SECTION 3
INFILTRATION

3.01 OBJECTIVE

The 2009 *Lake Wingra*: *A Vision for the Future,* prepared by the FOLW, identifies increasing infiltration in the Lake Wingra watershed as a critical element of Goal 2, restored spring flow. The report goes on to establish a target increase of 25 percent in spring flow. For purposes of this plan, the objective in working toward this target is described in terms of the following short-term and long-term goals.

1. Short-Term Goal: Recover 10 percent of the lost infiltration resulting from development.
2. Long-Term Goal: Recover 25 percent of the lost infiltration resulting from development.

Working toward these goals will, in kind, work toward meeting the two other targets identified under Goal 2: "Lost springs flowing year-round" and "Year-round flows from Lake Wingra into Wingra Creek."

In an effort to achieve this goal, this portion of the management plan:

1. Describes the Lake Wingra surface water watershed and groundwater watershed including current estimated annual average runoff and groundwater flow to the lake.
2. Describes the estimated current infiltration rates in the watershed.
3. Identifies existing, proposed, and potential recharge locations.
4. Performs an alternatives analysis that identifies ways to achieve the short-term goal of increasing infiltration in the watershed to recover 10 percent of the lost infiltration resulting from development.
5. Seeks to achieve the infiltration and TP reduction short-term goals through projects that jointly provide an infiltration and TP reduction benefit.
6. Reviews management changes that have the potential to achieve the short-term infiltration goals.
7. Recommends management changes to pursue.
8. Provides discussion on potential strategies for meeting the long-term goal.

3.02 BACKGROUND

A. Importance of Infiltration

Infiltration of rainfall/runoff into the ground has a threefold benefit to Lake Wingra. First, this water becomes a source for groundwater recharge and spring flow. Second, this water can contribute clean water (if direct surface infiltration) or pretreated water (if directed to a rain garden, bioretention, or other facility) for groundwater recharge and spring flow. Infiltrated water does not have the opportunity to pick up and convey additional pollutants to Lake Wingra as it would if conveyed through a storm sewer. Third, infiltration can reduce runoff peak flows and volumes. Figure 3.02-1 shows a graphic of different factors that affect spring flow.

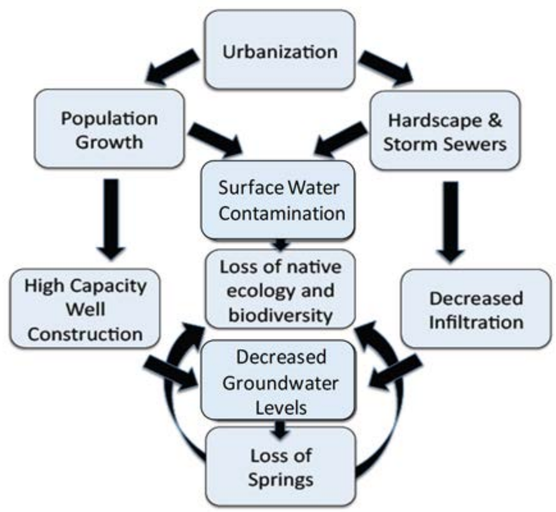


Figure 3.02-1 Factors Affecting Spring Flow

Groundwater recharge and spring flow are valuable to Lake Wingra because they sustain existing spring flow, improve lake water quality, provide unique habitat for plants and animals, reduce the temperature of the lake waters, and contribute base flow to Wingra Creek.

Increasing infiltration in the watershed provides the opportunity to enhance these benefits and restore spring flow.

B. Factors Affecting Infiltration

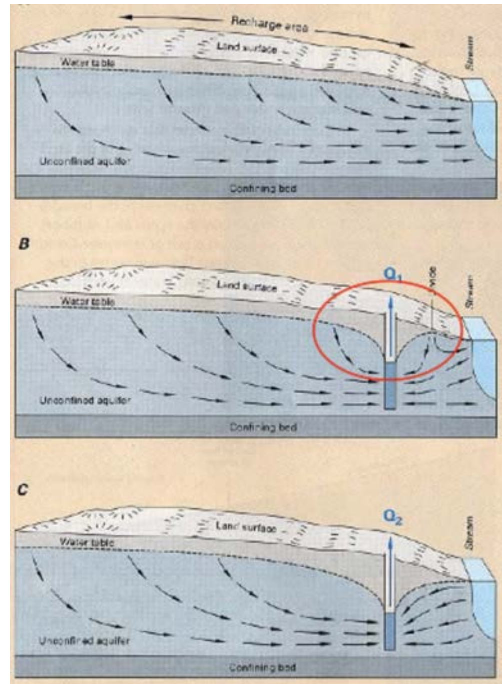
Several factors affect infiltration in the Lake Wingra watershed:

1. Amount of pervious/impervious area.
2. Soil types and condition (e.g., compaction level and sodium level)
3. Infiltration rate of pervious surfaces.
4. Amount of surface runoff.
5. dedicated postconstruction infiltration Best Management Practices (BMPs) in the surface water watershed and groundwater watershed.

C Effects of Development

Lake Wingra's original hydrologic cycle has been altered because of human development. Development in the form of construction of impervious surfaces has essentially sealed off significant amounts of formerly pervious surfaces that formerly allowed rainfall/runoff to infiltrate into the ground and recharge the groundwater table, which is now conveyed via storm sewer to Lake Wingra. Connection of internally drained areas (e.g., Odana wetlands) to the lake and filling of wetlands are also significant human impacts. Partially attributable to this is the loss of 24 springs (located mainly along the north shore of Lake Wingra) that formerly flowed into Lake Wingra according to Wayland Noland's 1951 report titled *Hydrography, Fish and Turtle Population of Lake Wingra.*

Additionally, groundwater wells constructed to serve society's needs for drinking water and irrigation have caused groundwater drawdown, primarily in the deep Mount Simon sandstone aquifer. Figure 3.02-2 illustrates a drawdown effect. The effects of development on and a description of the three aquifers in the study area (a shallow sand and gravel aquifer, an upper bedrock aquifer, and a lower bedrock aquifer) are further described.



Source: Groundwater Status Report Prepared for Friends of Lake Wingra, Sustainability Leadership Program, Edgewood College, Maribeth Kniffin, August 2011

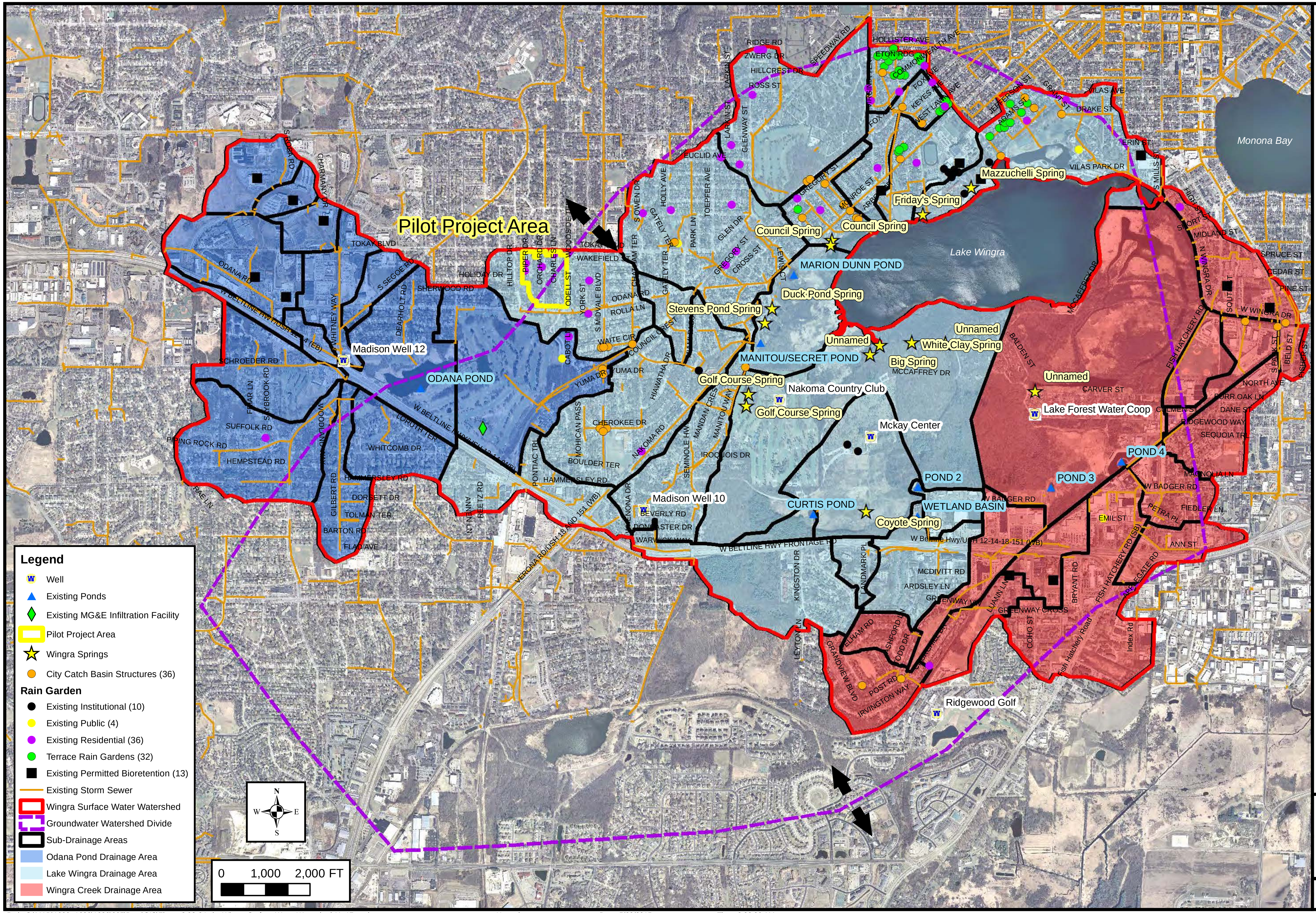
Figure 3.02-2 Drawdown Illustration

D. Existing Lake Wingra Springs

Groundwater flows manifest themselves at Lake Wingra as either surface springs or as seepage through the lake bottom. While over 24 springs have ceased flowing as noted previously, Table 3.02-1 lists 14 known active springs surrounding Lake Wingra. Figures 3.02-3 and 3.02-4 show the locations of the springs in relation to the surface water watershed and groundwater watershed based on a geographical information system (GIS) shapefile received from the UW-Madison Arboretum staff.

Spring Name	Number of Springs	Flow Rate (gpm) if available
Coyote Spring	1	Not Available
Unnamed 1	1	Not Available
Unnamed 2	1	Not Available
White Clay	1	Not Available
Unnamed 3	1	Not Available
Big	1	445 gpm
Golf Course Spring	2	90 gpm (1 spring only)
Duck Pond Spring	1	362 gpm
Stevens Pond	1	Not Available
Council Spring	2	Not Available
Friday's Spring	1	Not Available
Mazzuchelli Spring	1	Not Available

Table 3.02-1 Existing Lake Wingra Springs



LAKE WINGRA SURFACE WATER WATERSHED

LAKE WINGRA WATERSHED MANAGEMENT PLAN
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FIGURE 3.02-3
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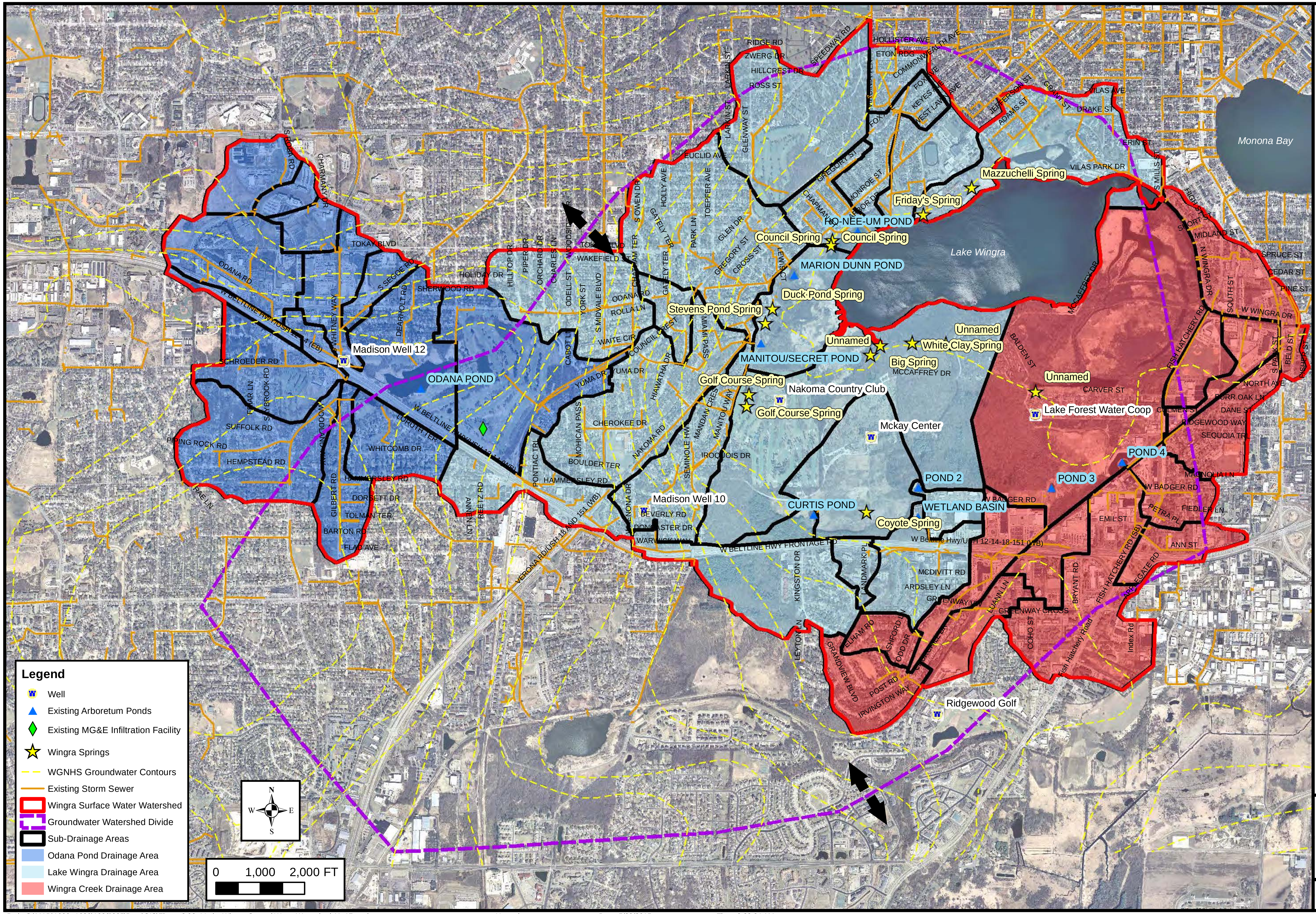

