



**STRAND**  
ASSOCIATES®

Excellence in Engineering Since 1946

# Total Phosphorus Leaf Credit Analysis

For the Interim TP Reduction Credit for Leaf Management Programs

**Jon H. Lindert, P.E., LEED AP – Strand Associates, Inc.**

[jon.lindert@strand.com](mailto:jon.lindert@strand.com)

**(608) 251-4843**

# Outline

- Background: MS4 & TMDL Requirements
- Background: MS4/TMDL Compliance Options
- Background: Street Trees & Leaf Collection
- TP Leaf Credit Requirements
- TP Leaf Credit Analysis Process
- TP Leaf Credit Analysis Results
  - Stoughton, Whitewater, Monona, Rothschild
- Analysis Challenges
- Future Evolution of TP Leaf Credit
- Lessons Learned



## BUREAU OF WATERSHED MANAGEMENT PROGRAM GUIDANCE

Storm Water Management Program

Wisconsin Department of Natural Resources  
101 S. Webster Street, P.O. Box 7921  
Madison, WI 53707-7921

Interim Municipal Phosphorus Reduction Credit for  
Leaf Management Programs

Effective March 2018

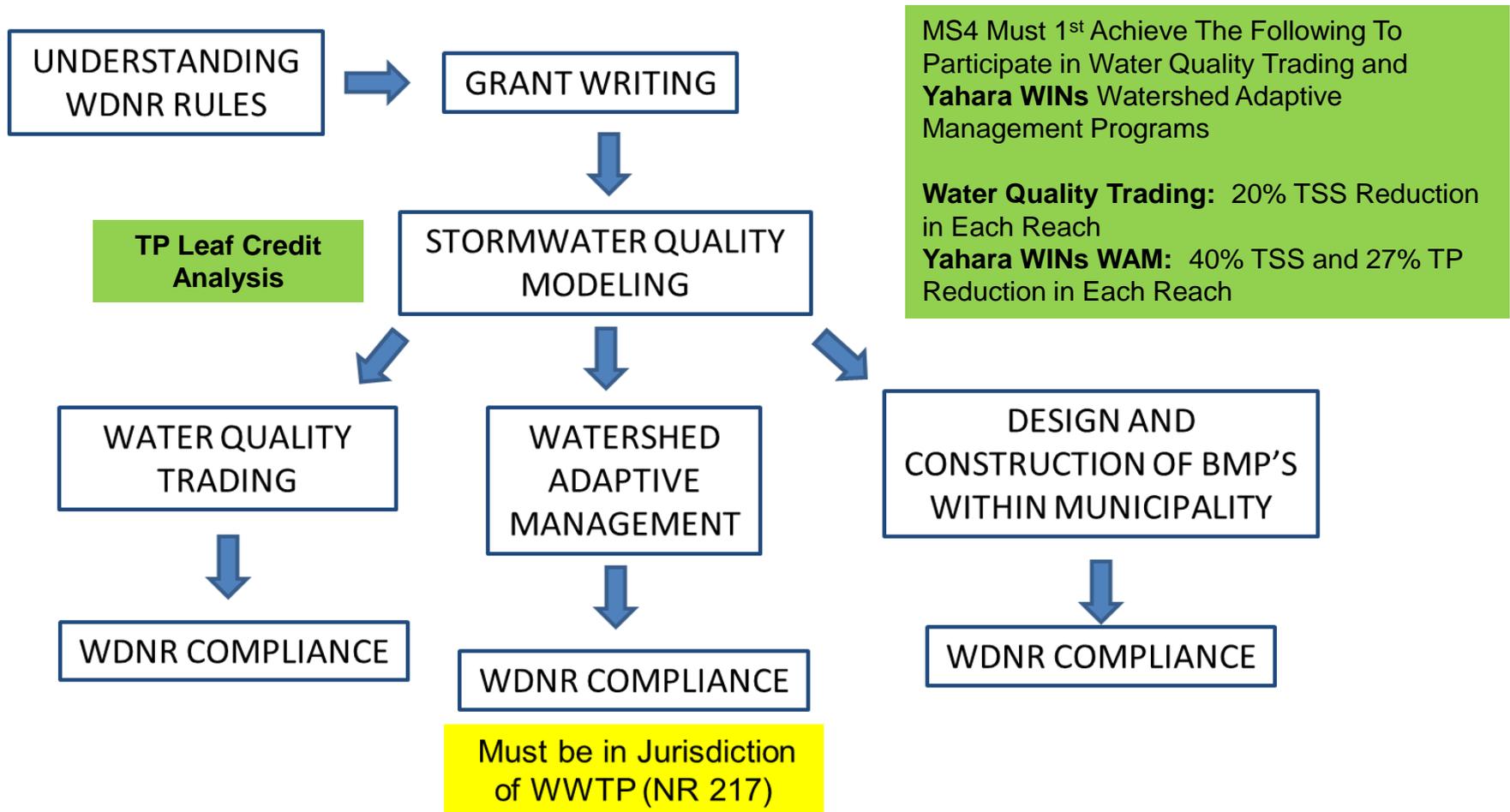
3800-2018-01

# Background: MS4 and TMDL Requirements

- MS4
  - 20% TSS Reduction by 2008
  - 40% TSS Reduction by 2013 (Subsequently Rescinded)
- Total Maximum Daily Load (TMDL)

TMDL Basin	EPA Approval	TSS Range	TP Range
Rock River	9/2011		
Lower Fox River	5/2012		
Menomonee, KK, & Milwaukee Rivers	3/2018	48 to 88%	14 to 88%
Wisconsin River	4/2019	NA	68.6 to 81.3%
Upper Fox and Wolf Rivers	2/2020	20 to 80 %	44 to 83%
NE Lakeshore	Pending		

