
PD 7441-021	Detention Pond	66	726	721	5	0.7%
PD 7442-022	Detention Pond	66	1,004	996	8	0.8%
PD 7443-024	Detention Pond	66	10,763	4,392	6,370	59.2%
PD 7446-039	Detention Pond	66	3,109	2,244	865	27.8%
PD 7460-005	Detention Pond	66	11,943	2,376	9,567	80.1%
PD 7464-004	Detention Pond	66	16,653	9,639	7,014	42.1%
PD 7468-004_Wet	Detention Pond	66	11,947	5,108	6,839	57.2%
PD 7542-027	Detention Pond	66	11,266	5,268	5,998	53.2%
PD 7644-058	Detention Pond	66	26,039	10,094	15,945	61.2%
PD 7739-001_E	Detention Pond	66	859	695	164	19.1%
PD 7739-001_W	Detention Pond	66	1,827	859	968	53.0%
PD 7840-001	Detention Pond	66	11,217	2,919	8,298	74.0%
PD 7841-002_N	Detention Pond	66	43,725	42,998	727	1.7%
PD 7841-002_S	Detention Pond	66	83,675	43,725	39,950	47.7%

Table 3-5. TSS and TP pollution reduction effectiveness of the existing structural SCMs, catch basin and proprietary device sumps and cleaning, and Coanda screen structure sumps and cleaning by reachshed.

3.3.7 Summary of Results

Rock River TMDL Reachshed ID	Annual TSS No Controls Load (lbs)	Annual TSS With Controls Load (lbs)[1]	Annual TSS Public Practice Reductions (lbs)	Percent TSS Reduction from No Controls (%)	Detention Ponds		
					Total Number of Detention Ponds	Annual TSS Reductions Due to Detention Ponds (lbs)	Percent TSS Reduction Due to Detention Ponds (%)
47	50,991	11,952	39,039	1	1	35,847	70.3%
62	675,103	308,986	365,303	1	20	295,235	43.7%
64	6,930,111	4,828,292	2,036,142	0	85	1,241,094	17.9%
65	434,983	213,892	168,701	0	5	128,302	29.5%
66	1,497,920	782,661	679,101	0	49	534,671	35.7%
City-wide Total	**9,589,108**	**6,145,783**	**3,443,325**	**0**	**160**	**2,235,148**	**23.3%**

Rock River TMDL Reachshed ID	Biofilters/Infiltration Basins			Catchbasin Cleaning		Street Cleaning	
	Total Number of Biofilters	Annual TSS Reductions Due to Biofilters (lbs)	Percent TSS Reduction Due to Biofilters (%)	Annual TSS Reductions Due to Catchbasin Cleaning (lbs)	Percent Reduction Due to Catchbasin Cleaning (%)	Annual TSS Reductions Due to Street Cleaning (lbs)	Percent Reduction Due to Street Cleaning (%)
47	0	0	0.0%	0	0.0%	3,191	6.3%
62	5	4,978	0.7%	1,363	0.2%	63,721	9.4%
64	8	11,193	0.2%	211,472	3.1%	572,375	8.3%
65	3	2,363	0.5%	5,114	1.2%	32,918	7.6%
66	11	12,278	0.8%	16,657	1.1%	115,483	7.7%
City-wide Total	**27**	**30,814**	**0.3%**	**234,606**	**2.4%**	**787,689**	**8.2%**

[1]*Not calculated directly from WinSLAMM models. Includes public practice and private practice reductions.*

Table 3-6. TSS reduction by practice by reachshed.

Reachshed	Area (ac)	Annual TSS No Controls Load (lbs)	Annual TSS With Controls Load (lbs)[1]	Annual TSS Public Practice Reductions (lbs)	Annual TSS Private Practice Reductions (lbs)	Percent Reduction (%)
47	442	50,991	11,952	39,039	0	76.6%
62	3,299	675,103	308,986	365,303	814	54.2%
64	25,200	6,930,111	4,828,292	2,036,142	65,677	30.3%
65	2,372	434,983	213,892	168,701	52,390	50.8%
66	6,545	1,497,920	782,661	679,101	36,159	47.8%
City-wide Total	**37,859**	**9,589,108**	**6,145,783**	**3,288,285**	**155,040**	**35.9%**

[1]Not calculated directly from WinSLAMM models. Includes public practice and private practice reductions.