LAKE WINGRA GROUND WATER WATERSHED

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FIGURE 3.02-4
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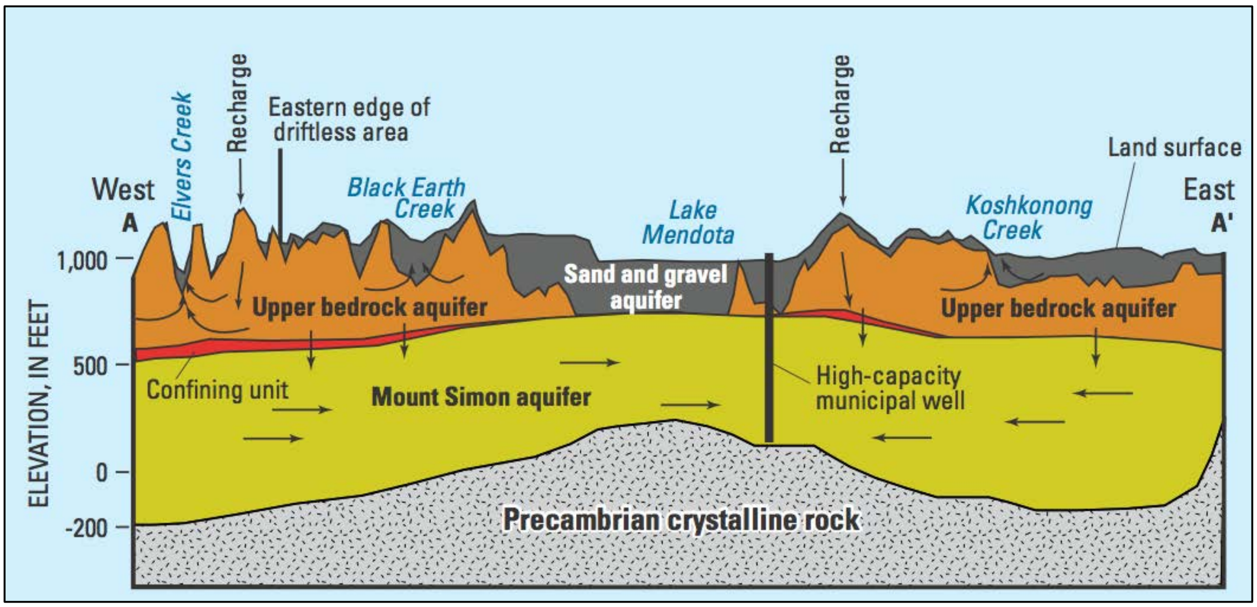
Path: S:\MAD\1000--1099\1020\065\Data\GIS\Figure 3.02-4 Lake Wingra Ground Water Watershed 11x17.mxd User: danc Date: 5/28/2015 Time: 8:23:34 AM

E. Dane County Regional Groundwater Model

At the time calculations were completed for this report, the WGNHS was in the midst of completing an update to the Dane County Regional Groundwater Model. Mike Parsen from WGNHS gave a presentation at the June 28, 2013, Issue Team Meeting describing the improvements to the model and relevant geology and groundwater issues to the Lake Wingra watershed. This model will be released soon to the public and will be useful for many projects and studies. The new model is more refined than the previous model and could be used to identify the potential source areas or recharge areas of specific springs.

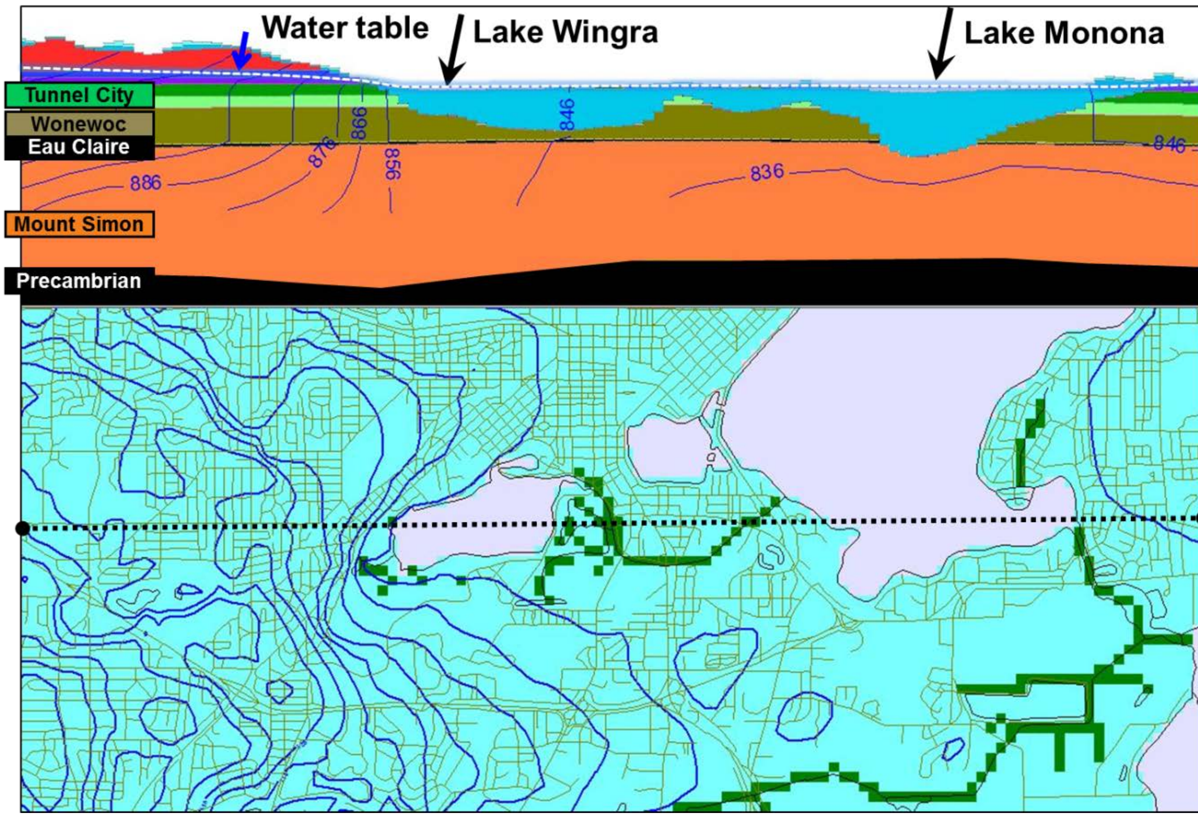


Source: WGHNS

Figure 3.02-5 Geologic Cross Section in Madison Area

Of particular importance to the Wingra Watershed Management Plan is an understanding of the link between surface water and groundwater. In the Wingra Watershed, there are three aquifers: a shallow sand and gravel aquifer, an upper bedrock aquifer, and a lower bedrock aquifer. Glacial deposits and recent stream sediments form the shallow sand and gravel aquifer (Lathrop et al., 2006). Dolomite and sandstone form the upper bedrock aquifer, and the deep Mount Simon aquifer is made of well-sorted sandstones (Swanson et al., 2006). Most of the high capacity water wells in the Madison area pump groundwater from the deep Mount Simon sandstone aquifer. Figure 3.02-5 depicts a geologic cross section in the Madison area from west to east. The upper bedrock aquifer is the source for the springs in the Lake Wingra watershed. The upper bedrock aquifer includes the Tunnel City formation, shown in Figure 3.02-6, which is generally believed to be the formation that is most connected to/contributes the most water to the majority of the Lake Wingra watershed springs. Thus, surface water infiltration is directly linked to the shallow sand and gravel aquifer and the upper bedrock aquifer while then connecting to the lower bedrock aquifer at locations of weak or partially absent confining unit, the Eau Claire aquitard.

The Eau Claire aquitard (shown in red on Figure 3.02-5) is a leaky confining unit that separates parts of the upper and lower aquifers throughout Dane County (Hunt et al., 2001). The exact thickness and presence of this aquifer is unknown ranging from over 60 feet thick in northwestern Dane County to absent in northeast Dane County (Bradbury et al., 2010). In the Yahara lakes area, the aquitard appears patchy and partially absent (Bradbury et al., 2010).

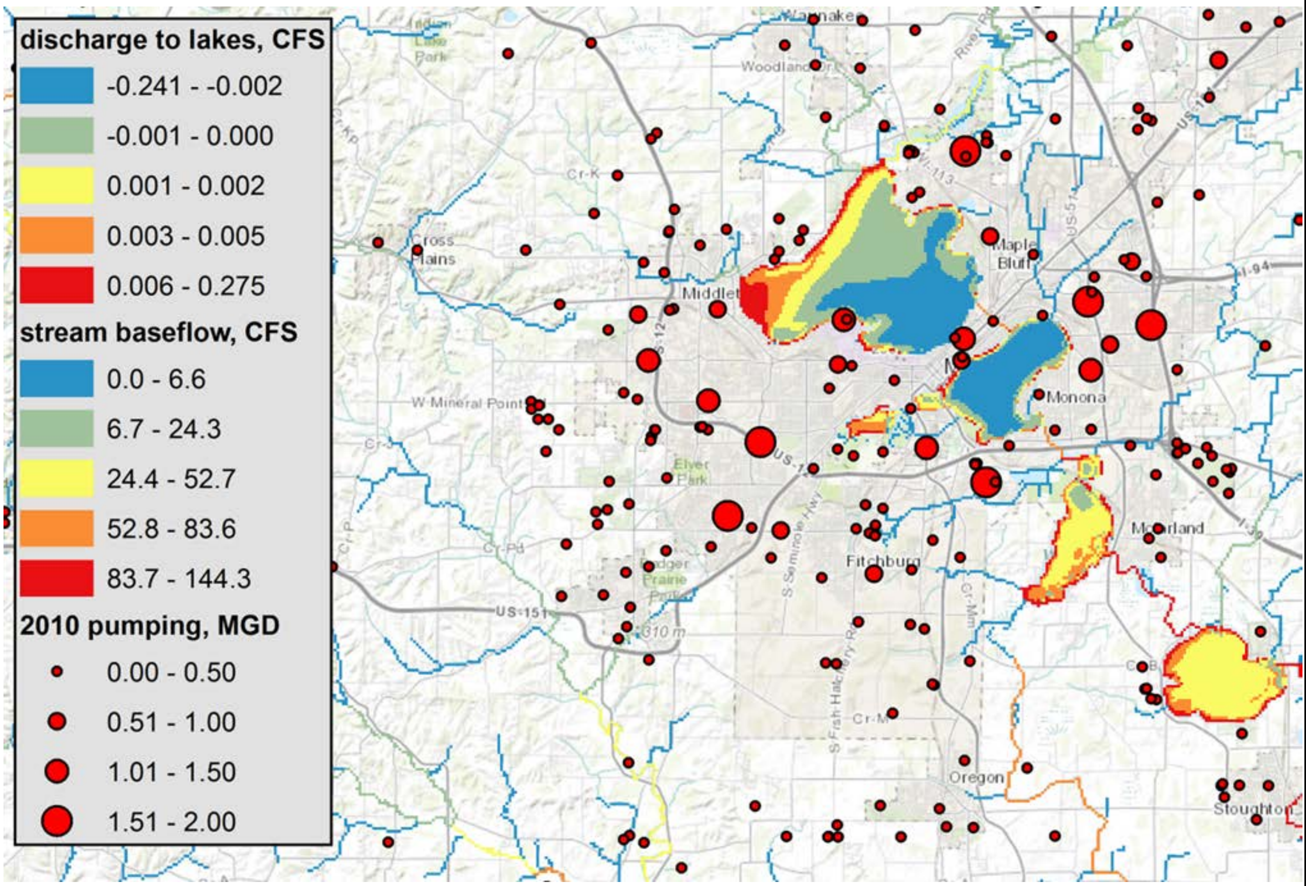


Source: WGHNS

Figure 3.02-6 Hydrostratigraphy in the Lake Wingra Area

The presence or absence of this aquitard has implications for surface water and deep aquifer (Mount Simon Sandstone) groundwater connection. In much of the Madison area where the aquitard is absent, groundwater in the Mount Simon aquifer is hydrologically connected to surface water and can either recharge or draw from the lakes, rivers, and wetlands (Hunt et al., 2001). Without intervention, ground and surface water are in state of approximate equilibrium (Fetter, 2001). Historically, Madison lakes, rivers and wetlands were groundwater sinks supported by the abundant quantity of groundwater from the Mount Simon aquifer and upward flow/discharge of groundwater from this aquifer to the lakes and streams (Lathrop et al., 2006). Today, because of the heavy pumping of groundwater from the Mount Simon aquifer, lakes lose water to the groundwater system, which may allow contaminated lake water to enter groundwater.

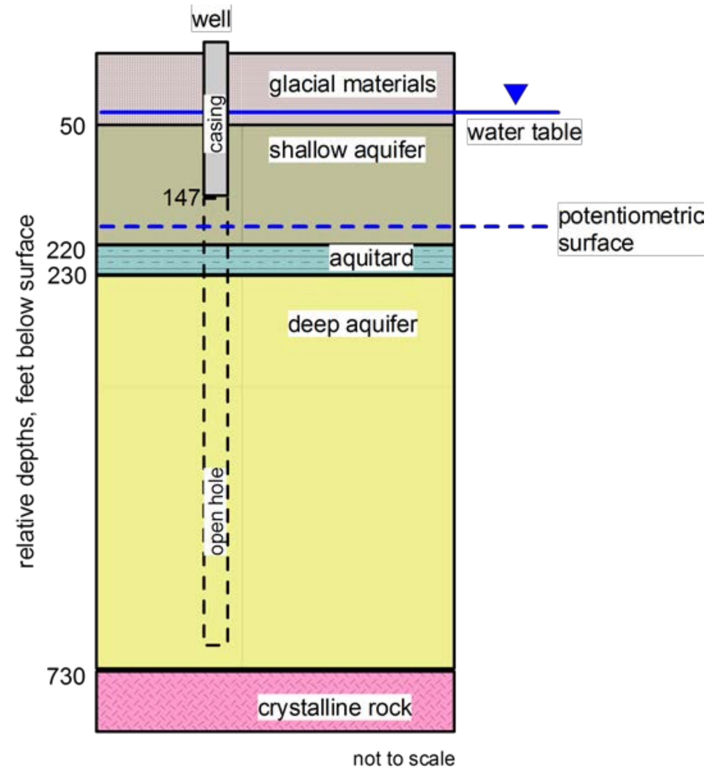
Figure 3.02-7 is a graphic from the updated Dane County Regional Groundwater Model. The graphic shows the numerous high capacity wells pumping groundwater primarily from the deep Mount Simon aquifer in the Madison area. The graphic also shows the model simulated areas of groundwater discharge to the Madison area lakes and streams. Model simulations indicate that Lake Monona and the southern half of Lake Mendota no longer receive groundwater. While Lake Wingra is still shown as a groundwater sink, groundwater withdrawals from area wells have also reduced the rate of groundwater discharge to Lake Wingra.