# Background: MS4/TMDL Compliance Options



# Background: Street Trees and Leaf Collection

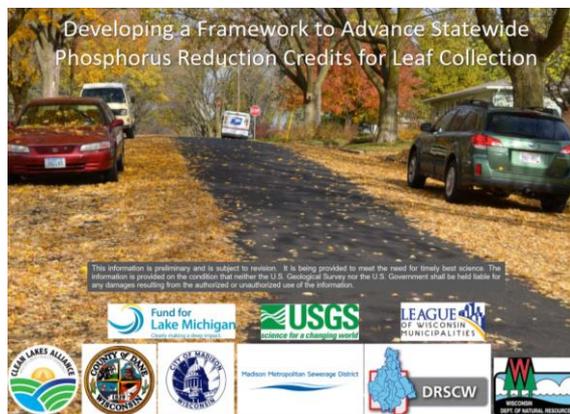
- USGS Study
  - Madison (2013-2018)
- City of Madison
  - 2014 Leaf Bagging Pilot Project
- WDNR TP Credit Guidance Document (2018)
- USGS Studies
  - Fond du Lac and Oshkosh (2018 and 2019)
  - March 27, 2020 Presentation



Leaves in street create opportunity for phosphorus runoff



Leaf leaches phosphorus into water



# TP Credit Requirements

- Tree Density Eligibility
  - Basins with <17% TP Reduction
  - Land use MDRNA (2-6 units/acre)
  - Curb and gutter drainage
  - 17% canopy over street (1 mature tree/80 lf curb)
- Leaf Collection Program Eligibility
  - Municipal ordinance prohibiting leaf placement in streets
  - Policy allowing piles or bags of leaves in terrace for collection.
  - Leaf collection occurs 4 times within October-November
  - Street sweeping within 24 hours of leaf collection
  - No leaves are left in the street overnight.

# TP Credit Analysis Process

- Basins w/ <17% TP Reduction
- MDRNA Land Use
- Curb and Gutter Drainage
- 1 Mature Tree / 80 lf Curb
- No leaves in street ordinance
- Leaves in terrace/bags policy
- Leaf Collection 4X in Oct./Nov.
- Street Sweep Within 24 hrs
- No leaves in street overnight