Table 3-7. Annual overall TSS reductions by reachshed.

Reachshed	Area (ac)	Annual TP No Controls Load (lbs)	Annual TP With Controls Load (lbs)[1]	Annual TP Public Practice Reductions (lbs)	Annual TP Private Practice Reductions (lbs)	Annual TP Reductions from Leaf Management (lbs)	Percent Reduction (%)
47	442	172	55	117	0	0.0	67.8%
62	3,299	2,247	1,363	868	0	15.4	39.3%
64	25,200	21,706	16,740	4,470	285	210.1	22.9%
65	2,372	1,268	874	371	5	17.0	31.0%
66	6,545	4,446	2,939	1,459	25	23.9	33.9%
City-wide Total	**37,859**	**29,839**	**21,972**	**7,285**	**315**	**266.4**	**26.4%**

[1]Not calculated directly from WinSLAMM models. Includes public practice, private practice and leaf management reductions.

Table 3-8. Annual overall TP reductions by reachshed.

4 Analysis

This section documents the City's progress to date towards meeting the water quality goals required by the Rock River TMDL, and the City's plan to meet those goals through participation in the Yahara WINS Adaptive Management program.

4.1 Goals

The City sees two primary benchmarks that must be achieved to satisfy its water quality requirements under the Rock River TMDL as well as the City's MS4 permit (Wisconsin Pollutant Discharge Elimination System (WPDES) Permit No. WI-S058416-19) via the Yahara WINS Adaptive Management program. These targets, and the City's proposed methods to achieve them, are summarized below.

4.1.1 Reduction of 40% TSS/27% TP from No Controls

As shown in Tables 3-8 and 3-9, the City has met or exceeded 40% TSS and 27% TP removal relative to the No Controls condition in four of the five reachsheds included within the City of Madison municipal boundary. In the fifth, reachshed 64, the City's TSS and TP reductions are at only 30.3% and 22.9%. As the City's area within reachshed 64 is significantly larger than its combined area within 47, 62, 65, and 66, it is not surprising that underachievement in that reachshed negatively weights cumulative City-wide reductions. City-wide, the City of Madison has achieved TSS and TP reductions of 35.9% and 26.4%, or deficits of 4.1% and 0.6% relative to the threshold of 40% TSS and 27% TP removal.

The Yahara WINS Adaptive Management agreement states that MS4s in the Rock River TMDL area may only purchase TP credits to meet their TMDL requirements through participation in the Yahara WINS adaptive management program once the MS4's baseline reduction of 40% TSS and 27% TP removal relative to a no-controls condition has been met. Per the text of the agreement, participating MS4s have until Jan 1, 2036 (the terminus of the current Adaptive Management agreement) to meet these baseline reductions. This position was reiterated by the WDNR during a City of Madison/WDNR meeting on Dec 19, 2019 (meeting minutes included with this report as part of Appendix E). As the City's reductions of both TSS and TP in reachshed 64 and City-wide do not meet this baseline criteria, the City expects to increase its in-City reduction quantities to achieve the minimum 40% TSS/27% TP reduction standard. Tables 4-1 and 4-2 below show the TSS and TP reductions required to achieve compliance with this standard.

Reachshed	Annual TSS No Controls Load (lbs)	Percent TSS Reduction (%)	Baseline 40% Reduction Threshold Met?	Percent TSS Reduction Deficit (%)	Annual TSS Removal Required to Meet Baseline Threshold (lbs)
47	50,991	76.6%	Yes	-	-
62	675,103	54.2%	Yes	-	-
64	6,930,111	30.3%	No	9.7%	670,225
65	434,983	50.8%	Yes	-	
66	1,497,920	47.8%	Yes	-	
City-wide Total	**9,589,108**	**35.9%**	**No**	**4.1%**	**392,318**

Table 4-1. TSS Reductions Required to Achieve 40% TSS Reduction from No Controls by Reachshed.