Source: WGHNS

Figure 3.02-7 Pumping Wells and Groundwater Discharge to Streams and Lakes

Another way the surface water and the deep Mount Simon aquifer are hydrologically connected is by cross-connecting wells. According to the WGNHS, the updated Dane County Regional Groundwater Model includes 589 wells. Of those, 31 are unused and are cross-connected while another 100 are in use but also cross-connected. As illustrated in Figure 3.02-8, a cross-connected well allows surface water and groundwater from above the aquitard to migrate down to the deep Mount Simon aquifer. The Dane County Regional Model quantifies the ambient flow through these wells in Dane County from the shallow aquifers to the deep Mount Simon aquifer at between 3 to 5 million gallons per day (mgd).

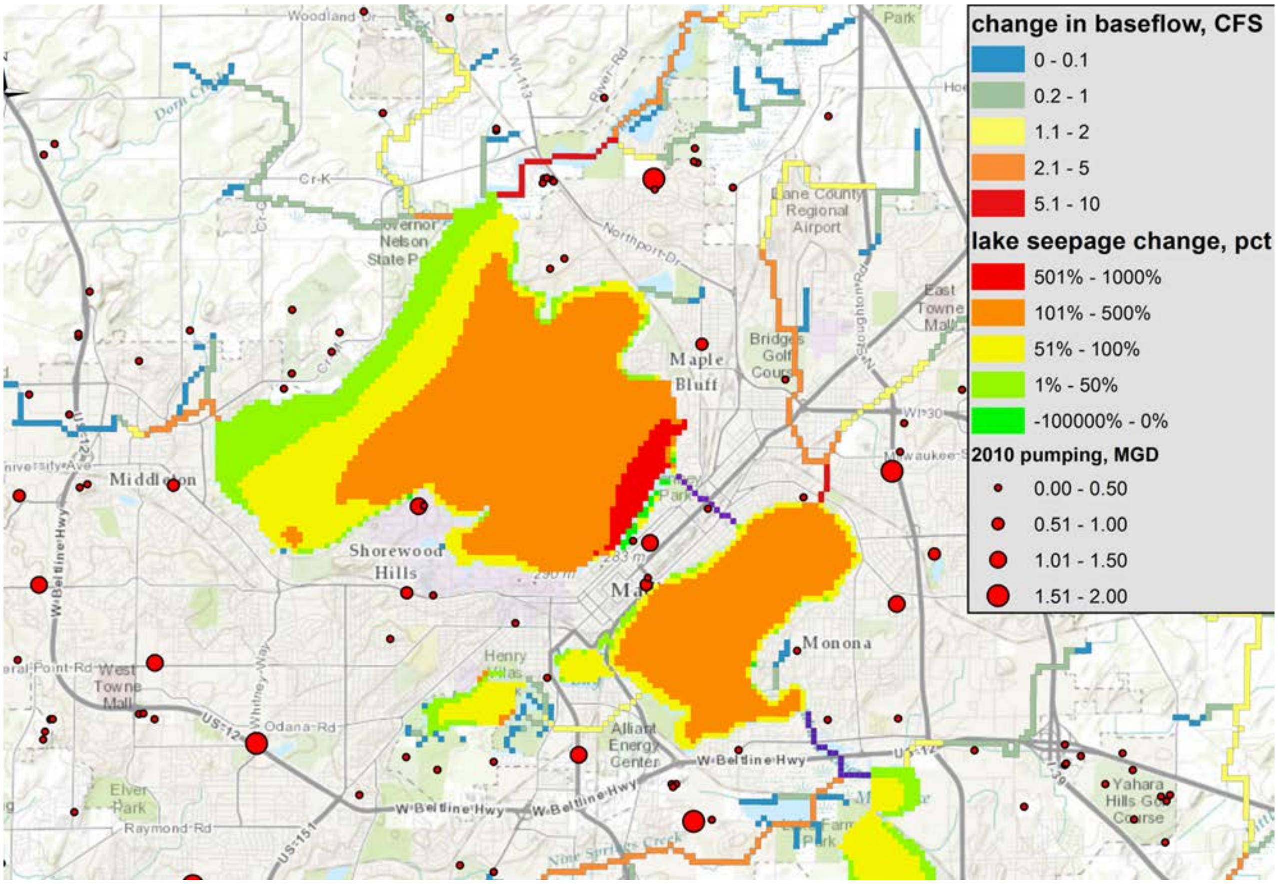


Source: WGHNS

Figure 3.02-8 Cross-Connecting Well

Figure 3.02-9 shows the simulated changed base flow conditions resulting from groundwater pumping around the Madison lakes. The percent change of lake seepage to Lake Wingra is estimated to range from approximately 1 to 100 percent.

Because surface water is directly connected to the shallow aquifers, reduced pumping of groundwater from those aquifers would likely have a direct, positive effect on base flow (spring flow and groundwater discharge to surface waters). Unfortunately, most groundwater withdrawal in the area is from wells installed in the deep Mount Simon aquifer. There is also some level of connection between surface water, the shallow aquifers, and ultimately the deep aquifer in the Madison area as discussed in the previous paragraphs. These connections are where the shale aquitard is absent and at cross-connecting wells. Reducing the groundwater pumping from the deep sandstone aquifer would also have a positive effect on spring flow and groundwater discharge to surface waters. Reducing the withdrawal rate from the deep aquifer could be accomplished through water conservation. However, water demands from future development may offset these gains unless an alternative potable water source for the municipalities in the area is identified.



Source: WGHNS

Figure 3.02-9 Change in Base Flow Because of Groundwater Pumping

3.03 CONTRIBUTING WATERSHED CHARACTERISTICS

The primary contributors to infiltration in the watershed are annual precipitation and pervious surfaces that convey a portion of the precipitation to the groundwater. Likewise, impervious surfaces prevent precipitation from being infiltrated into the ground. A combination of naturally occurring pervious surfaces (e.g., UW-Madison Arboretum), pervious surfaces within the urban environment (yards, golf courses), and dedicated infiltration-type facilities [Madison Gas & Electric (MG&E) Infiltration Facilities, rain gardens, bioretention basins] all contribute to the infiltrative capacity of the watershed.

A. <u>Watershed</u>

1. Surface Water Watershed

The official watershed boundary for the management plan is shown in Figure 3.02-3. It includes areas that drain to Wingra Creek as well as to the Gardner Marsh. While the study boundary includes these eastern areas, these areas do not drain into Lake Wingra and, therefore, do not affect lake chloride or phosphorus concentrations. Likewise, the groundwater watershed generally conforms to the surface water watershed on the eastern side of the lake meaning that groundwater is being fed from the lake rather than feeding the lake. Figure 3.03-1 depicts the estimated groundwater flow in and out of Lake Wingra as established by Pennequi and Anderson in 1983. In that regard, the two different blue-shaded areas within Figure 3.02-3 illustrate the tributary area directly draining into the lake the tributary area that affects recharge of groundwater flowing to Lake Wingra. Taking this into account, the Lake Wingra surface water watershed (both blue areas on Figure 3.02-3) encompasses 3,636 acres; 1,105 of these acres first drain through the Odana Hills Golf Course pond before draining to Lake Wingra.

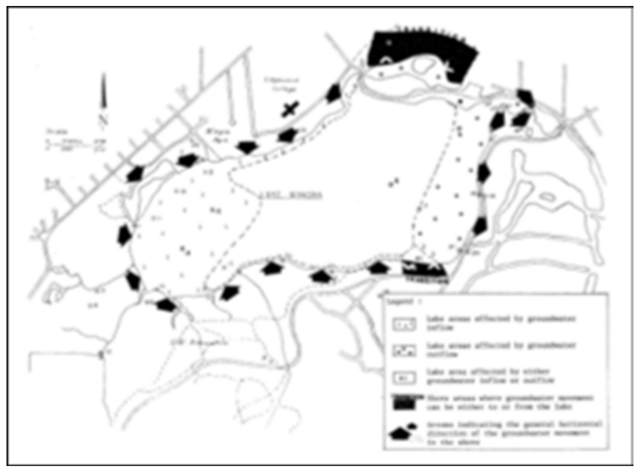


Figure 3.03-1 Estimated Lake Wingra Groundwater Inflow and Outflow

The watershed generally drains from west to east via a system of storm sewers, open channels, and ditches as shown on Figure 3.02-3. Surrounding Lake Wingra are six ponds including Pond 2/Wetland Basin, Coyote Pond (a natural seepage depression also fed by upstream storm sewers), Curtis Pond, Secret Pond, Marion-Dunn Pond, and Ho-Nee-Um Pond. Each pond provides some level of stormwater quality treatment of runoff before discharge into Lake Wingra but generally does not provide appreciable infiltration of stormwater runoff. Two ponds, Pond 4 and Pond 3, drain downstream of the lake to Wingra Creek.

2. Groundwater Watershed

Lake Wingra's groundwater watershed encompasses an area of approximately 6,177 acres and does not coincide with the surface water watershed boundary as shown in Figure 3.02-4. The groundwater watershed was generated based on groundwater contours obtained from the WGNHS.

B. Pervious/Impervious Area Analysis

A map showing pervious and impervious areas within the watershed is shown in Figure 3.03-2 including their underlying land use.

Estimates based on GIS analysis and City databases indicate that of the 3,636 acres within the watershed, 2,550 acres (70 percent) are pervious and 1,086 acres (30 percent) are impervious. Of these pervious areas, 1,790 acres (70 percent) are nonresidential land use including multifamily residential and 760 (30 percent) are residential (single-family and duplex) land use.

C. Soils in the Watershed

The amount of stormwater runoff produced by a storm event is impacted by the types of soil underlying the watershed. Soils having a high percentage of sand and gravel will absorb a higher percentage of stormwater runoff than will soils having high clay content. This means that sandy soil generally produces less runoff than clay soil.

The Natural Resources Conservation Service (NRCS) classifies soil types in categories known as Hydrologic Soils Groups (HSG). Group A soils consist of sandy soils having high infiltration rates and low runoff potential. Group B soils have moderately fine to moderately coarse textures and moderate runoff potential. Group C soils are typically sandy clay loam soils having moderately fine to fine textures and a low infiltration capacity. Examples of Group D soils are clays, soils with a permanent high water table, and shallow soils over nearly impervious material. Group D soils have a very low infiltration capacity and have high runoff potential.

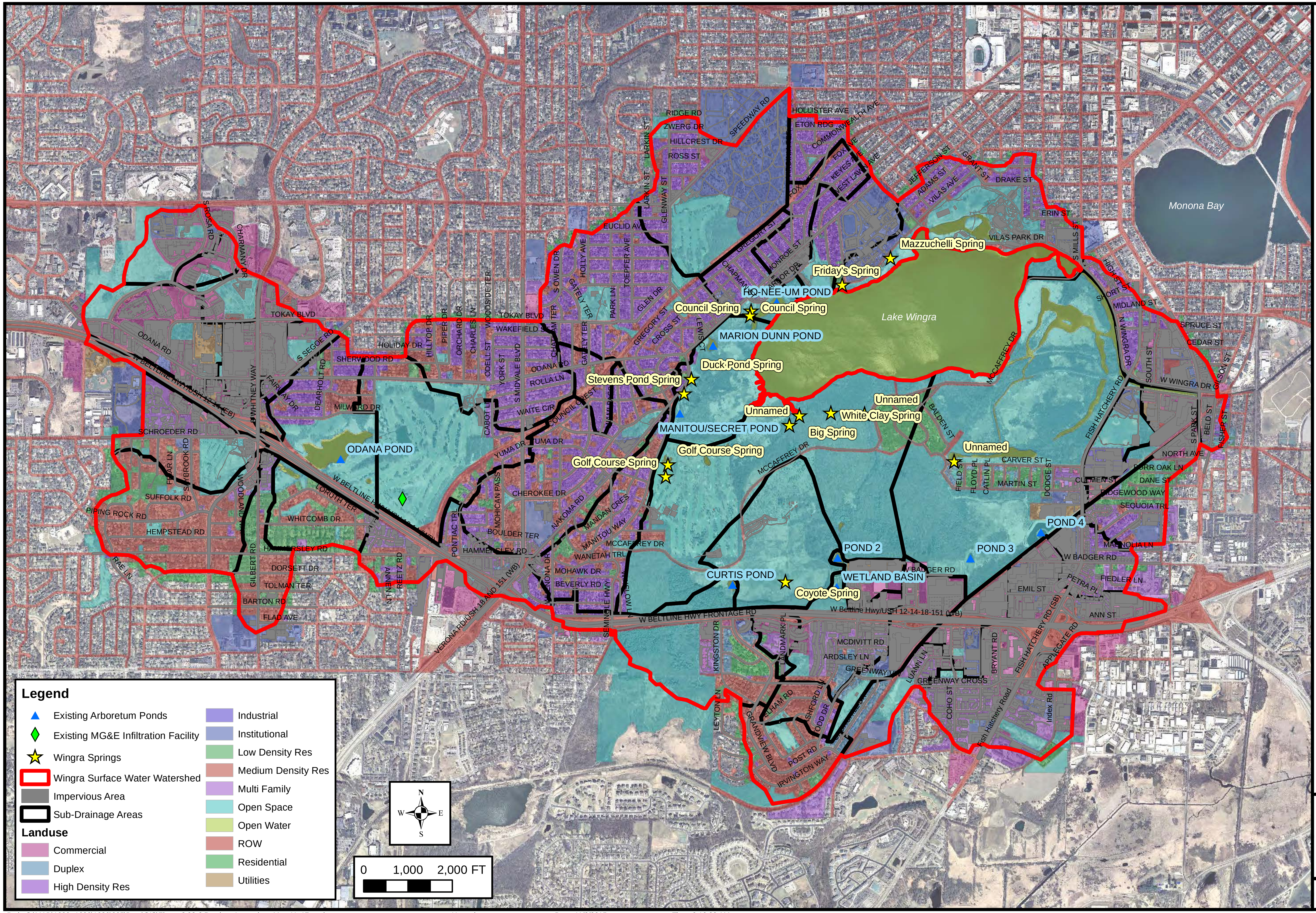
Hydrologic soil groups and soil types (based on the highest percentage of clay, silt, and sand in a particular soil type) in the watershed (directly draining to the lake) are identified in Tables 3.03-1, 3.03-2, and 3.03-3 and illustrated in Figures 3.03-3 and 3.03-4. According to the Dane County, Wisconsin, Soils Survey (published by the United States Department of Agriculture Soil Conservation Service in cooperation with the University of Wisconsin; Wisconsin Geological and Natural History Survey, Soils Department; and Wisconsin Agricultural Experiment Station), local soils are primarily silt loam. These soils are classified by the NRCS as mainly HSG Group B soils. Infiltration rates for the Group B soils range from 0.15 to 0.30 inches per hour.