**GIS:**  
Terrace  
Trees  
Layer

**GIS:**  
WinSLAMM  
Watersheds,  
Landuse, and  
Curb &  
Gutter

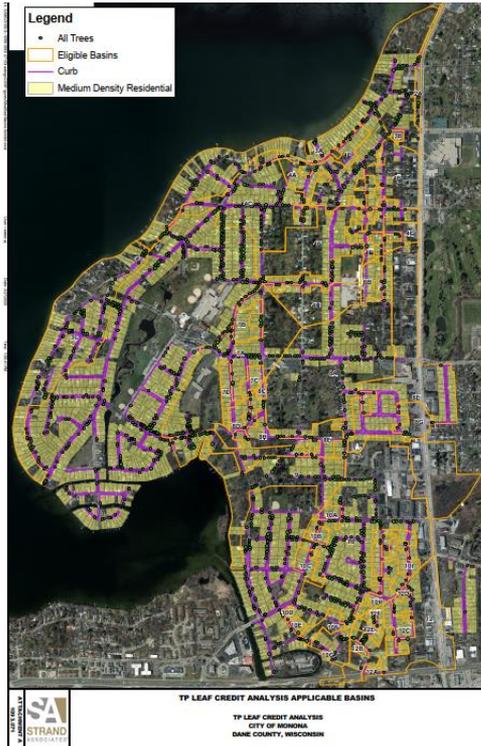
Confirm Eligibility  
for Tree Density

Optimize  
Watersheds to  
Maximize  
Credit

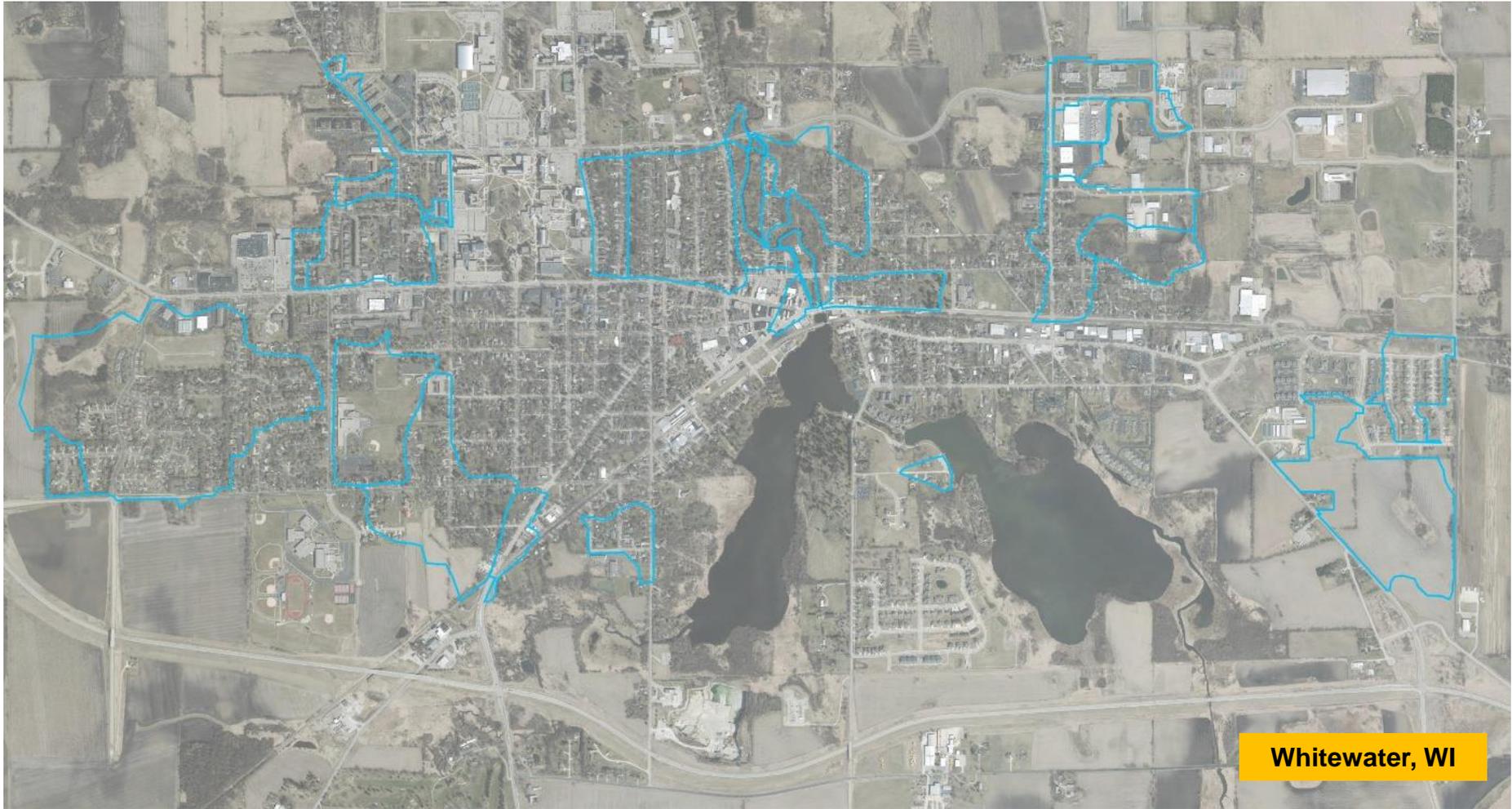
Document Leaf  
Collection  
Programs

**Iterative Process**

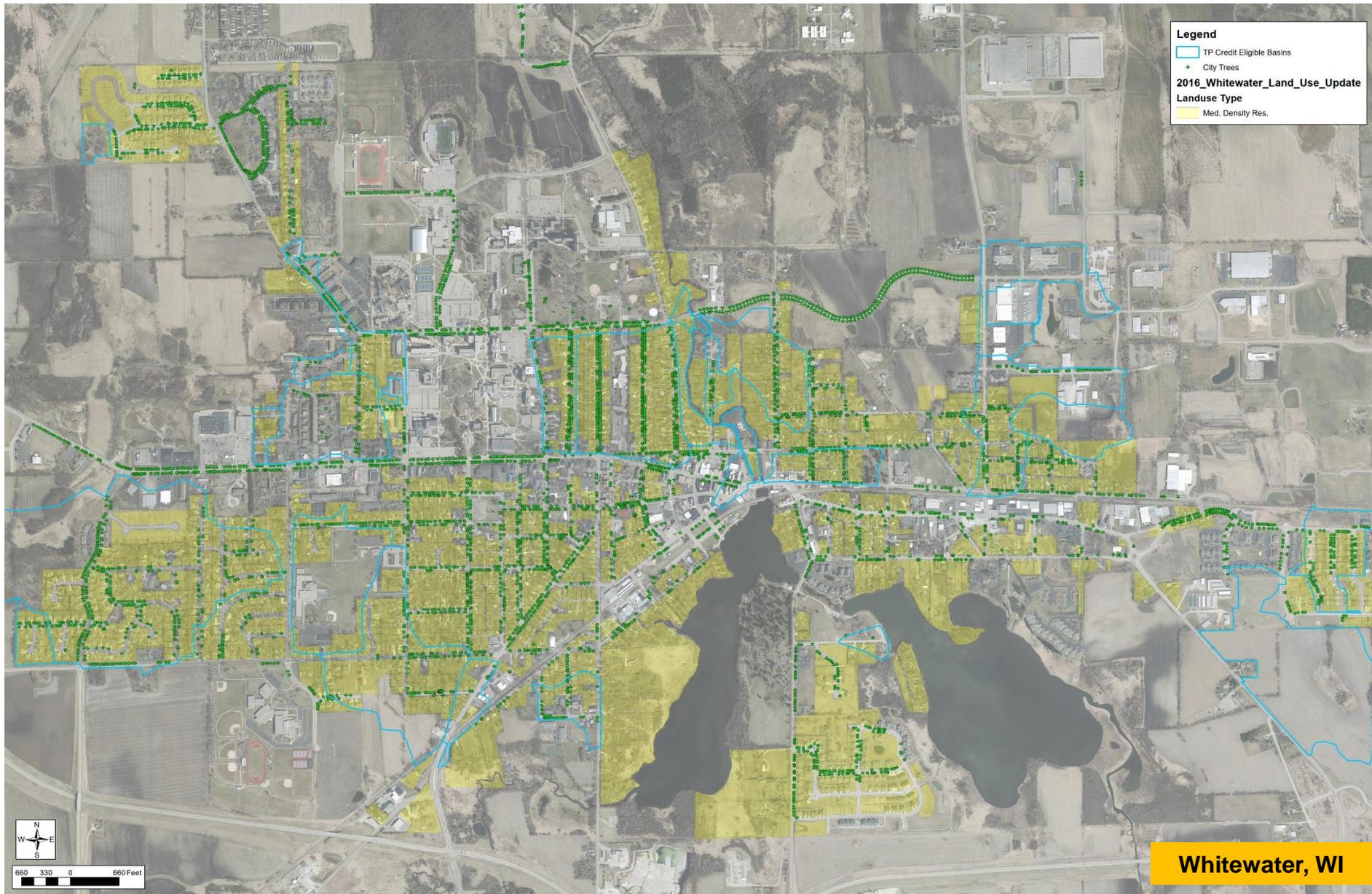