Reachshed	Annual TP No Controls Load (lbs)	Percent TP Reduction (%)	Baseline 27% Reduction Threshold Met?	Percent TP Reduction Deficit (%)	Annual TP Removal Required to Meet Baseline Threshold (lbs)
47	172	67.8%	Yes	-	-
62	2,247	39.3%	Yes	-	-
64	21,706	22.9%	No	4.1%	895
65	1,268	31.0%	Yes	-	
66	4,446	33.9%	Yes	-	
City-wide Total	**29,839**	**26.4%**	**No**	**0.6%**	**190**

Table 4-2. TP Reductions Required to Achieve 27% TP Reduction from No Controls by Reachshed.

The City has developed an internal plan to achieve a City-wide 40% TSS/27% TP reduction from no controls by Jan 1, 2036 as required by the Adaptive Management agreement. That plan is will guide the City's efforts to remove 392,318 lbs of TSS (4.1% City-wide) and 190 lbs of TP (0.6% TP City-wide) in addition to reductions already achieved by the City's current BMP matrix, and is discussed broadly in Section 4.2 of this report.

4.1.2 Removal of TP in Excess of 27% as Required to Meet TMDL Requirements

The City intends to meet the Rock River TMDL load reductions above the 40% TSS/27% TP reduction from No Controls condition through participation in Yahara WINS adaptive management program, per Appendix A.3 of WPDES Permit No. WI-S058416-4. Table 4-3 below shows the quantity of TP (in lbs) that the City of Madison must purchase annually through Yahara WINS to achieve compliance with the Rock River TMDL in all reachsheds within the City of Madison.

Note that the TP reduction for reachshed 64 has been adjusted from existing conditions to reflect an additional 190 lbs of TP removed annually. This reflects the assumption that the City will achieve 27% TP reduction from No Controls conditions on a cumulative, City-wide basis, outside adaptive management, as described in Section 4.1.1.

Reachshed	City of Madison Annual TP No Controls Load (lbs)	Cumulative City of Madison Annual TP Reduction (lbs)	Target TP Reduction from No Controls (%)	City of Madison TP Reduction from No Controls (%)	City of Madison TP Reduction Deficit to Meet TMDL Standard (%)	City of Madison Annual TP Deficit (lb)
47	172	117	27%	67.8%	**-40.8%**	0
62	2,247	883	78%	39.3%	**38.7%**	869
64	21,706	5,155[1]	61%	**23.7%**[1]	**37.3%**	8,086
65	1,268	394	63%	31.0%	**32.0%**	405
66	4,446	1,507	54%	33.9%	**20.1%**	894
Total TP Annual Purchase Through Yahara WINS						**10,254**

[1]*Cumulative and percent reduction includes 190 lbs TP required to achieve 27% City-wide TP reductions, as shown in Table 4-2*

Table 4-3. TP Quantities to be Purchased Through Yahara WINS Adaptive Management Program

4.2 Future Plans

As described in Section 4.1.2 above, the City of Madison intends to comply with the Rock River TMDL load reduction goals above the 40% TSS/27% TP reduction baseline (relative to No Controls) through the purchase of TP through the Yahara WINS adaptive management program. As shown in Table 4-3, the City's annual TP purchase through Yahara WINS shall be 10,254 lbs.

As described in Section 4.1.1, the Yahara WINS Adaptive Management implementation agreement states that municipalities participating in the program must achieve a baseline of 40% TSS/27% TP reduction from a "no controls" condition within their municipal boundary by the end of the Adaptive Management Program (Jan 1, 2036) to be eligible for participation in the program. The City plans to meet this requirement through a combination of structural BMP additions/improvements and stormwater quality programs, included but not limited to the following:

- Post-construction stormwater standards set by municipal ordinance for both TSS reduction and volume control for redevelopment sites that exceed the WDNR-set uniform state standards for redevelopment post-construction stormwater management.
- Implementation of a City-wide Distributed Green Infrastructure Installation program with public works projects.
- Design and construction of joint flood control/water quality improvement capital projects, including wet pond expansions and dry to wet pond conversion projects, in parallel with the City's Watershed Study program.
- Installation of City-developed Coanda screen structures (see Section 3.3.5) with public works projects to increase in-line stormwater treatment.
- Continued improvement of the City's already-robust leaf management program.
- Continued improvement to the City's weekly sweeping program in the Snow Emergency Area (see Section 3.3.1), including a transition to vacuum-assisted sweeping where practicable.