HSG	Percent of Watershed
A	0.1
A/D	5.6
B	82.8
B/D	9.3
C	1.0
D	1.2
Total	**100.0**

Table 3.03-1 Hydrologic Soil Groups

Predominant Soil Composition	Percent of Watershed
Silty	85.4
Sandy	8.1
Clayey	5.3
Water	1.2
Total	**100.0**

Table 3.03-2 Predominant Soil Composition



PERVIOUS/IMPERVIOUS AREA MAP

LAKE WINGRA WATERSHED MANAGEMENT PLAN
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FIGURE 3.03-2
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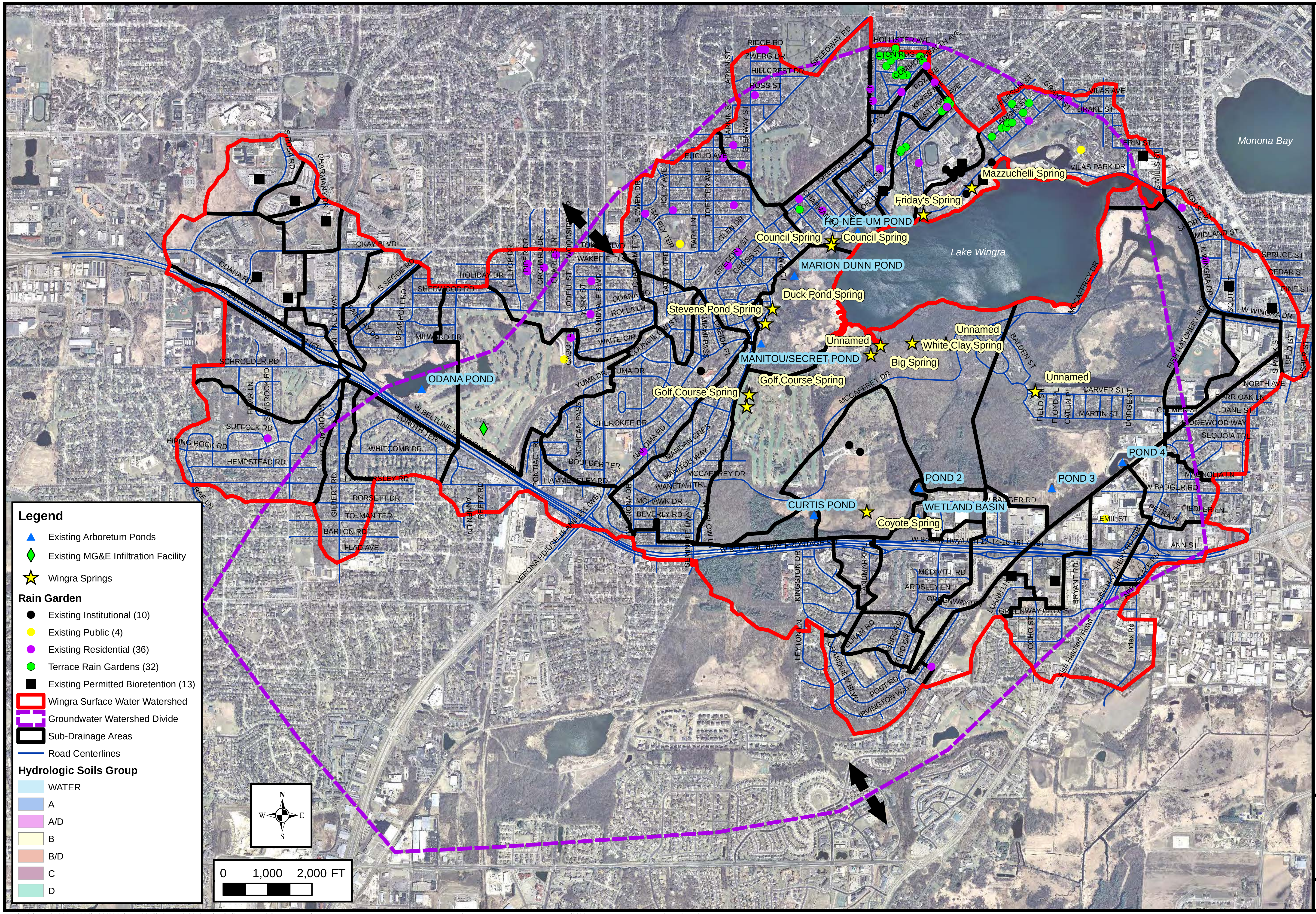

LAKE WINGRA WATERSHED SOILS
HYDROLOGIC SOIL GROUP

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FIGURE 3.03-3
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Path: S:\MAD\1000--1099\1020\065\Data\GIS\Figure 3.03-3 Lake Soils Map_HSG 11x17.mxd User: danc Date: 11/3/2015 Time: 9:17:37 AM

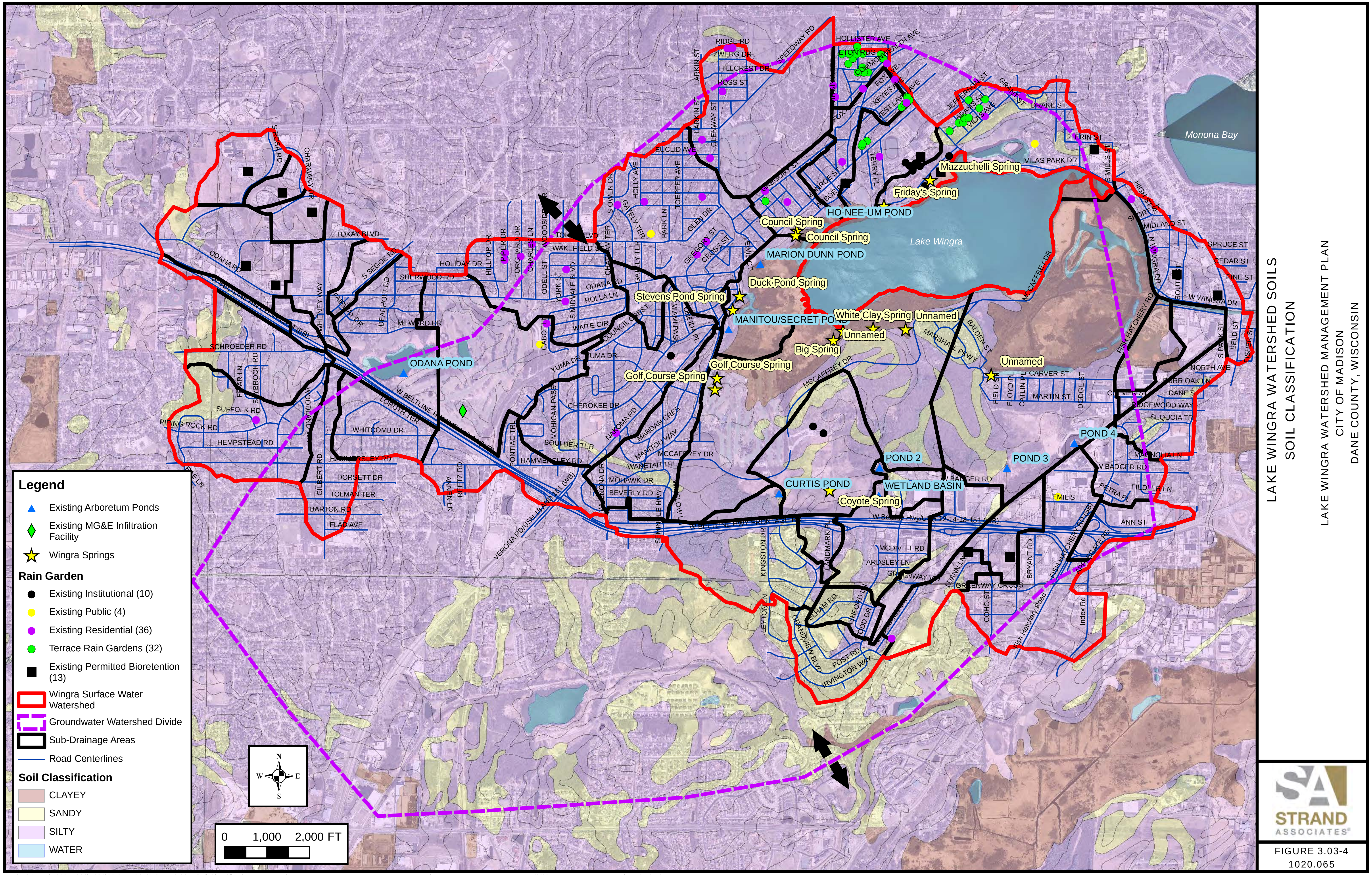

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Table 3.03-3 Wingra Watershed (Directly Draining to Lake) Soils

Symbol	Soil	HSG	Percent of Watershed
BbA	Batavia Silt Loam, Gravelly Substratum, 0 to 2 Percent Slopes	B	0.26%
BbB	Batavia Silt Loam, Gravelly Substratum, 2 to 6 Percent Slopes	B	0.45%
BoB	Boyer Sandy Loam, 2 to 6 Percent Slopes	B	0.93%
BoC2	Boyer Sandy Loam, 6 to 12 Percent Slopes, Eroded	B	1.76%
BoD2	Boyer Sandy Loam, 12 to 20 Percent Slopes, Eroded	B	0.15%
DnB	Dodge Silt Loam, 2 to 6 Percent Slopes	B	28.24%
DnC2	Dodge Silt Loam, 6 to 12 Percent Slopes, Eroded	B	3.69%
DsB	Dresden Silt Loam, 2 to 6 Percent Slopes	B	2.30%
GsB	Grays Silt Loam, 2 to 6 Percent Slopes	B	5.08%
GsC2	Grays Silt Loam, 6 to 12 Percent Slopes, Eroded	B	0.43%
Ho	Houghton Muck	A/D	5.32%
KdC2	Kidder Loam, 6 to 12 Percent Slopes, Eroded	B	0.29%
KdD2	Kidder Loam, 12 to 20 Percent Slopes, Eroded	B	1.84%
KeB	Kegonsa Silt Loam, 2 to 6 Percent Slopes	B	1.02%
KrD2	Kidder Soils, 10 to 20 Percent Slopes, Eroded	B	0.28%
Mc	Marshan Silt Loam	B/D	0.03%
MdC2	McHenry Silt Loam, 6 to 12 Percent Slopes, Eroded	B	14.68%
MdD2	McHenry Silt Loam, 12 to 20 Percent Slopes, Eroded	B	0.53%
MhC2	Military Loam, 6 to 12 Percent Slopes, Eroded	B	1.15%
MhD2	Military Loam, 12 to 20 Percent Slopes, Eroded	B	0.66%
Os	Orion Silt Loam, Wet	B/D	0.68%
Pa	Palms Muck	A/D	0.28%
RaA	Radford Silt Loam, 0 To 3 Percent Slopes	B	0.04%
RpE	Rodman Sandy Loam, 12 to 35 Percent Slopes	A	0.02%
SaA	Sable Silty Clay Loam, 0 to 3 Percent Slopes	B/D	3.31%
ScA	St. Charles Silt Loam, 0 to 2 Percent Slopes	B	0.38%
ScB	St. Charles Silt Loam, 2 to 6 Percent Slopes	B	9.11%
ScC2	St. Charles Silt Loam, 6 to 12 Percent Slopes, Eroded	B	3.06%
SfA	Salter Silt Loam, 0 to 2 Percent Slopes	B	0.13%
SfB2	Salter Silt Loam, 2 to 6 Percent Slopes, Eroded	B	0.45%
ShA	Salter Sandy Loam, Wet Variant, 0 to 3 Percent Slopes	C	0.96%
SpC	Spinks And Plainfield Loamy Sands, 6 to 12 Percent Slopes	A	0.05%
TrB	Troxel Silt Loam, 1 to 3 Percent Slopes	B	0.50%
VrB	Virgil Silt Loam, 1 to 4 Percent Slopes	B	1.70%
VwA	Virgil Silt Loam, Gravelly Substratum, 0 to 3 Percent Slopes	B	3.82%
W	Water Greater Than 40 Acres	D	1.15%
Wa	Wacousta Silty Clay Loam	B/D	5.27%
		Total	100%

[1]HSG = Hydrologic soils group

D. Infiltration Rate Analysis

According to preliminary results of the Dane County Regional Groundwater Model presented by Mike Parsen of WGNHS on June 28, 2013, the calibrated recharge rate for lands within the Wingra Watershed based on soil-water balance modeling is generally in the range of 6.1 to 8 inches per year as shown in Figure 3.03-5. This means that of the average annual 34.2 inches of rainfall, approximately 6.1 inches to 8 inches per year would infiltrate into the ground from pervious areas and contribute to groundwater flows. (i.e., 6.1 inches/year = 0.00069 in/hr) However, this infiltration performance is different from the estimated infiltration rate of soils. The estimated infiltration rate for soils in the watershed (directly draining to lake) is included in Tables 3.03-4, 3.03-5, and 3.03-6 and Figures 3.03-6, 3.03-7, and 3.03-8. Table 3.03-4 is based on designated WDNR Infiltration Rates for various soil types. Tables 3.03-5 and 3.03-6 are based on saturated hydraulic conductivity rates published by NRCS for different soils types at the ground surface and at a 3-foot depth, respectively. For purposes of infiltration modeling for this plan, proposed infiltration BMPs are analyzed using a range of infiltration rates (0.3, 0.5, and 1.0 in/hr) to provide a range of possible performance since site-specific data was not available.