Submit to WDNR



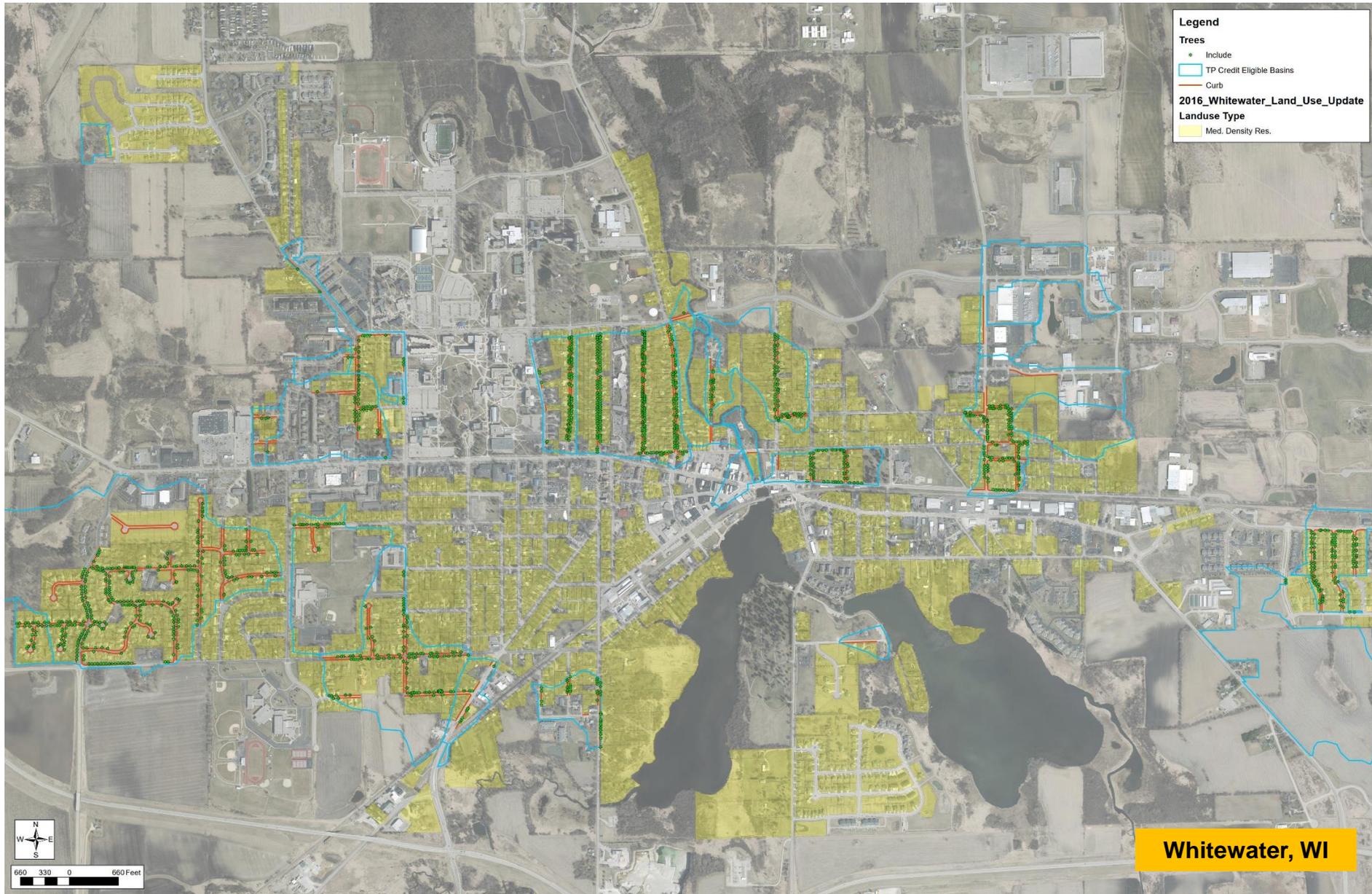
# TP Credit Analysis Process: Initial Basin Eligibility <17%



# TP Credit Analysis Process: Initial Basin Eligibility



# TP Credit Analysis Process: Optimized Eligibility



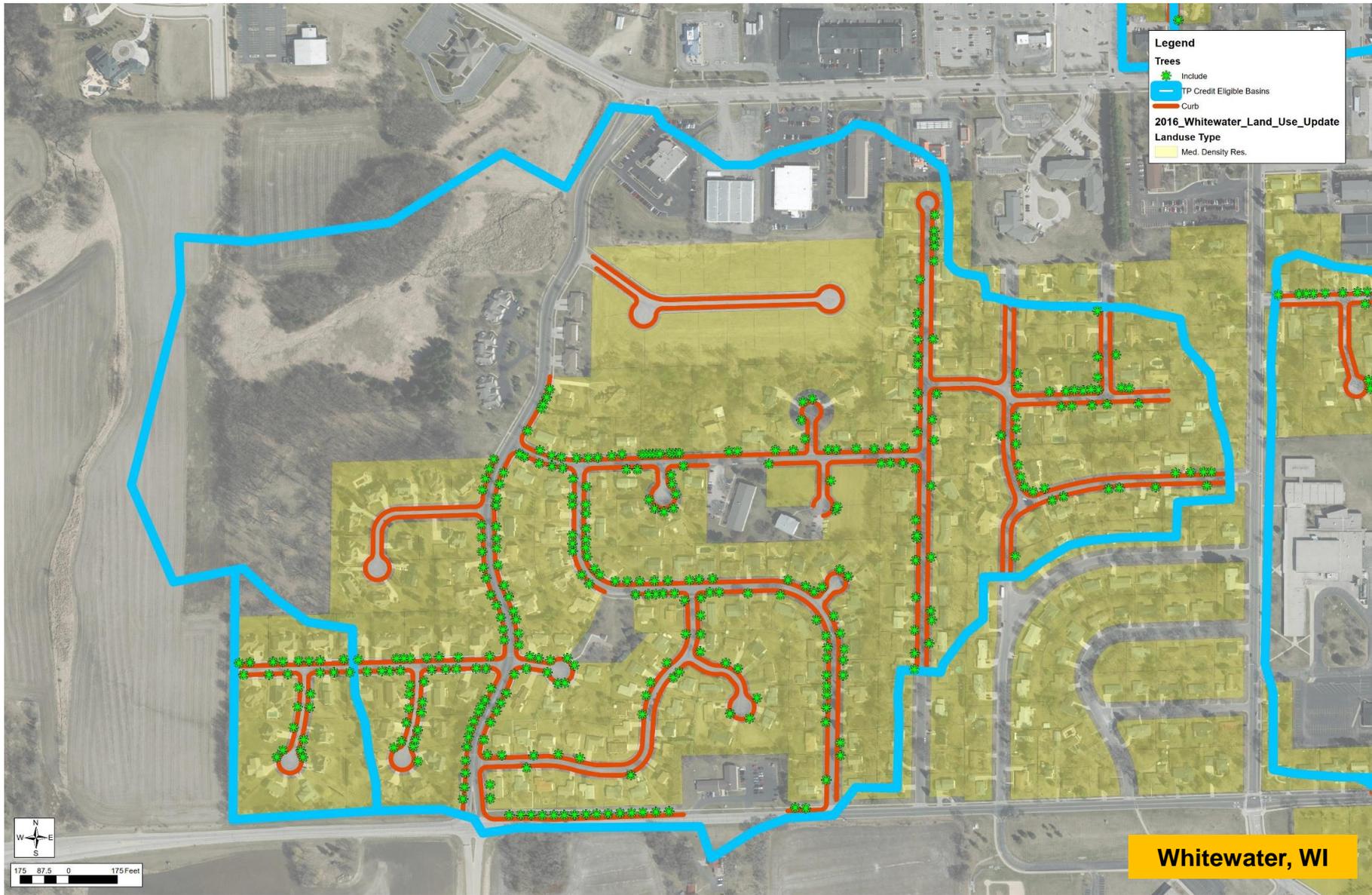
# TP Credit Analysis Process: Initial Credit Calculations