Appendix A: Figures

Figure 1A: Rock River TMDL Reachsheds in the City of Madison, WI

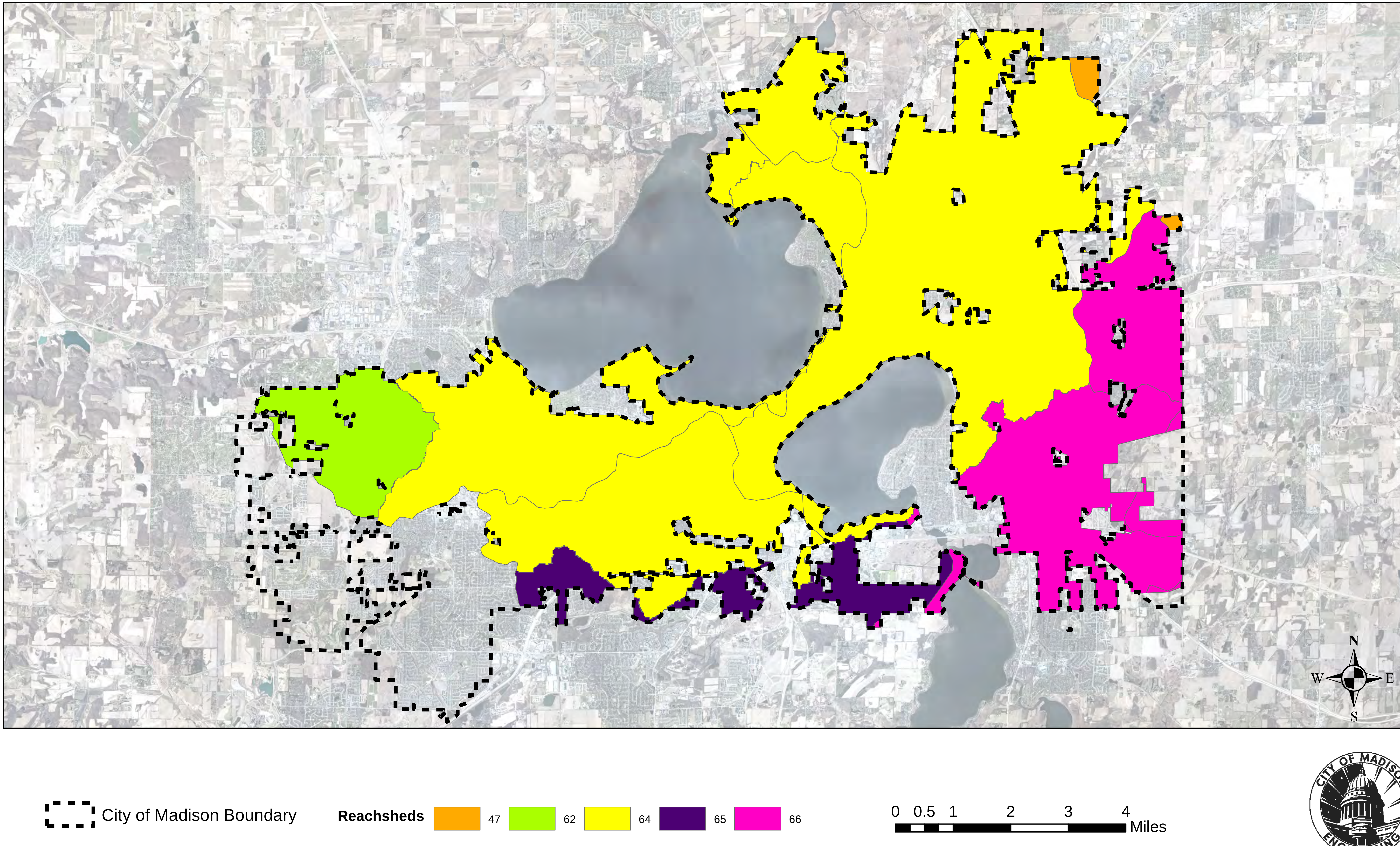