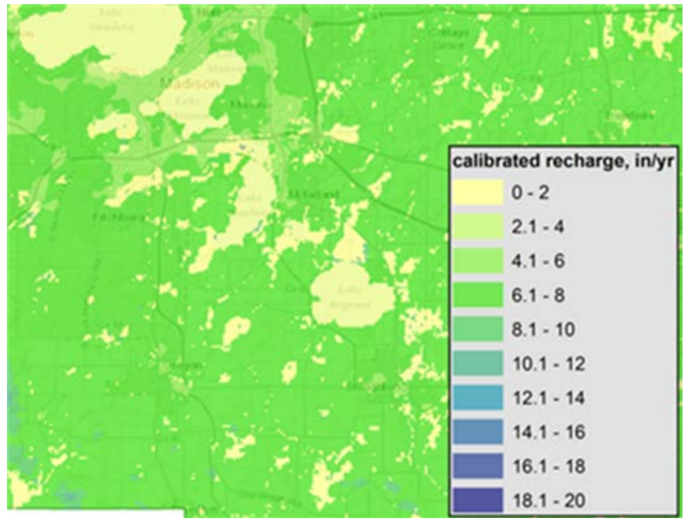


Figure 3.03-5 Modeled Recharge Rates–Dane County Regional Groundwater Model

WDNR Infiltration Rate (in/hr)	Total Acres	Percent
0.00	41	1%
0.04	306	8%
0.07	190	5%
0.13	**2,802**	**77%**
0.24	153	4%
0.50	136	4%
1.63	5	0%
Total	3,634	100%

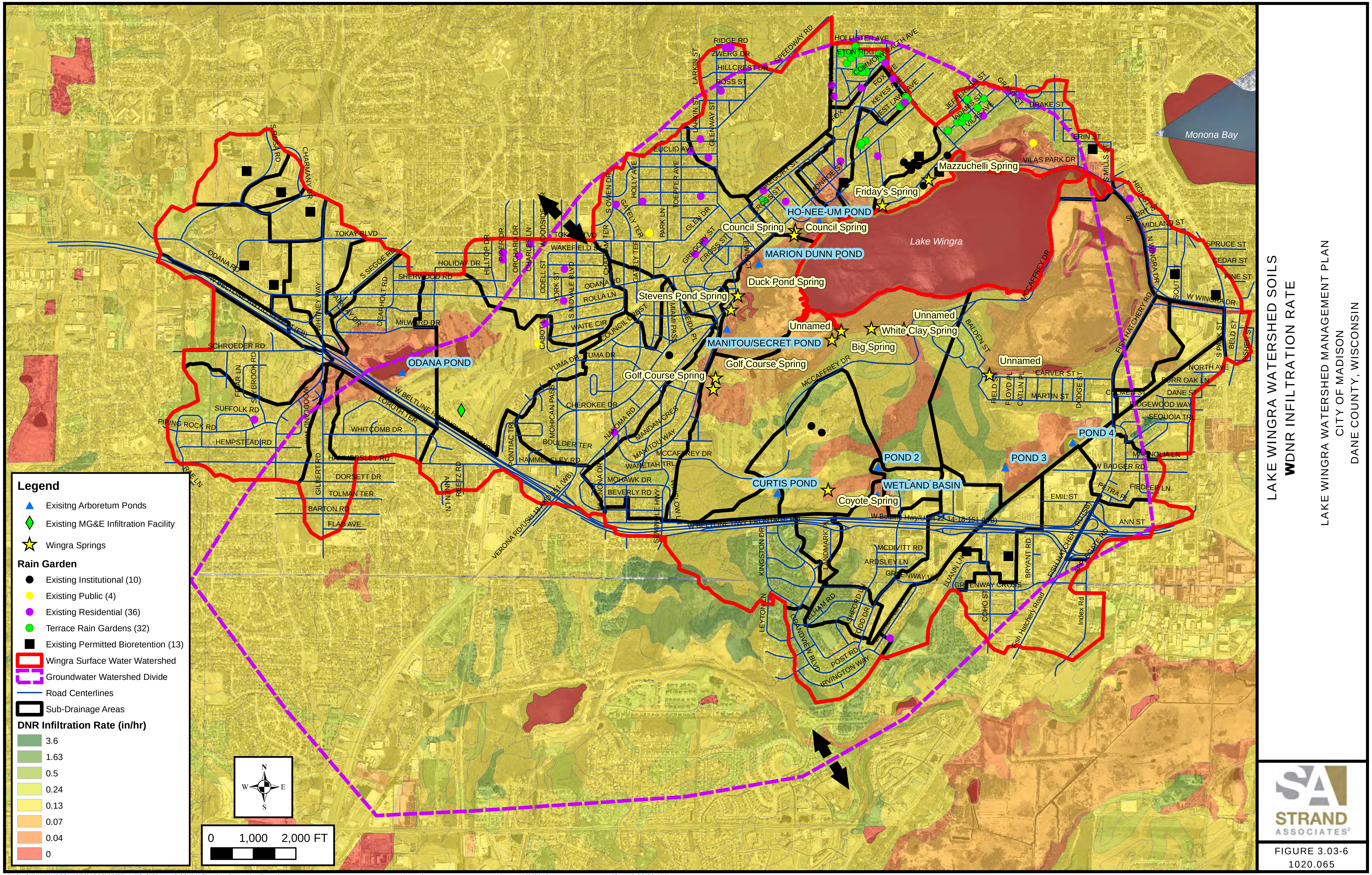
Table 3.03-4 Lake Wingra Watershed WDNR Infiltration Rate

Infiltration Rate (in/hr)	Total Acres	Percent
0.00	41	1%
1.28	**3,251**	**89%**
3.12	200	5%
3.97	136	4%
13.04	5	0%
Total	3,634	100%

Table 3.03-5 Lake Wingra Watershed Surface Ksat Rate

Infiltration Rate (in/hr)	Total Acres	Percent
0.00	41	1%
1.28	**2,444**	**67%**
1.34	34	1%
1.91	16	0%
1.92	9	0%
3.12	**223**	**6%**
3.97	**740**	**20%**
13.04	89	2%
19.98	37	1%
Total	3,634	100%

Table 3.03-6 Lake Wingra Watershed 3-Foot Depth Ksat Rate



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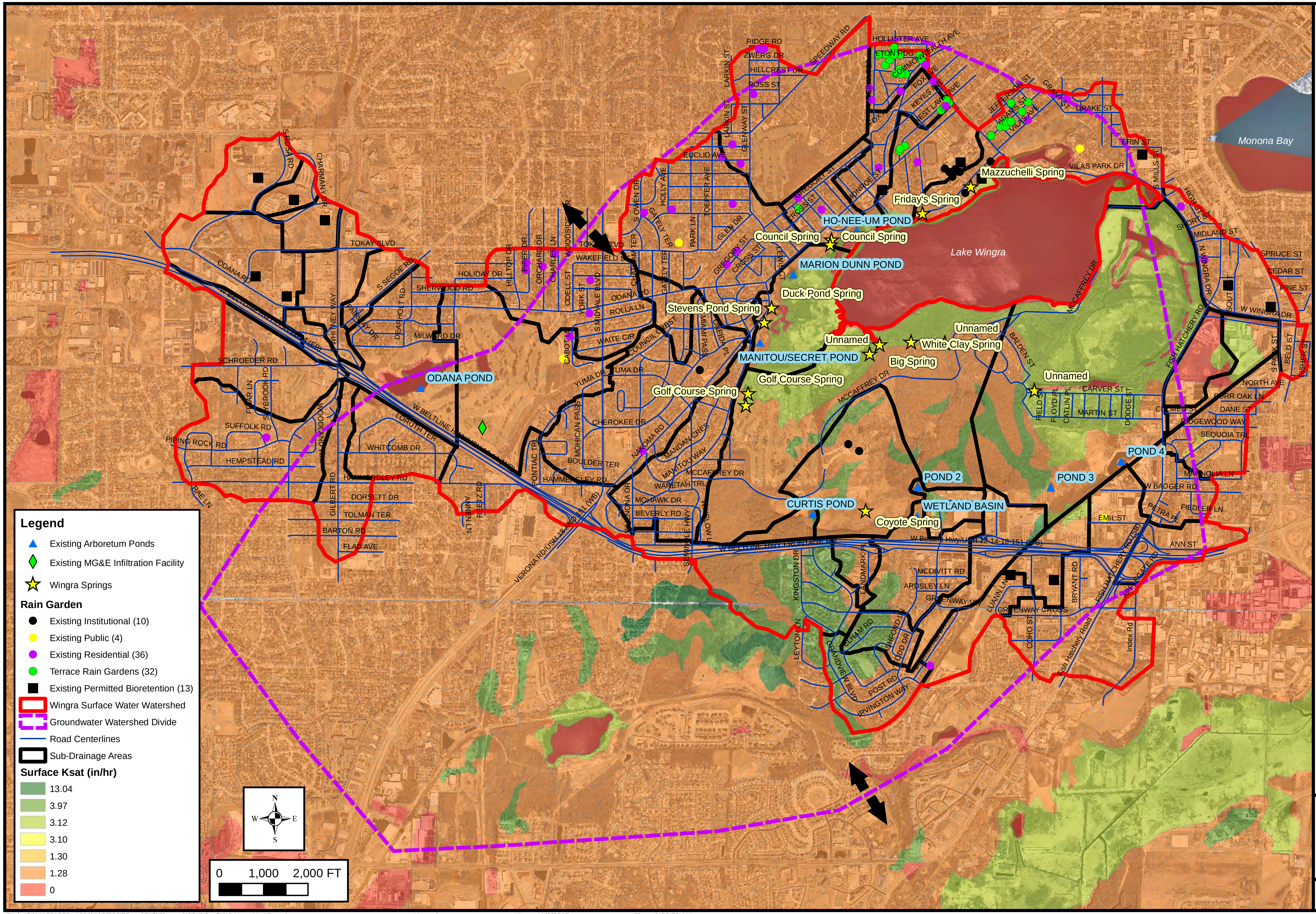

LAKE WINGRA WATERSHED SOILS
SURFICIAL SATURATED HYDRAULIC CONDUCTIVITY

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FIGURE 3.03-7
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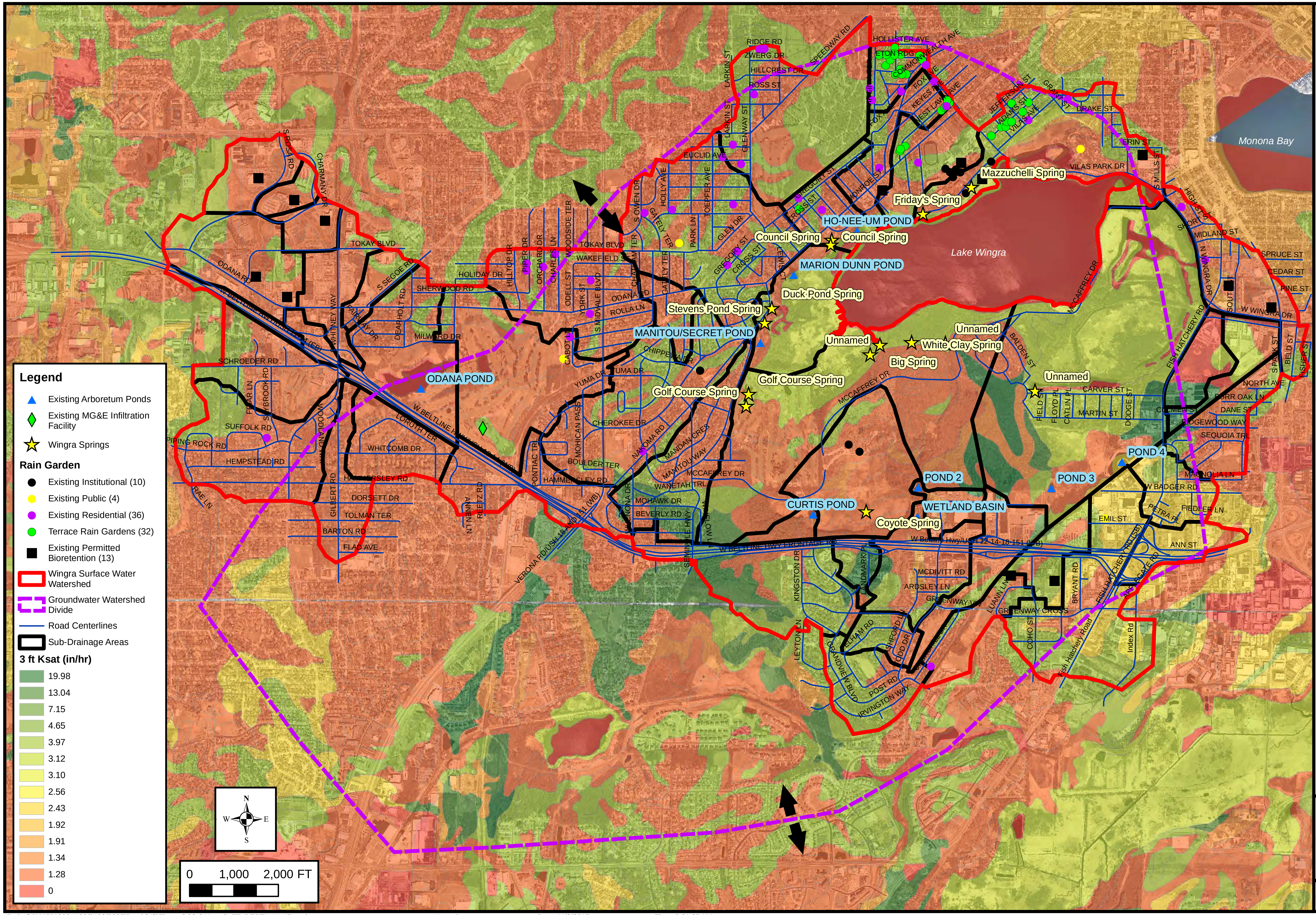

LAKE WINGRA WATERSHED SOILS
3-FOOT DEPTH SATURATED HYDRAULIC CONDUCTIVITY

LAKE WINGRA WATERSHED MANAGEMENT PLAN
CITY OF MADISON
DANE COUNTY, WISCONSIN

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FIGURE 3.03-8
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E. Surface Runoff Amount

The City provided Strand a Program for Predicting Polluting Particle Passage Thru Pits, Puddles, and Ponds (P8) model that was used to estimate the average annual runoff from the watershed. Utilizing the Mdsn6095.pcp and Mdsn6095.tmp precipitation and temperature files, respectively, the P8 models were run from October 1, 1980, to September 30, 1981, to simulate the average annual runoff from the watershed. The P8 model predicts that the average annual runoff is 82,842,408 ft^3. For purposes of comparison, the USGS/WDNR WinSLAMM model was obtained that indicates the average annual runoff is approximately 84,501,324 ft^3 (after adjusting to match the watershed areas between the two models), which compares well with the P8 results.

F. Groundwater Flow to Lake Wingra

Based on groundwater modeling completed by the WGNHS and documented in an August 30, 2013, letter from WGNHS to Strand, the estimate of annual average groundwater flow to Lake Wingra is 31,636,725 ft^3 as shown in Table 3.03-7. This estimate does not include the infiltration from the MG&E Infiltration Facility at the Odana Hills Golf Course. Previously, a rate of 37,892,637 ft^3 was used as published in Table 1 of the article *Responses to Urbanization: Groundwater, Stream Flow, and Lake Level Responses to Urbanization in the Yahara Lakes Basin* published in the Winter 2005 Lakeline Magazine by Ken Bradury et. al. It was confirmed with Mike Parsen of the WGNHS that this estimate also does not include the infiltration from the MG&E Infiltration Facility at the Odana Hills Golf Course. This article indicates that current groundwater flow to the lake represents a 64 percent reduction from historic flow rates.

Item	Volume (cubic feet)
Groundwater Flow to Lake (Springs)	22,674,530
Groundwater Flow to Lake (Seepage)	16,335,575
Total	**39,010,105**
Groundwater Outflow From Lake (Seepage)	7,373,380
Net Groundwater Inflow to Lake	31,636,725

Table 3.03.7 WGNHS Groundwater Estimates

G. Infiltration Goal

As shown in Table 3.03-8, the City's P8 model estimates annual percolation/infiltration volume under existing and predevelopment conditions. This analysis shows that approximately 26 percent of the predevelopment infiltration volume has been lost resulting from development in the watershed. A realistic short-term goal is shown in Table 3.03-8 as well as a long-term goal to serve as a vision for further improvement.