Basin	Basin Area (ac)	MDR Area (ac)	# Trees/ 80 lf	1 Tree/ "X" lf	Baseline TP, lbs/yr	Existing TP Reduction	Max. Credit (17%)	Percentage Difference	Maximum Potential TP (lbs) removed	TP (lbs) removed
67-01	92.90	75.43	0.64	126.58	73.01	11.8%	17.0%	5.2%	3.80	0.00
67-04	301.12	226.07	0.64	125.65	218.81	5.3%	17.0%	11.7%	25.60	0.00
67-09	9.20	1.87	0.00	-	1.81	0.0%	17.0%	17.0%	0.31	0.00
67-16	30.65	3.36	0.36	220.95	3.25	11.0%	17.0%	6.0%	0.19	0.00
67-10	17.30	2.38	0.00	-	2.30	7.8%	17.0%	9.2%	0.21	0.00
67-20	40.37	10.45	0.65	128.12	10.11	7.8%	17.0%	9.2%	0.93	0.00
67-22	50.27	29.86	1.39	53.97	28.90	5.2%	17.0%	11.8%	3.41	3.41
67-24	7.72	0.19	0.00	-	0.19	2.4%	17.0%	14.6%	0.03	0.00
67-25	21.16	17.01	0.80	99.76	16.46	5.2%	17.0%	11.8%	1.94	0.00
67-26	8.29	7.47	0.86	92.71	7.23	5.2%	17.0%	11.8%	0.85	0.00
67-27	5.35	5.11	0.66	121.05	4.95	2.2%	17.0%	14.8%	0.73	0.00
67-28	14.71	1.52	0.00	0.00	1.47	4.9%	17.0%	12.1%	0.18	0.00
67-50	13.58	0.38	1.45	55.05	0.37	5.7%	17.0%	11.3%	0.04	0.04
67-51	16.25	2.95	1.52	52.55	2.86	9.5%	17.0%	7.5%	0.21	0.21