Figure 1B: Rock River TMDL Watersheds in the City of Madison, WI

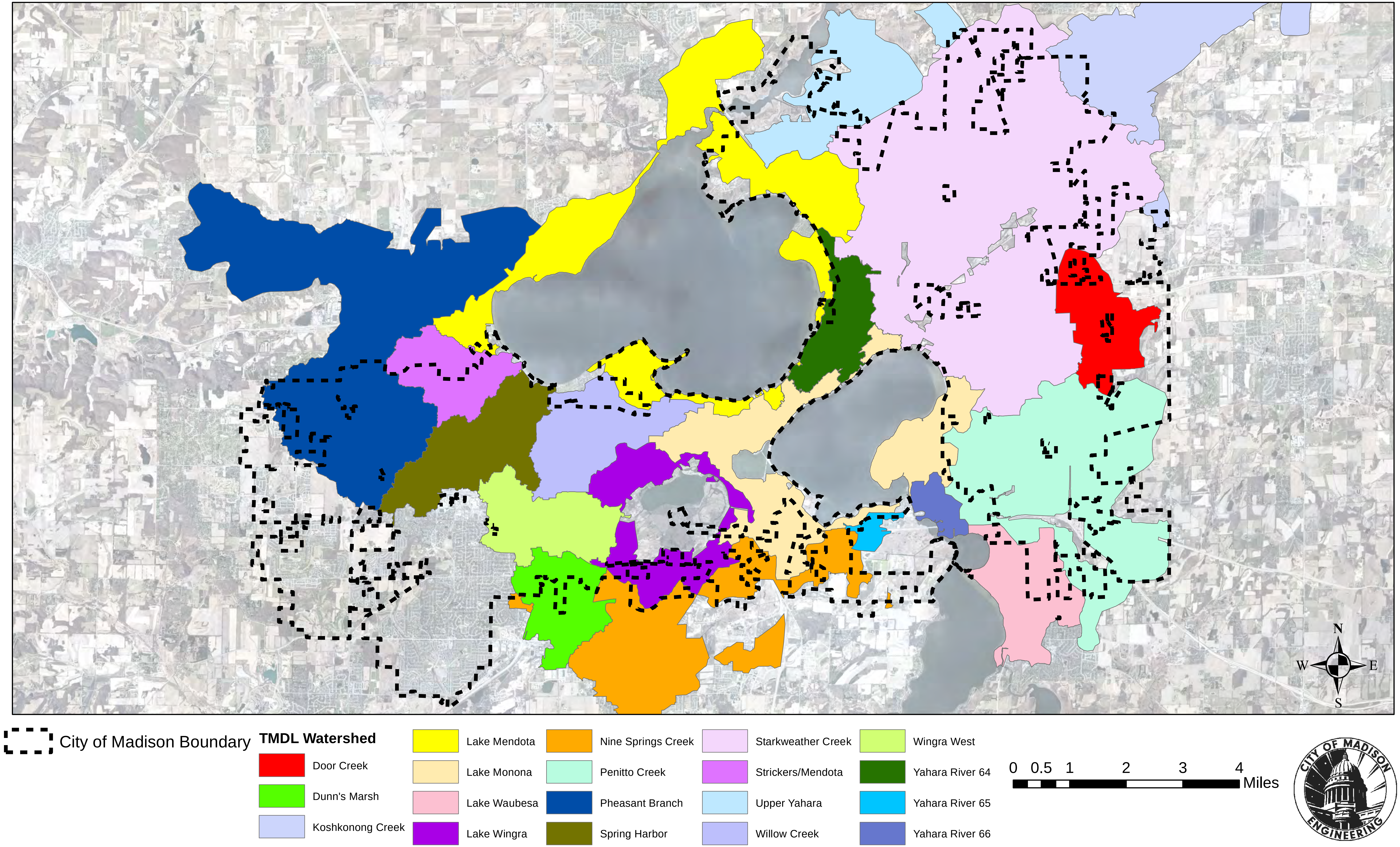

Figure 1C: Rock River TMDL Subbasins in the City of Madison, WI