Condition	Volume (cubic feet)
Predevelopment Conditions	377,634,700
Existing Conditions	278,400,672
Reduction (Lost Infiltration)	99,234,028
Percent Reduction	26.3%
Short-Term Goal: 10 Percent of Lost Infiltration	*9,923,403*
Long-Term Goal: 25 Percent of Lost Infiltration	*24,808,507*

Table 3.03-8 Watershed Percolation/Infiltration Rate

H. Existing Infiltration Facilities In Watershed

The Wingra Watershed is currently home to one of the highest densities of infiltration facilities in the City (see Figure 3.03-9). These facilities include private rain gardens, street terrace rain gardens, permitted private bioretention basins, and the MG&E Infiltration Facility at the Odana Hills Golf Course and a public infiltration facility. A description of each follows. The total estimated existing annual average infiltration volume resulting from these facilities is in the range of 3.75 million ft^3 as shown in Table 3.03-9. This leaves an infiltration gap in the range of 6.17 million ft^3 that needs to be made up by proposed additional infiltration facilities to meet the short-term goal.

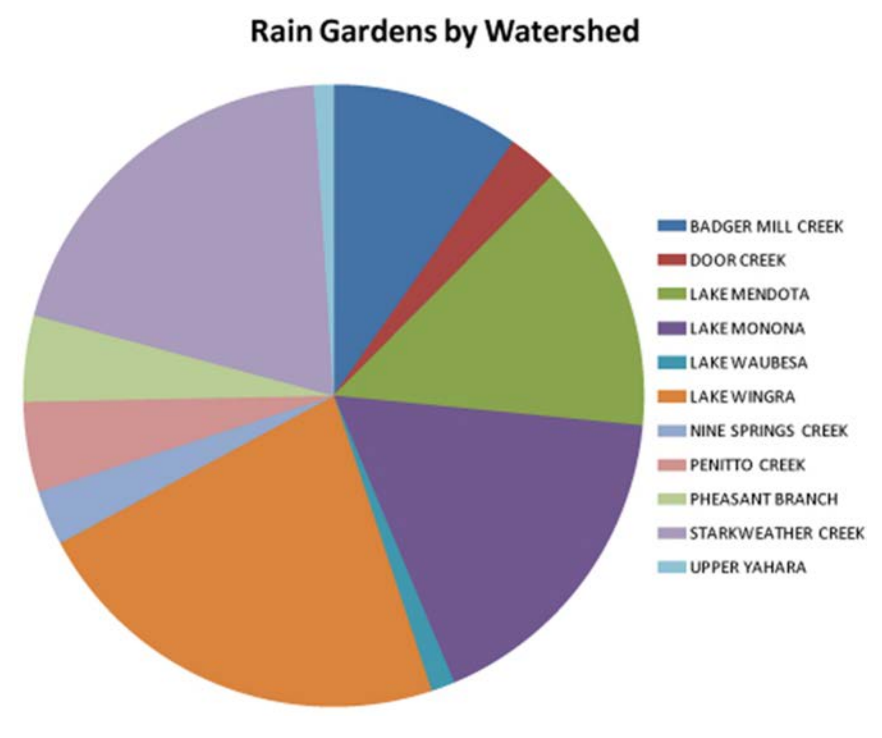


Figure 3.03-9 Rain Gardens By Watershed

	Infiltration Performance (ft^3) at Varying Infiltration Rates		
Facility	**0.3 in/hr**	**0.5 in/hr**	**1.0 in/hr**
Structural Improvements			
36 Existing Residential Rain Gardens	37,636	39,204	40,772
4 Existing Public Rain Gardens (City of Madison)	14,462	15,682	16,901
10 Existing Institutional Rain Gardens (Arboretum, Edgewood College, Henry David Thoreau School)	36,155	39,204	42,253
32 Existing Terrace Rain Gardens	9,757	9,757	11,151
13 Existing Permitted Bioretention Basins	47,001	50,965	54,929
Odana Hills Golf Course: MG&E Infiltration Facility	3,600,000	3,600,000	3,600,000
Total	**3,745,011**	**3,754,812**	**3,766,007**
Short-Term Goal: 10 Percent of Lost Infiltration	*9,923,403*	*9,923,403*	*9,923,403*
Infiltration Gap	*6,178,392*	*6,168,591*	*6,157,396*

Table 3.03-9 Infiltration Performance of Existing Infiltration Facilities in Watershed

1. Rain Gardens–The City administers the 1,000 Rain Gardens project that encourages and tracks rain gardens in the City. To date, the City has registered 523 rain gardens, of which 36 are in the Lake Wingra Watershed as shown on each of the figures in this section. Figure 3.03-10 shows an example of a rain garden serving a residential roof area.

Source: Roger Bannerman

Figure 3.03-10 Wingra Watershed Rain Garden Example

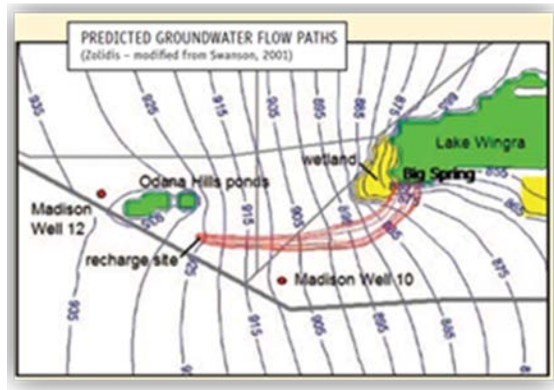
Figure 3.03-11 Adams Street Terrace Rain Garden Project

2. Terrace Rain Gardens–Originally initiated as the Adams Street Terrace Rain Garden (see Figure 3.03-11) project in 2005, the City's program has been formalized as the Terrace Rain Garden Program. The City offers cost-sharing to homeowners who are interested in participating in this volunteer program along City street terraces. It is

our understanding the City has installed 32 terrace rain gardens (according to City GIS identified as Public) in the Lake Wingra Watershed.

3. Permitted Private Bioretention Basins–To date, the City has a record of thirteen bioretention facilities in the watershed at locations shown on each of the GIS figures in this section.

4. MG&E Infiltration Facility at Odana Hills Golf Course–The MG&E Infiltration Facility is located in the Odana Hills Golf Course. This facility is predicted to increase flows to Big Spring as shown in Figure 3.03-12. This facility performed at the levels shown in Table 3.03-10 between 2005 and 2012. While the average annual infiltration volume from 2006 to 2012 is 5,862,867 cubic feet per year (ft^3/year), concerns with chloride contamination surfaced in 2011. This concern prompted a seasonal modified operation of the facility that calls for a reduced volume of infiltration moving forward. According to conversations with David Benforado of MG&E on July 25, 2013, MG&E is comfortable using the 2011 performance of approximately 3.6 million ft^3 as the annual average surface water infiltration per year. For purposes of the Wingra Watershed Plan, the 3.6 million ft^3 of annual average surface water infiltration is used. It should be noted that MG&E, as part of their cogeneration permit, was supposed to infiltrate 80,000,000 gallons (10.7 million ft^3) per year. It appears that MG&E is obligated to meeting that permit requirement, perhaps through contribution towards another facility in the Wingra watershed.



Source: Nancy Zolidis

Figure 3.03-12 MG&E Infiltration Facility Projected Groundwater Flow Path

Year	Infiltration (million gallons)	Infiltration (ft³)	Rainfall (inches)		Well (million gallons)	Well (ft³)
2005	0	0	24.7		14	1,871,534
2006	18	2,406,258	36.6		7	935,767
2007	55	7,352,455	44.3		30	4,010,430
2008	71	9,491,351	44.0		0	0
2009	60	8,020,860	38.2		0	0
2010	58	7,753,498	37.9		0	0
2011	27	3,609,387	30.3		16	2,138,896
2012	18	2,406,258	26.2		154	20,586,874
Total	307	41,040,067			221	29,543,501
Average	**43.86**	**5,862,867**	**35.3**	**Average**	**29.57**	**3,953,138**

Table 3.03-10 WWCF Water Mitigation

5. Westmorland Park Infiltration Facility–The City constructed a bioretention basin in Westmorland Park. This basin is modeled as a pond in the City's P8 model, and therefore, no infiltration performance is listed. This facility is proposed to be expanded as one of the alternative components and will be modeled for infiltration performance.

I. Proposed Infiltration Facilities In Watershed

The following is a listing of additional infiltration facilities that have the potential to incrementally increase infiltration in the watershed. All facilities will also provide a certain level of phosphorus reduction. Table 3.03-11 lists twelve potential infiltration facilities and their corresponding infiltration performance as modeled in P8. As can be seen, all facilities would need to be constructed in order to generally meet the short-term infiltration goal. As shown on Figure 3.02-4, the Lake Wingra groundwater watershed extends only approximately two-thirds of the way to the western boundary of the surface water watershed. For this reason, additional source-area-type BMPs (downspout disconnection program, rain barrel program, private residential rain gardens, commercial rain gardens, porous pavement, and terrace rain gardens) should be targeted for the eastern two-thirds of the surface water watershed and within the Lake Wingra groundwater watershed.

At the public meeting for this project, it was suggested that interpretive signage be included on all structural practices to engage the public.

Facility	Infiltration Performance (ft3) at Varying Infiltration Rates 0.3 in/hr	0.5 in/hr	1.0 in/hr	% of Total	OPCC	Total 20-Year Present Worth	20-Year NPW Cost/cf
Structural Improvements							
Westmorland Park Bioretention Basin	374,616	431,244	557,568	6.9%	$ 249,300	$ 367,640	$ 0.04
Downspout Disconnection Program (35% Watershed Participation)	950,893	950,893	950,893	15.2%	$ 466,900	$ 877,124	$ 0.05
Rain Barrel Program (25% Watershed Participation)	339,605	339,605	339,605	5.4%	$ 151,600	$ 377,697	$ 0.06
1,000 Private Residential Rain Gardens (Serving Roofs Only)	1,045,440	1,089,000	1,132,560	17.4%	$ 1,047,600	$ 1,654,205	$ 0.08
Devolis Park (Axel Avenue) Bioretention	239,580	248,292	261,360	4.0%	$ 331,200	$ 479,671	$ 0.10
Arbor Hills Greenway Infiltration *(@1.63 in/hr)*	535,788	535,788	535,788	8.6%	$ 883,500	$ 1,279,398	$ 0.12
Glenway Wet Pond & Infiltration	779,724	779,724	779,724	12.5%	$ 1,819,400	$ 1,952,764	$ 0.13
Grandview Boulevard Bioswale	326,700	335,412	344,124	5.4%	$ 612,100	$ 893,405	$ 0.13
60 Private Commercial Rain Gardens (Serving Roofs Only)	128,066	130,680	135,907	2.1%	$ 290,200	$ 417,396	$ 0.16
4 Acres Porous Pavement (Serving 12 acres)	888,624	888,624	888,624	14.2%	$ 2,471,413	$ 3,143,409	$ 0.16
Monroe Street Green Street	196,020	226,512	291,852	3.6%	$ 532,100	$ 835,587	$ 0.18
1,000 Terrace Rain Gardens	304,920	304,920	457,380	4.9%	$ 1,370,500	$ 2,184,378	$ 0.36
TOTAL	**6,109,976**	**6,260,694**	**6,675,385**	**100%**	**$ 10,225,813**	**$ 14,462,675**	**$0.11 (avg)**
Infiltration Gap to Meet Short-Term Goal	6,178,392	6,168,591	6,157,396				
Difference	-68,416	92,103	517,989				

Notes: OPCC = Planning level opinion of probable construction cost.
NPW=Net present worth
All costs are 1st Quarter 2014 dollars.

Table 3.03-11 Infiltration Performance and Cost-Effectiveness of Proposed Infiltration Facilities

1. City of Madison 1,000 Rain Garden Program–Continuation of this program will be instrumental in providing source area infiltration BMPs in the watershed for single-family residential and duplex land uses. This program could be expanded to the non-single-family residential and duplex sector (e.g., commercial, business, institutional, and multifamily residential). These programs are expected to serve mainly rooftops. Table 3.03-12 provides information on the opportunities for expansion of this program.

Land Use	Parcels in the Watershed	Rooftop Area (acres)
Residential (Single-Family and Duplex)	4,620	183
Nonresidential (Commercial, Business, Institutional, Multifamily Residential, and Institutional)	460	178

Table 3.03-12 Rain Garden Opportunities

For purposes of this plan, performance of residential and commercial rain gardens was evaluated with the assumptions shown in Table 3.03-13.

Measure	Assumptions
Private residential rain garden	▪ 6:1 watershed to rain garden area ratio ▪ Avg. residential roof area = 2,800 SF ▪ 1/4 of roof drains to rain garden ▪ 0.6 lbs of TP per acre of roof ▪ 0.5 in/hr infiltration rate ▪ Infiltration: 93% of annual runoff infiltrated ▪ Phosphorus: 93% reduction ▪ Participation: 22% (1,000) of residential parcels in watershed (4,620)
Commercial rain garden	▪ 6:1 watershed to rain garden area ratio ▪ Avg. commercial roof area = 5,600 SFf ▪ 1/4 of roof drains to rain garden ▪ 0.6 lbs of TP per acre of roof ▪ 0.5 in/hr infiltration rate ▪ Infiltration: 93% of annual runoff infiltrated ▪ Phosphorus: 93% reduction ▪ Participation: 13% (60) of non-residential parcels in watershed (460) ▪ Cost: Constructed as a bioretention basin with engineered soil and underdrain

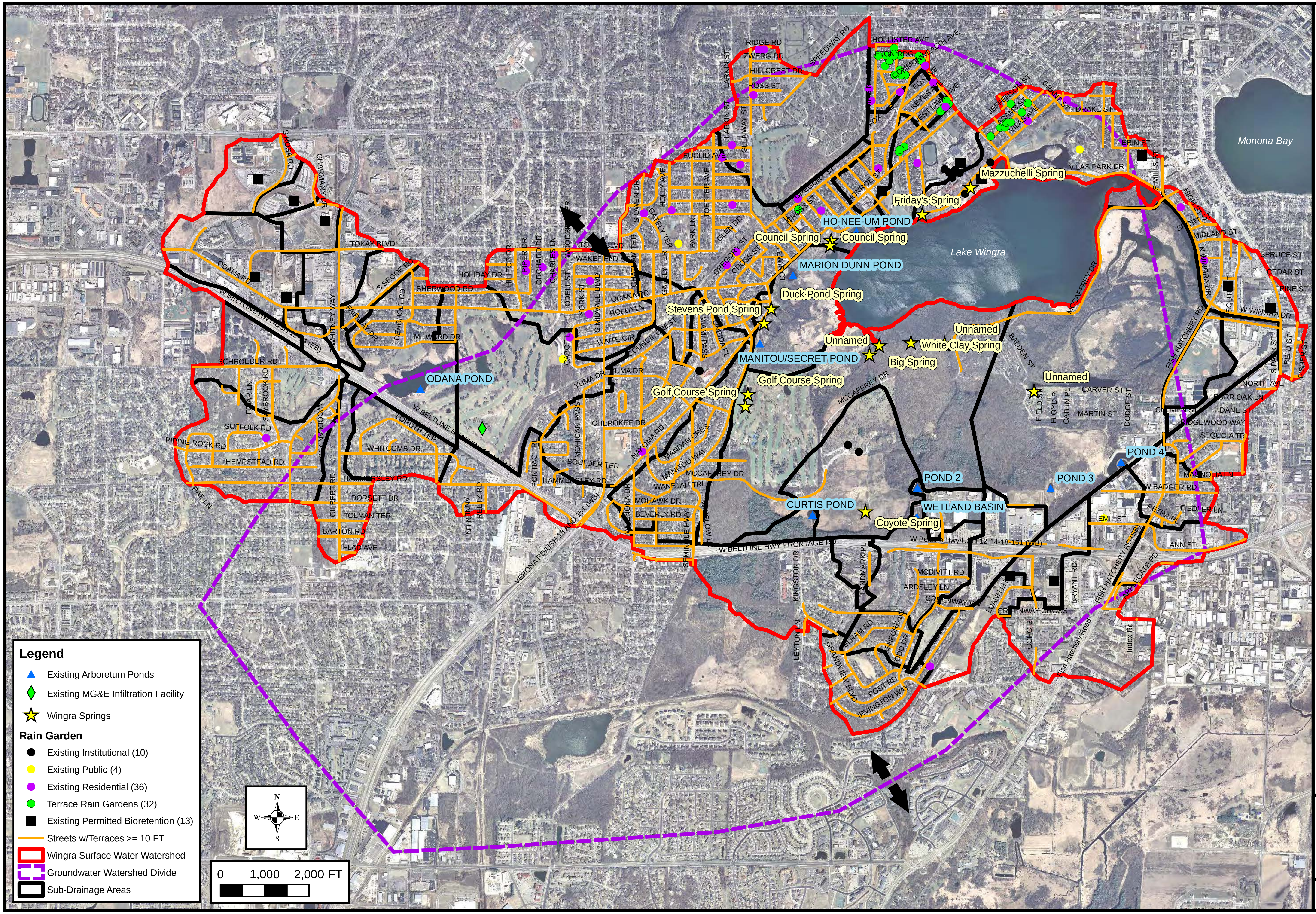
Table 3.03-13 Rain Garden Assumptions

It is recommended that the Infiltration and Phosphorus Catalyst Teams further investigate the assumptions used for the analysis shown in Table 3.03-13 and adjust the relative contribution of these measures toward meeting the short-term infiltration and phosphorus goals.