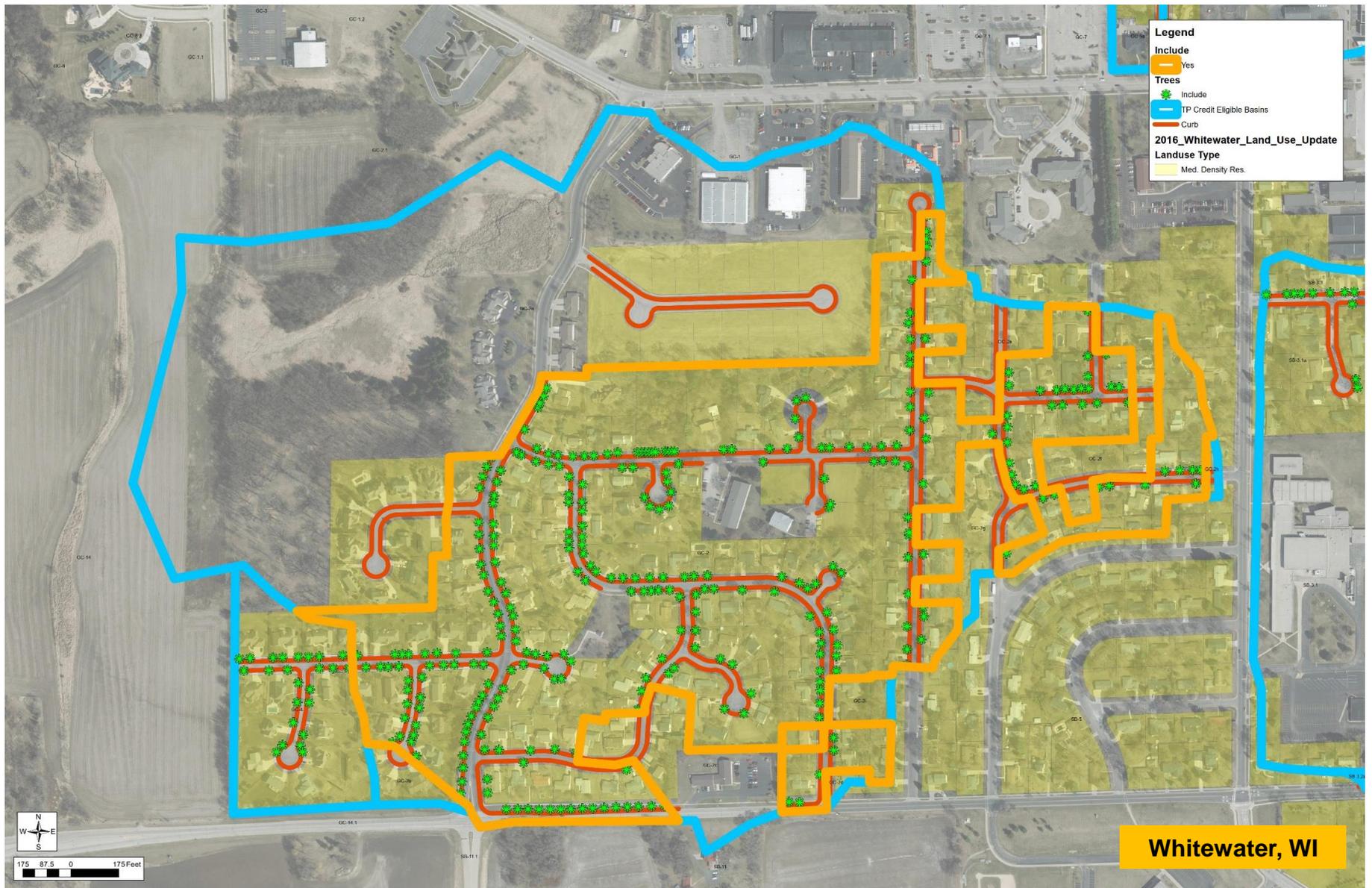
---

Total TP: **38.44 lbs**      **3.67 lbs**

# TP Credit Analysis Process: Example Optimization



# TP Credit Analysis Process: Example Optimization



# TP Credit Analysis Process: Monona



# TP Credit Analysis Results

## TP Credit Analysis 2

City of Whitewater, WI  
10/4/2019

TP Yield, no controls, lbs	lbs/ac/yr
96.79	0.97

100 Acres MDR, silty soil WinSLAMM v 10

Basin	Basin Area (acs)	MDR Area (ac)	Length of Curb (LF)	# of Trees	Eligible if <= 80	Eligible if >= 1	MDR * 0.97 lbs/ac/yr	Existing TP Reduction	Max Credit (17%)	Percentage Difference	Baseline TP * Percentage Difference
					LF Curb/Tree	# Trees/80 LF Curb	Baseline TP, lbs/yr				Eligible TP (lbs) removed
GC-10.3	4.005	0.758	0	0	-	-	0.73	0.0%	17.0%	17.0%	0.00
GC-2	75.068	53.665	21,608	315	68.60	1.17	51.94	5.4%	17.0%	11.6%	6.02
GC-4	8.130	6.313	1,598	24	66.59	1.20	6.11	3.3%	17.0%	13.7%	0.84
GC-5	0.855	0.528	158	3	52.74	1.52	0.51	7.5%	17.0%	9.5%	0.05
GC-5.1	4.931	0.455	66	1	66.27	1.21	0.44	10.1%	17.0%	6.9%	0.03
GC-6	26.879	5.556	2,143	33	64.93	1.23	5.38	7.8%	17.0%	9.2%	0.49
SB-1	12.907	4.463	2,084	38	54.83	1.46	4.32	15.3%	17.0%	1.7%	0.08
SB-2	5.285	1.205	692	10	69.16	1.16	1.17	5.3%	17.0%	11.7%	0.14
SB-3.1	41.078	9.498	1,097	19	57.74	1.39	9.19	9.0%	17.0%	8.0%	0.74
SB-3.2	50.402	31.356	8,673	119	72.88	1.10	30.35	4.4%	17.0%	12.6%	3.83
TL-3	4.089	0.888	484	0	-	0.00	0.86	4.2%	17.0%	12.8%	0.00
WC-11	10.487	8.675	506	0	-	0.00	8.40	0.0%	17.0%	17.0%	0.00
WC-12.1	28.870	19.921	3,126	59	52.98	1.51	19.28	4.6%	17.0%	12.4%	2.39
WC-12.2	1.009	0.117	51	1	-	0.00	0.11	14.4%	17.0%	2.6%	0.00
WC-12.3	3.846	3.170	1,202	18	66.79	1.20	3.07	12.5%	17.0%	4.5%	0.14
WC-29	16.835	9.852	7,577	125	60.61	1.32	9.54	13.3%	17.0%	3.7%	0.35
WC-31	21.049	9.748	68	0	-	0.00	9.43	5.0%	17.0%	12.0%	0.00
WC-33.1	30.015	0.598	652	0	-	0.00	0.58	7.2%	17.0%	9.8%	0.00
WC-4	11.199	4.913	3,174	53	59.89	1.34	4.75	9.0%	17.0%	8.0%	0.38
WC-5.2 CITY	15.252	5.871	1,587	20	79.35	1.01	5.68	16.7%	17.0%	0.3%	0.02
WC-50	22.829	12.314	6,422	103	62.35	1.28	11.92	7.4%	17.0%	9.6%	1.14
WC-52	72.002	0.004	90	2	45.10	1.77	0.00	0.0%	17.0%	17.0%	0.00
WC-6	0.262	0.189	75	1	74.90	1.07	0.18	5.0%	17.0%	12.0%	0.02
WC-60	18.272	8.317	3,098	66	46.94	1.70	8.05	6.8%	17.0%	10.2%	0.82
WC-61	56.316	35.219	10,724	252	42.56	1.88	34.09	12.2%	17.0%	4.8%	1.64
WC-8	4.222	0.998	150	0	-	0.00	0.97	8.8%	17.0%	8.2%	0.00
WC-9	4.642	0.000	0	0	-	-	0.00	8.6%	17.0%	8.4%	0.00
<b>Totals</b>	<b>550.74</b>	<b>234.59</b>					<b>227.06</b>				<b>19.10</b>

# TP Credit Analysis Results

Municipality	Draft Maximum TP Credit (prior to analysis)	Draft TP Credit (Original)	WDNR-Approved TP Credit (With Optimized Basins)	Difference between Original and Optimized Basins	Value of TP Credit Analysis: \$/lb TP (20 Year NPW)
Stoughton	66.0	4.9	<b>37.7</b>	+32.8 lbs	\$29/lb
Whitewater	77.1	8.3	<b>19.1</b>	+10.8 lbs	\$60/lb
Monona	23.3	1.8	<b>13.0</b>	+11.2 lbs	\$74/lb
Rothschild	9.8	1.4	<b>9.0 (Pending)</b>	+7.6 lbs	\$99/lb