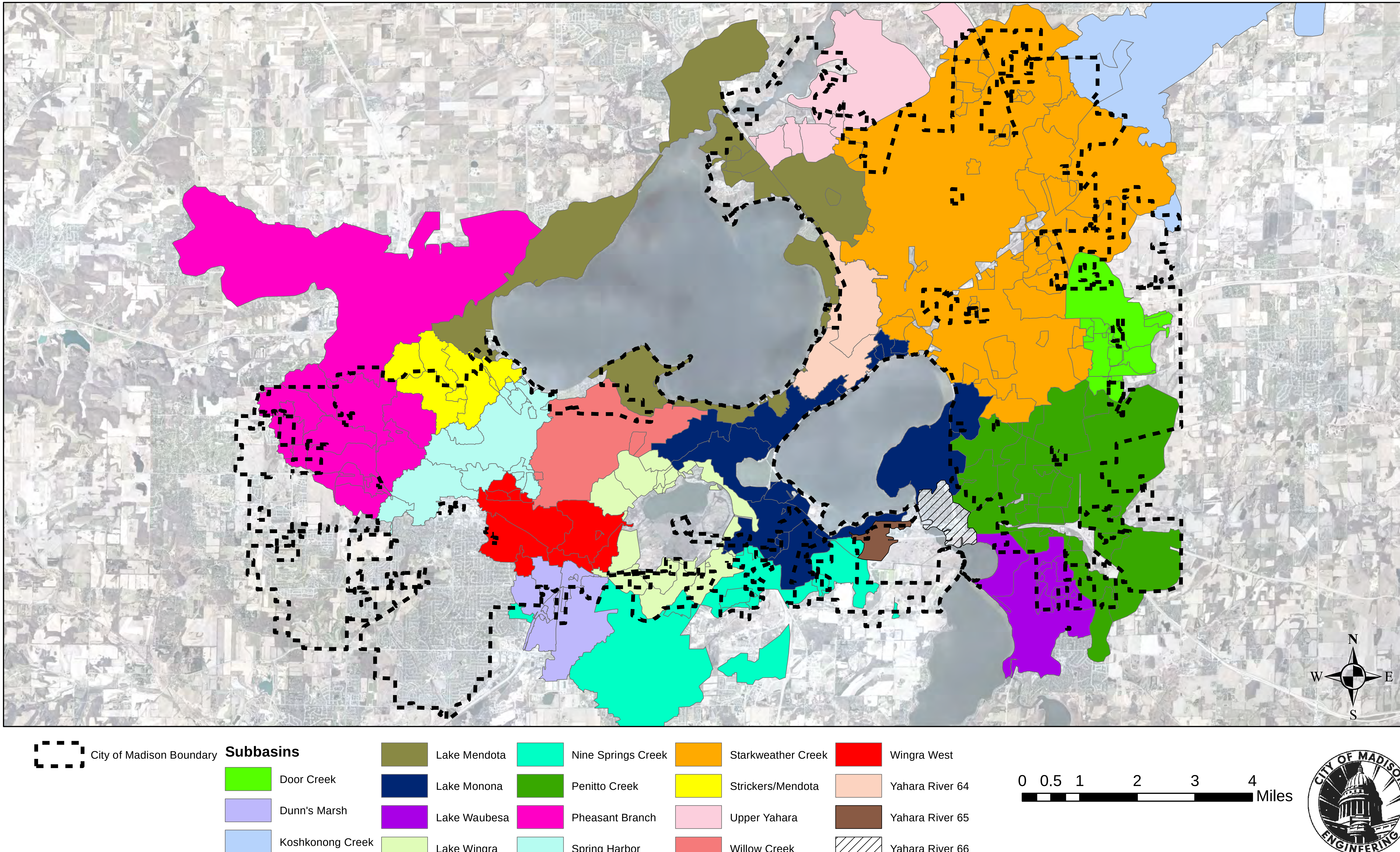

Figure 2: Areas Excluded from Rock River TMDL Modeling in the City of Madison, WI