2. City of Madison Terrace Rain Garden Program–Continuation of this program will be instrumental in providing source area infiltration BMPs in the watershed that serve single-family residential and duplex land uses and portions of their associated public right-of-way. Figure 3.03-13 shows the location of streets in the watershed with terraces greater than or equal to 10 feet generally considered a minimum for implementation of terrace rain gardens. Figure 3.03-14 shows the location of streets in the watershed with terraces greater than or equal to 10 feet and a pavement rating less than 7, which allows for targeting implementation of terrace rain gardens because a rating less than 7 means the pavement is in a state of decline such that the road will likely be reconstructed or resurfaced sooner than higher rated streets.

   This program is incentivized by the City as the City pays for 75 percent of the construction cost (minus the cost of plants) and the homeowner pays for 25 percent of the construction cost (plus the cost of the plants). Costs are assessed to homeowners on their property tax bill.

   At the public information meetings, there was significant discussion regarding improvements to the City's existing program including enhancements of the City's promotion of terrace rain gardens to residents and additional opportunities because of terrace ash tree removals (potentially more opportunities for full terrace rain garden or more simply for depression of the terrace alongside tree removal). Additional discussion is included in Appendix F.



LAKE WINGRA WATERSHED
STREETS WITH TERRACES GREATER THAN OR EQUAL TO 10 FEET WIDE

LAKE WINGRA WATERSHED MANAGEMENT PLAN
CITY OF MADISON
DANE COUNTY, WISCONSIN

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FIGURE 3.03-13
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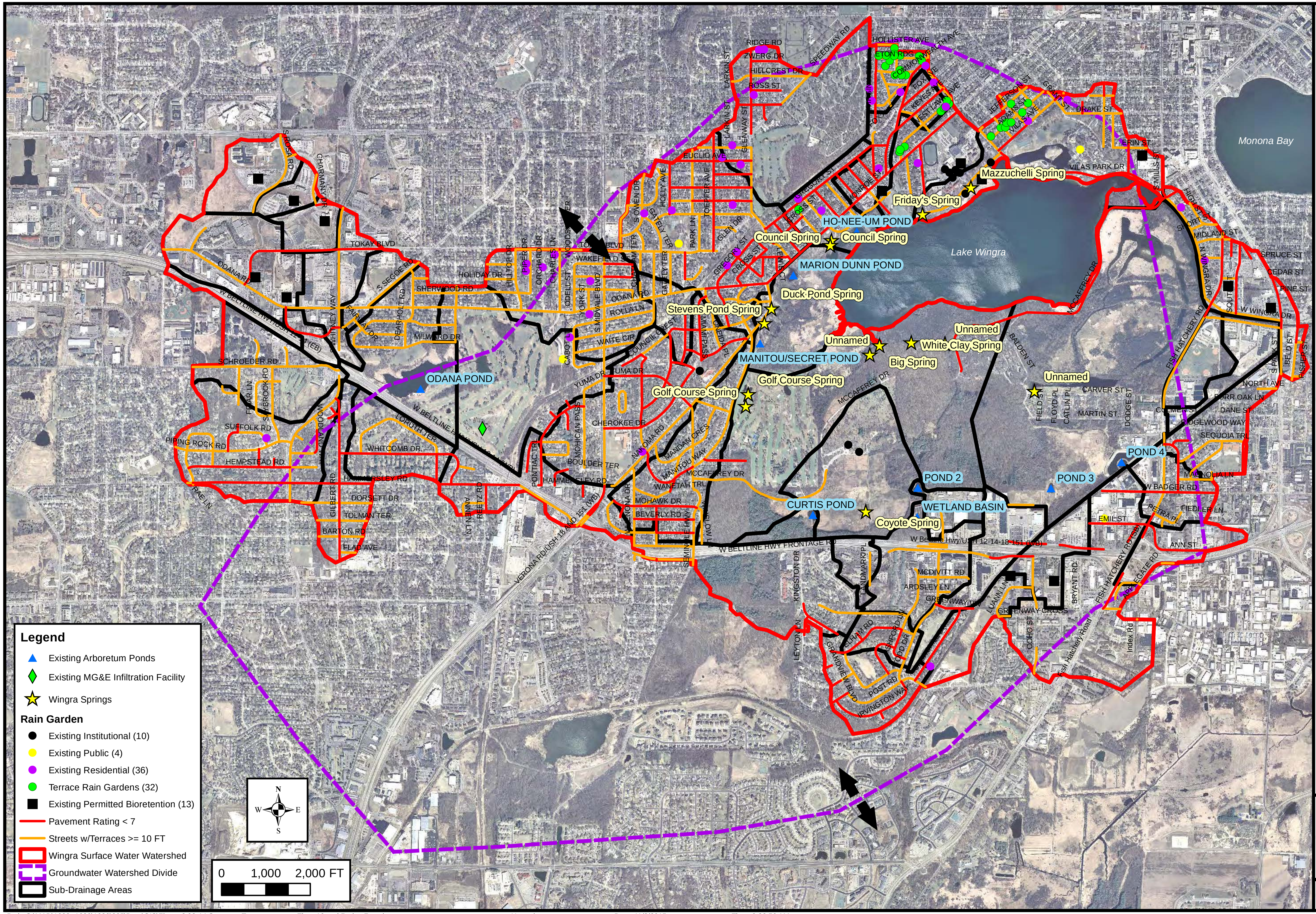

STREETS WITH TERRACES GREATER THAN OR EQUAL TO 10 FEET AND PAVEMENT RATING LESS THAN 7

LAKE WINGRA WATERSHED MANAGEMENT PLAN
CITY OF MADISON
DANE COUNTY, WISCONSIN

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FIGURE 3.03-14
1020.065

For purposes of this plan, performance of terrace rain gardens was evaluated with the assumptions shown in Table 3.03-14.

Measure	Assumptions
Terrace rain garden	▪ 12:1 watershed to terrace rain garden bottom area ratio ▪ Rain garden top footprint = 10 feet x 15 feet ▪ Rain garden bottom footprint = 2 feet x 10 feet ▪ 0.5 in/hr infiltration rate ▪ Infiltration: 78% of annual runoff infiltrated ▪ Phosphorus: 100% reduction ▪ Participation: 1,000 terrace rain gardens (4,620 residential parcels in watershed) ▪ Cost: Designed and constructed as part of City street reconstruction projects

Table 3.03-14 Terrace Rain Garden Assumptions

3. Porous Pavement–As redevelopment occurs, use of porous pavement (see Figure 3.03-15) in nonresidential land uses is effective in converting impervious surfaces to pervious surfaces. Whether using porous concrete, porous asphalt, or porous pavers, each technique requires a storage layer beneath the pavement and an underdrain pipe in addition to the surficial porous pavement. The WDNR has developed a Permeable Pavement Conservation Practice Standard 1008 that provides a guide for planning and design of these facilities. There appear to be opportunities for porous pavement installation at the southern end of the Odana Hills Golf Course Parking lot (approximately one-half acre) as well as generally at parks and locations of overflow parking. The City should consider a porous pavement program/strategy that incentivizes incorporation of porous pavement in redevelopment projects.

Figure 3.03-15 Porous Pavement

For purposes of this plan, performance of porous pavement was evaluated with the assumptions shown in Table 3.03-15.

Measure	Assumptions
Porous pavement	▪ 3:1 watershed to porous pavement ratio (e.g., runon) ▪ 4 acres of porous pavement serving 12-acre watershed ▪ 0.5 in/hr infiltration rate ▪ Constructed in eight 0.5-acre porous pavement projects ▪ Infiltration: 100% of annual runoff infiltrated ▪ Phosphorus: 100% reduction ▪ Cost: Incremental cost to install porous concrete pavement rather than traditional asphalt

Table 3.03-15 Porous Pavement Assumptions

4. Westmorland Park Bioretention–The existing depressional area where this existing facility is located presents an opportunity to expand the facility. Because of the large upstream watershed (86 acres), a diversion of flows from larger storm events around the basin may be advisable. Figure 3.03-16 shows a picture of the proposed bioretention area and Figure 3.03-17 shows the watershed draining to this area.

Figure 3.03-16 Proposed Westmorland Park Bioretention Area

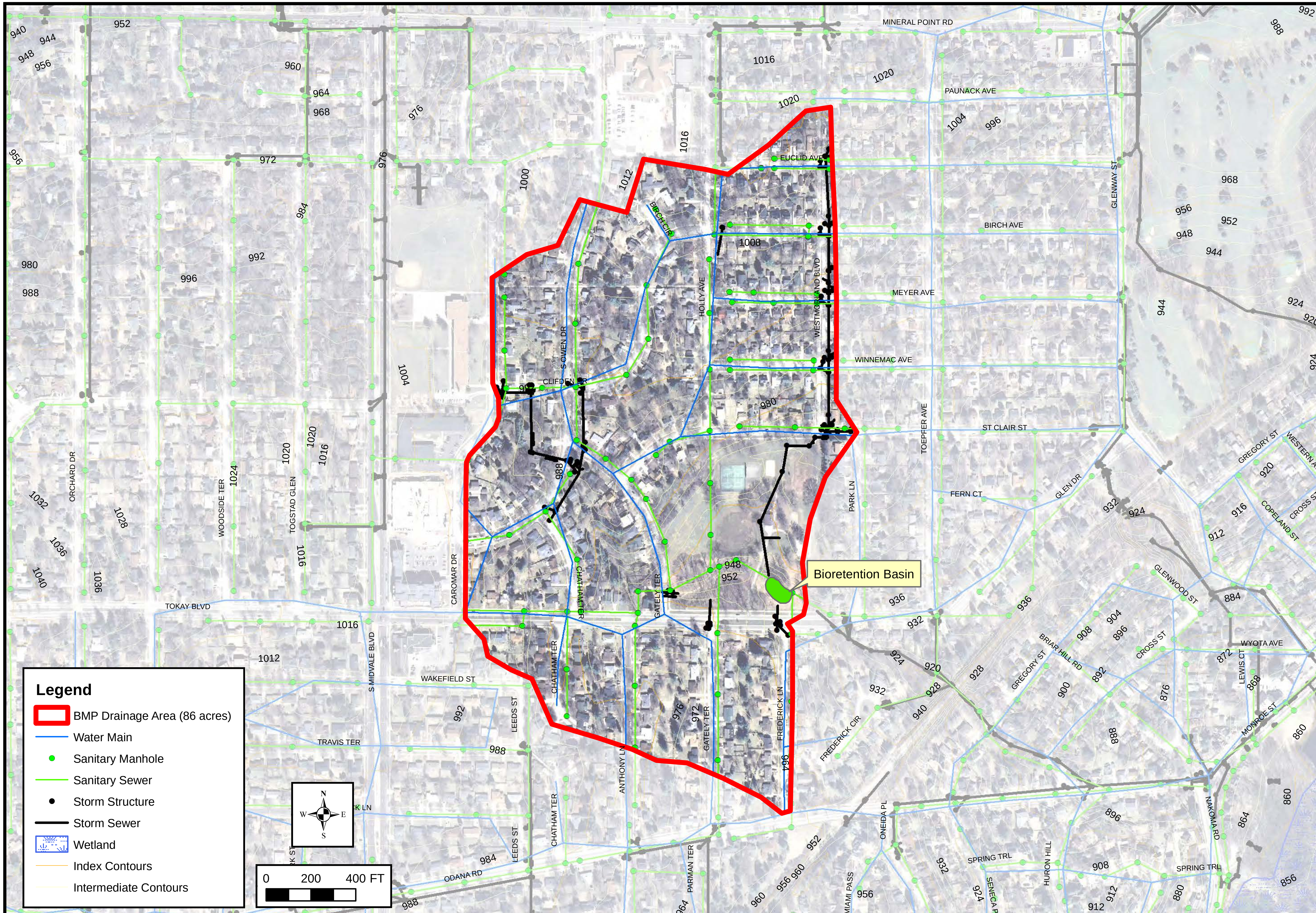
5. Arbor Hills Greenway Infiltration Facility–The City has planned for the construction of an infiltration facility in the Arbor Hills Greenway as shown in Figure 3.03-18. This project was originally analyzed in 2008 as a student report titled *Arbor Hills Greenway Stormwater Infiltration Design.*

6. Devolis Park (Axel Avenue) Bioretention Facility–This proposed project is within the Lake Wingra groundwater watershed but not in the surface water watershed. Therefore, the increased infiltration will affect Lake Wingra and the improved surface water quality will affect Wingra Creek downstream of the lake. Figure 3.03-19 shows a picture of the proposed bioretention area and Figure 3.03-20 shows the watershed draining to this area.