Constructed BMPs Cost Range: \$1,000 to \$10,000/lb TP NPW (Avg. \$3,000)

# TP Credit Analysis Results

State of Wisconsin  
DEPARTMENT OF NATURAL RESOURCES  
Waukesha Service Center  
141 NW Barstow St., Room 180  
Waukesha, WI 53188

Tony Evers, Governor  
Preston D. Cole, Secretary  
Telephone (262) 574-2100  
Toll Free 1-888-936-7463  
TTY Access via relay - 711



February 5, 2020

Brad Marquardt  
Public Works Director  
Whitewater, City  
312 West Whitewater St  
Whitewater, WI 53190

SUBJECT: City of Whitewater Leaf Management Credit  
WPDES Permit No. WI-S050075-03-0

Dear Mr. Marquardt,

The Department has received the City of Whitewater's updated request for total phosphorus reduction credit for its leaf management program on January 28, 2020. The Department has reviewed the documentation and determined that the proposed program is consistent with the conditions outlined in the Interim Municipal Phosphorus Reduction Credit for Leaf Management Programs guidance. The City's practice of bagged leaf collection 3 times during October and November along with street sweeping 4 times during October and November is expected to reduce the total phosphorus load by 19.1 lbs/year. The City may apply this 19.1 lbs/year reduction towards the Rock River TMDL Wasteload Allocation.

The Department conducted its review based upon current guidance and scientific understanding of leaf management. As additional research is completed, the quantity of credit may be adjusted accordingly.

If you have any questions regarding this approval, please contact me at (262) 888-0578 or [Jacob.Zimmerman@wisconsin.gov](mailto:Jacob.Zimmerman@wisconsin.gov).

Sincerely,

A handwritten signature in black ink, appearing to read 'Jacob Zimmerman'.

Jacob Zimmerman, PE  
Storm Water Engineer

cc: Raveena John, Strand  
John Lindert, Strand  
Amy Minser, WDNR  
Samantha Katt, WDNR

# Analysis Challenges-Leaf Collection Program Eligibility

Municipality	Stoughton	Whitewater	Monona	Rothschild
Leaf Collection 4X in Oct./Nov.	<ul style="list-style-type: none"> <li>Weekly from Mid-Oct to End Nov.</li> <li>Equivalent to 7 Collections</li> </ul>	<ul style="list-style-type: none"> <li><b>1X Late Oct.</b></li> <li><b>2 to 3X by Nov. 15</b></li> </ul>	<ul style="list-style-type: none"> <li>Every 10 to 12 days in Oct/Nov</li> <li>Equivalent to 4 to 6 Collections</li> </ul>	<b>Late Sept. to Early Nov</b>
Street Sweeping Within 24 Hours of Collection	<ul style="list-style-type: none"> <li>Vacuum Collection Leaving Minimal Residue</li> <li>No Sweeper Follows</li> </ul>	<ul style="list-style-type: none"> <li>Sweep 2X in October</li> <li>Sweep 2X in November</li> </ul>	<ul style="list-style-type: none"> <li>Vacuum Collection Leaving Minimal Residue</li> <li>Sweeper Follows</li> </ul>	TBD
No Leaves in Street Overnight	<ul style="list-style-type: none"> <li>Ordinance prohibits</li> <li>Part of Protocol</li> </ul>	<ul style="list-style-type: none"> <li>Combination of ordinance prohibiting and bagged leaves</li> </ul>	<ul style="list-style-type: none"> <li>Ordinance prohibits</li> <li>Part of Protocol</li> </ul>	TBD
Leaf Storage Location	Terrace	Bags on Terrace	Terrace	TBD
Pick up Method	Vacuum Truck	Load Bags In Truck	Vacuum Truck	TBD

WDNR has been flexible with eligibility interpretations. If municipality's operations meet the intent of the requirements, WDNR has granted approval for the existing program or with tweaks to the existing programs.

# Analysis Challenges-Leaf Collection Program Details

- Ordinances
- Public Announcements / Schedule
- Leaf Collection Program Narrative
- Photos Documenting Collection/Sweeping

**City of Monona – Public Works & Utilities**

6211 Schuler Road  
Monona, Wisconsin 53116  
Phone: 608-202-2525  
Fax: 608-202-8225  
[www.cityofmonona.com](http://www.cityofmonona.com)

**Memorandum**

To: Strand Engineering Associates, Inc.  
Jon Lindert  
Rowena John  
Josh Steaks

From: City of Monona, Public Works Department  
Brad Bruun – Public Works Project Manager and GIS Specialist

Date: 2/24/2020

Subject: Leaf Collection Credit

Jon and Rowena,

The City of Monona performs curbside leaf collection annually starting in the month of October running through the end of November or as weather allows. Residents are required to place leaves on the terrace behind the curb along with their property between those dates in order to have them collected. A drop off site is also available to residents who would rather bag their leaves or who do not want to place them at the curb. Spring leaf collection is also available to residents during the month of April. Residents are informed of this every year through leaf news letters, the City's website, and Facebook. Monona public works crews use vec trucks with a rotating arm to collect curbside. The public works crews follow this up by scheduling streets to be swept using a street cleaner with curb brush and vacuum after leaves have been collected. The City's Code Enforcement staff routinely does mobile inspections to try and keep residents informed of any wrongdoing as it pertains to keeping leaves out of the streets. By ordinance, residents are not allowed to place leaf debris or piles in the streets. Monona staff annually promote leaf management and adopt a storm drain program to encourage proper management of leaves. Leaf collecting crews are typically able to collect on each city street in a 20-22 day cycle, which repeats until the collection season is over. Most residents will receive collection services several times a season. The number of times a truck can get around to a property is dependent on weather and equipment health. The City uses 3 leaf vac trucks to perform this service.

If there is more information that you will need please do not hesitate to ask.

Thank you,  
Brad Bruun  
(608) 202-2125 Ext. 7402  
[brad@cityofmonona.wi.us](mailto:brad@cityofmonona.wi.us)

## City of Monona Narrative

16022019  
12.08.010 - Prohibited.