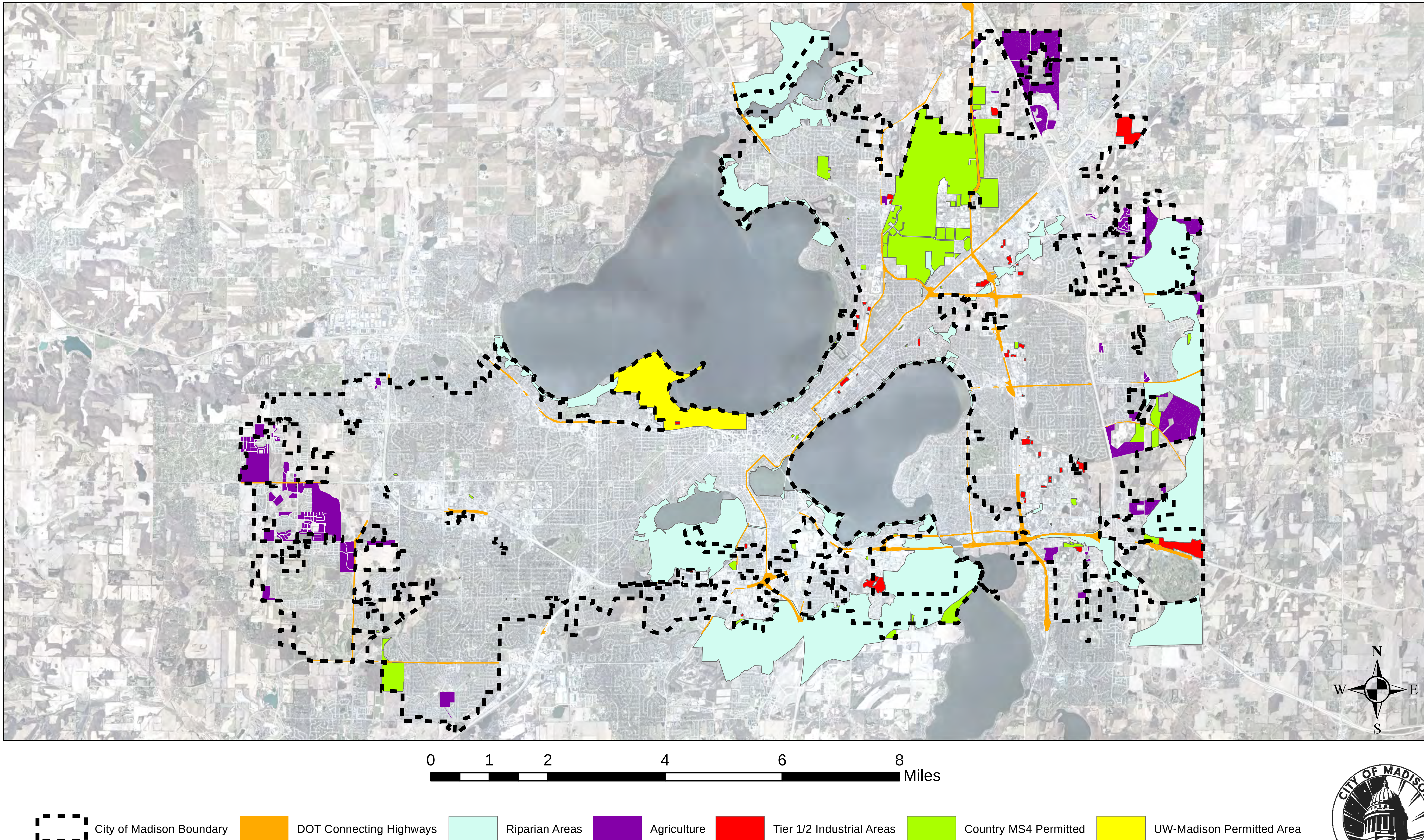

Figure 3: Rock River TMDL Soils in the City of Madison, WI