Figure 3.03-19 Proposed Devolis Park Bioretention Area

Figure 3.03-21 Proposed Grandview Boulevard Bioswale Area

7. Grandview Boulevard Bioswales–A unique opportunity presents itself along Grandview Boulevard where a boulevard approaching 40 feet in width could be depressed to create a series of bioretention swales. Figure 3.03-21 shows a picture of the proposed bioswale area, and Figure 3.03-22 shows the watershed draining to this area. *This project is located in the Town of Madison.*



WESTMORLAND PARK
BIORETENTION BASIN

LAKE WINGRA WATERSHED MANAGEMENT PLAN
CITY OF MADISON
DANE COUNTY, WISCONSIN

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FIGURE 3.03-17
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ARBOR HILLS
INFILTRATION BASIN

LAKE WINGRA WATERSHED MANAGEMENT PLAN
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DANE COUNTY, WISCONSIN

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FIGURE 3.03-18
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DEVOLIS PARK
BIORETENTION BASIN

LAKE WINGRA WATERSHED MANAGEMENT PLAN
CITY OF MADISON
DANE COUNTY, WISCONSIN

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FIGURE 3.03-20
1020.065

GRANDVIEW BOULEVARD
BIORETENTION SWALES

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DANE COUNTY, WISCONSIN

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FIGURE 3.03-22
1020.065

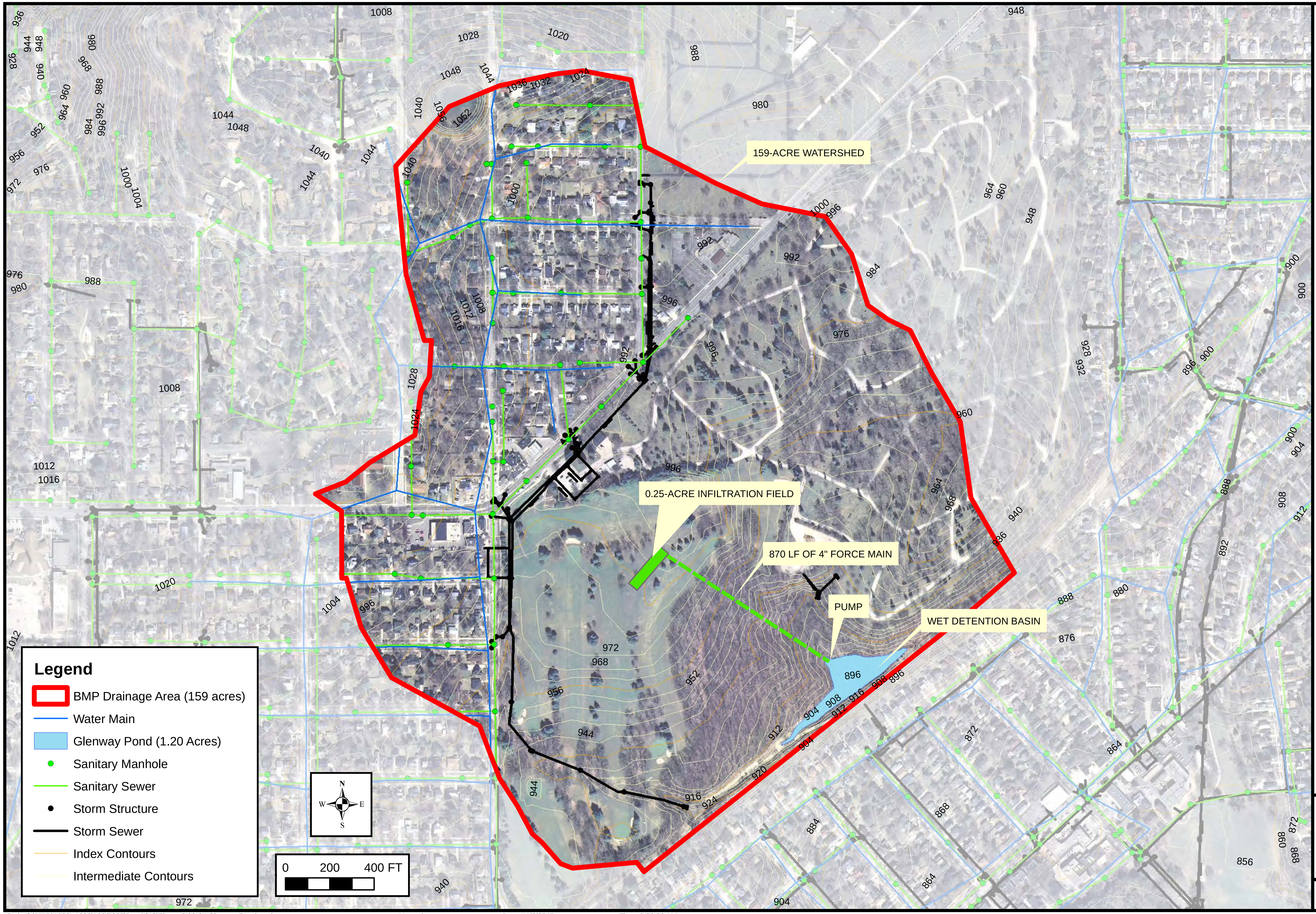
Path: S:\MAD\1000--1099\1020\065\Data\GIS\Figure 3.03-22 Grandview Blvd.mxd User: danc Date: 11/3/2015 Time: 9:37:33 AM

8. Glenway Golf Course Infiltration Facility–Similar to the MG&E Infiltration Facility in the Odana Golf Course, this proposed project would include a wet detention basin that would pretreat stormwater prior to pumping up to an infiltration area on the golf course. Sizing of this facility is similar to the sizing of the MG&E Infiltration Facility. It is our understanding there are existing groundwater seepage into basement issues downstream of this proposed facility that would need to be addressed. Figure 3.03-23 shows an aerial view of the proposed facility, and Figure 3.03-24 shows the watershed draining to this area.

Figure 3.03-23 Proposed Glenway Golf Course Infiltration Facility

9. Monroe Street Reconstruction with Green Features–The City is planning to reconstruct Monroe Street in 2017 with design beginning in 2014. This project presents opportunities for incorporation of green features such as bioretention planters and bioretention bumpouts for traffic calming/pedestrian refuge to provide both infiltration and stormwater quality improvement. Our analysis assumes that the reconstruction project will seek to achieve a 53 percent total suspended solids (TSS) reduction along the corridor and corresponding 29 percent TP reduction. Figure 3.03-25 and 3.03-26 show three examples of bioretention features integrated into street redevelopment projects that Strand has been involved with. Figure 3.03-27 shows the watershed draining to the Monroe Street corridor. At the public information meetings for this project, it was suggested that redevelopment and street recostruction projects be required to provide infiltration even though current ordinances do not require infiltration for these project types.

Figure 3.03-25 Examples of Bioretention Planters for Street Reconstruction



GLENWAY GOLF COURSE
WET DETENTION BASIN AND INFILTRATION

LAKE WINGRA WATERSHED MANAGEMENT PLAN
CITY OF MADISON
DANE COUNTY, WISCONSIN

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FIGURE 3.03-24
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Path: S:\MAD\1000--1099\1020\065\Data\GIS\Figure 3.03-24 Glenway Pond.mxd User: danc Date: 11/3/2015 Time: 9:38:26 AM

Figure 3.03-26 Example of Bioretention with Traffic Calming/Pedestrian Refuge in Aurora, Illinois

10. Rain Barrels and Downspout Disconnection

Figure 3.03-28 Rain Barrel Example

There have been various initiatives seeking to increase infiltration through installation of rain barrels and downspout disconnection (redirecting a downspout from draining over impervious area to over pervious area). Sustain Dane was instrumental in selling and installing rain barrels from 2005 to 2011, when they sold the business now known as RainReserve. The City of Madison now promotes and provides guidance (including a link to purchasing the Rain Reserve system) on rain barrel installation on its Stormwater Management webpage. Figure 3.03-28 shows an example of a rain barrel. The Madison Area Municipal Storm Water Partnership (MAMSWAP) also maintains a myfairlakes.com webpage that has a rain barrel page and a page regarding downspout disconnection. Downspout disconnection refers to the redirection of a downspout from a impervious area to a pervious area, thus disconnecting from the impervious area that would convey flows quickly downstream.

For purposes of this plan, performance of rain barrels and downspout disconnection was evaluated with the assumptions shown in Table 3.03-16.

MONROE STREET
STREET CONSTRUCTION WITH GREEN FEATURES

LAKE WINGRA WATERSHED MANAGEMENT PLAN
CITY OF MADISON
DANE COUNTY, WISCONSIN

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FIGURE 3.03-27
1020.065

Path: S:\MAD\1000--1099\1020\065\Data\GIS\Figure 3.03-27 Monroe Street.mxd User: danc Date: 11/3/2015 Time: 9:39:21 AM

Measure	Assumptions
Rain barrels	▪ Avg. residential roof area = 2,800 SF ▪ 1/4 of roof drains to disconnected downspout(s) ▪ 50% of annual runoff stored by rain barrel ▪ 50% of rain barrels are maintained ▪ Infiltration: Runoff stored assumed to infiltrate ▪ Phosphorus: 25% of TP in stored runoff runs off after next rain event ▪ Participation: 25% of the 4,620 residential parcels in the watershed
Downspout disconnection	▪ Avg. residential roof area = 2,800 SF ▪ 1/4 of roof drains to disconnected downspout(s) ▪ 100% of annual runoff from 1/4 of roof area drained to lawn area ▪ Infiltration: 50% of annual runoff infiltrates and 50% continues on as runoff ▪ Phosphorus: 50% of annual runoff infiltrates and 50% continues on as runoff with associated TP load ▪ Participation: 35% of the 4,620 residential parcels in the watershed

Table 3.03-16 Rain Barrel and Downspout Disconnection Assumptions

It is recommended that the Infiltration and Phosphorus Catalyst Teams further investigate the assumptions used for the analysis shown in Table 3.03-16 and adjust the relative contribution of these measures toward meeting the short-term infiltration and phosphorus goals.

3.04 ALTERNATIVES ANALYSIS

A. Alternatives Analysis Overview

This section discusses alternatives analyzed to meet the short-term infiltration goal of recovering 10 percent of the infiltration lost to development. All the projects identified would need to be completed to achieve the goal, depending on the infiltration rate of in situ soils. Table 3.03-11 shows the cost-effectiveness of each project in terms of a 20-year net present worth cost per cubic foot of infiltrated stormwater. As can be seen, there is a wide range of cost-effectiveness. This information allows for prioritizing project implementation. It is envisioned that the most cost-effective projects would be completed first.

Costs presented were estimated using historical bid costs, where available, and supplemented by other reference sources. All estimated project costs include allowances for engineering and contingencies and soils investigation where necessary. Land acquisition or easement costs, if needed, have not been included. The goal of this section is to provide the City personnel with the information required to initiate the budgeting and planning phase for facilities improvements. All costs are presented in 1st quarter 2014 dollars. Future construction costs should be adjusted for inflation when final project schedules are determined. Opinions of probable construction cost will be updated during the design phase; Appendix B contains detailed cost spreadsheets.

The costs for excavation assume there will be off-site disposal of the excavated material. If an on-site source of disposal is identified, this cost would be reduced. As appropriate, costs for soil investigation and wetland delineation are included. This information will provide important design information and determine regulatory constraints.

B. Long-Term Goal Discussion

The long-term infiltration goal is to recover 25 percent of the infiltration lost to development. This is an ambitious goal that will serve to guide future efforts to increase infiltration in the watershed. Achievement of the goal may take major shifts in development patterns (e.g., conversion of curb and gutter streets to drainage via grass-lined swales), major implementation of source area infiltration BMPs (1000s of rain gardens in the watershed) and/or identification and implementation of additional larger infiltration projects in the watershed. Regardless of the goal, increasing infiltration in the watershed may increase the potential for basement groundwater flooding in the watershed. It is recommended that each infiltration project that is implemented be assessed for basement groundwater flooding potential and mitigating measures be taken as necessary.

3.05 SOCIAL MARKETING OPPORTUNITIES

Table 3.05-1 lists the different infiltration facilities necessary to meet the short-term infiltration goal. Most of these are project-based whereby City budgeting will be instrumental in providing a revenue source for the projects. Two of the projects include continuation and expansion of existing programs that involve residential and nonresidential property owners. These projects rely on property owners to participate in the program and lend themselves well to social marketing strategies. The City's Stormwater Utility Rate Adjustment Policy currently provides incentives for construction of stormwater BMPs by way of a reduction in stormwater utility charge. It is recommended that this policy be periodically reviewed for effectiveness.

Facility	Responsible Party	Social Marketing Opportunity	Pilot Project Opportunity
Westmorland Park Bioretention Basin	City of Madison	No, City project	No
Downspout Disconnection Program (35% Watershed Participation)	City of Madison/FOLW/ Residential property owners	Yes	Yes
Rain Barrel Program (25% Watershed Participation)	City of Madison/FOLW/ Residential property owners	Yes	Yes
1,000 Private Residential Rain Gardens (Serving Roofs Only)	City of Madison/FOLW/ Residential property owners	Yes	Yes-Ongoing program
Devolis Park (Axel Avenue) Bioretention	City of Madison	No, City project	No
Arbor Hills Greenway Infiltration (@1.63 in/hr)	City of Madison	No, City project	No
Glenway Golf Course Wet Pond and Infiltration	City of Madison	No, City project	No
Grandview Boulevard Bioswales	City of Madison/Town of Madison	No, City/Town project	No
60 Private Commercial Rain Gardens (Serving Roofs Only)	City of Madison/FOLW/ Nonresidential property owners	Yes	Yes
4 Acres Porous Pavement (Serving 12 acres)	City of Madison/FOLW/ Nonresidential property owners	Yes	Yes
Monroe Street Green Street	City of Madison	No, City project	No
1,000 Terrace Rain Gardens	City of Madison/FOLW/ Residential property owners	Yes	Ongoing program including incentives

Table 3.05-1 Infiltration Project-Based Social Marketing Opportunities

3.06 PROPOSED MANAGEMENT CHANGES TO ACHIEVE SHORT-TERM INFILTRATION GOAL

Table 3.06-1 describes p potential management measures that could be implemented to achieve the short-term infiltration goal in the Lake Wingra watershed. The table also rates their implementation feasibility, potential effectiveness, and implementation priority. These ratings are a qualitative assessment to an understanding of potential prioritization. As can be seen, each of these measures rank "+++" for each category. Table 3.03-11 shows the necessary projects to meet the short-term infiltration goal. Each of the measures identified in Table 3.06-1 will be necessary to implement the corresponding facilities shown in Table 3.03-11.

Management Measure	Implementation Feasibility	Potential Effectiveness	Implementation Priority
Implement Dedicated Funding For City Projects Interaction with City of Madison Public Works, Engineering, Parks Departments to promote Lake Wingra Watershed projects. Goal to prioritize projects for inclusion in Capital Improvement Plans. Interact with Town of Madison for the Grandview Boulevard project.	+++	+++	+++
Expansion of City's 1,000 Rain Gardens Initiative Provide additional strategies to increase participation in the program.	+++	+++	+++
Expansion of City's Terrace Rain Garden Program Provide additional strategies to increase participation in the program.	+++	+++	+++
Creation of a City Porous Pavement Initiative Create this initiative for nonresidential property owners to promote redevelopment of properties with porous pavement. The initiative would be a blend of integration into City development process as well as a voluntary program for discretionary replacement of traditional with porous pavement.	+++	+++	+++

Table 3.06-1 Proposed Management Measures