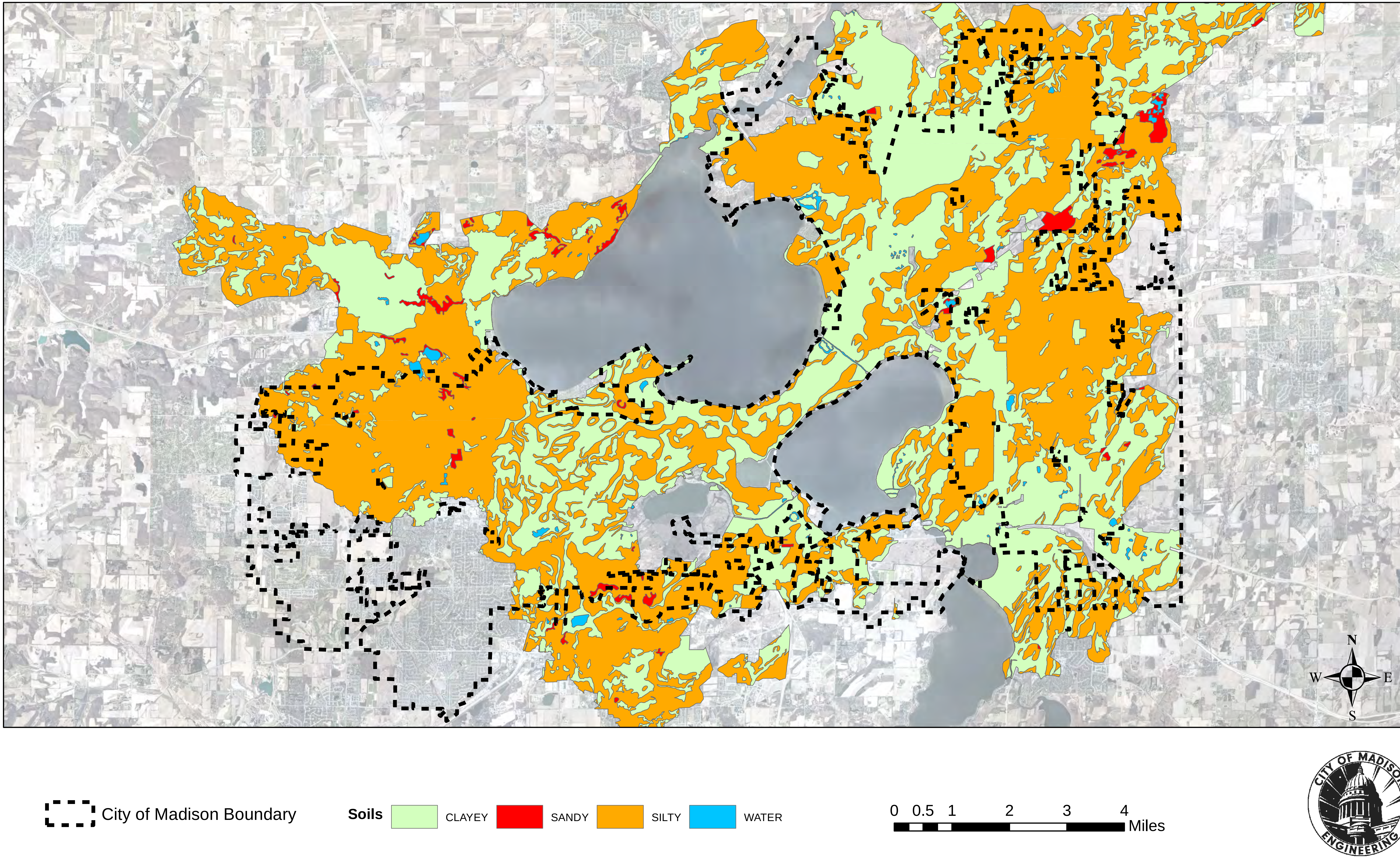

Figure 4: Land Use in the City of Madison, WI for Use in Rock River TMDL Modeling