Whitewater, WI Code of Ordinances

(a) No person, except as provided in Section 12.08.020, shall place, deposit, keep, or cause to be placed, deposited or kept in or upon any street, alley, gutter, sidewalk or public ground within the limits of this city any stone, brick, timber, lumber, iron, wood or other material for building, or any wood, snow, rubbish, earth, grass clippings or lawn debris, or any thing or substance whatever; nor shall any person burn or cause to be burned any such substance in any public street or alley; nor shall any person leave any automobile, truck, trailer, equipment or other vehicle standing or parked in or upon any street, alley, sidewalk, or public ground so as to encumber the same, or so as to obstruct, impede, or hinder travel thereon; nor shall any person leave, or cause to suffer any box, barrel, crate, cask, bale, package, merchandise, or other thing to stand, be or remain upon any street, alley, sidewalk, gutter, or public ground longer than may be actually necessary for the act of delivering or receiving the same.

(b) Any person violating any of the provisions of this section shall forfeit and pay a penalty of not less than twenty-five dollars nor more than two hundred fifty dollars, together with the costs of prosecution.

(Ord. 983 551, 1982; prior code §6.01(1)).  
(Ord. No. 1759A, § 1, 2-16-2010)

## Ordinance Whitewater



Leaf Vacuum  
City of Monona

## Brush Pick-up & Leaf Collection Schedule

CHRISTMAS TREE COLLECTION							CURBSIDE LEAF COLLECTION (dependent on weather)							CURBSIDE BRUSH PICK-UP																																																
<b>January 2018</b>																					<b>April 2018</b>																					<b>June 2018</b>																				
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S																																										
1	2	3	4	5	6		8	9	10	11	12	13	14	3	4	5	6	7	8	9																																										
7	8	9	10	11	12	13	15	16	17	18	19	20	21	10	11	12	13	14	15	16																																										
14	15	16	17	18	19	20	22	23	24	25	26	27	28	17	18	19	20	21	22	23																																										
21	22	23	24	25	26	27	29	30						24	25	26	27	28	29	30																																										
28	29	30	31																																																											
<b>August 2018</b>																					<b>October 2018</b>																					<b>November 2018</b>																				
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S																																										
1	2	3	4	5	6		7	8	9	10	11	12	13	4	5	6	7	8	9	10																																										
5	6	7	8	9	10	11	14	15	16	17	18	19	20	11	12	13	14	15	16	17																																										
12	13	14	15	16	17	18	21	22	23	24	25	26	27	18	19	20	21	22	23	24																																										
19	20	21	22	23	24	25	28	29	30	31				25	26	27	28	29	30																																											
26	27	28	29	30	31																																																									

No Brush/Leaf Collection is scheduled in February, March, May, July, September and December.

- Please...**
- place leaves and brush, including Christmas trees, on the terrace the **Monday** of the scheduled collection week by 7 a.m.
  - DO NOT set out more than 10 days prior to the scheduled pick-up per City Ordinance 62-2.
- Yard Waste Site**  
1051 Collins Road, Dunkirk, WI  
Open April 2–November 20, 2018  
Tues & Thurs 1–7 p.m., Sat 9 a.m.–5 p.m.\*
- \$20 Annual Permit Fee**



## City of Stoughton calendar

# Analysis Challenges-Leaf Collection Method



Street Sweeper  
City of Whitewater



Leaf Vacuum  
City of Stoughton

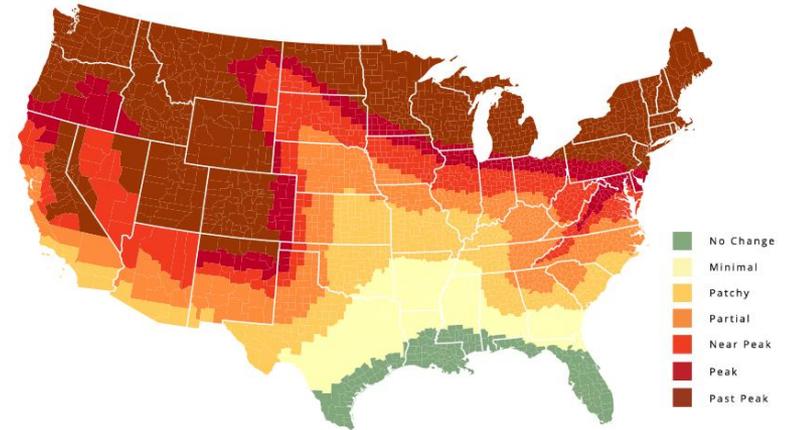
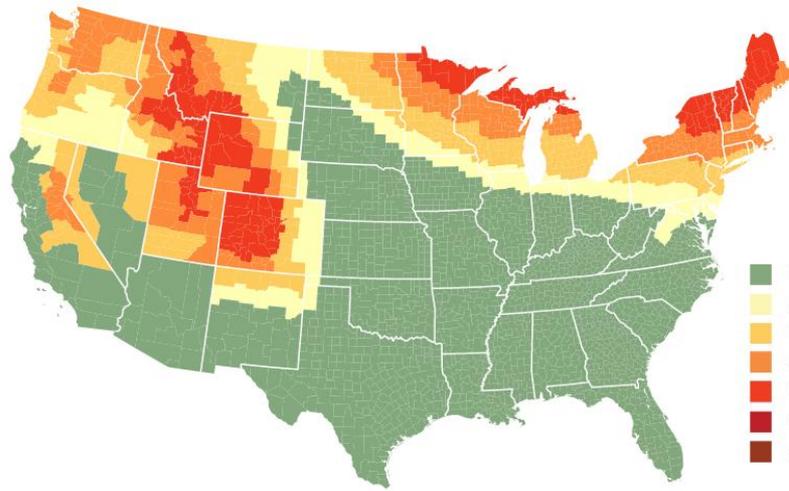


Leaf Vacuum  
City of Monona

# Analysis Challenges-Regional Differences/Timing

## 2019 Fall Foliage Maps

September 28, 2019



October 26, 2019

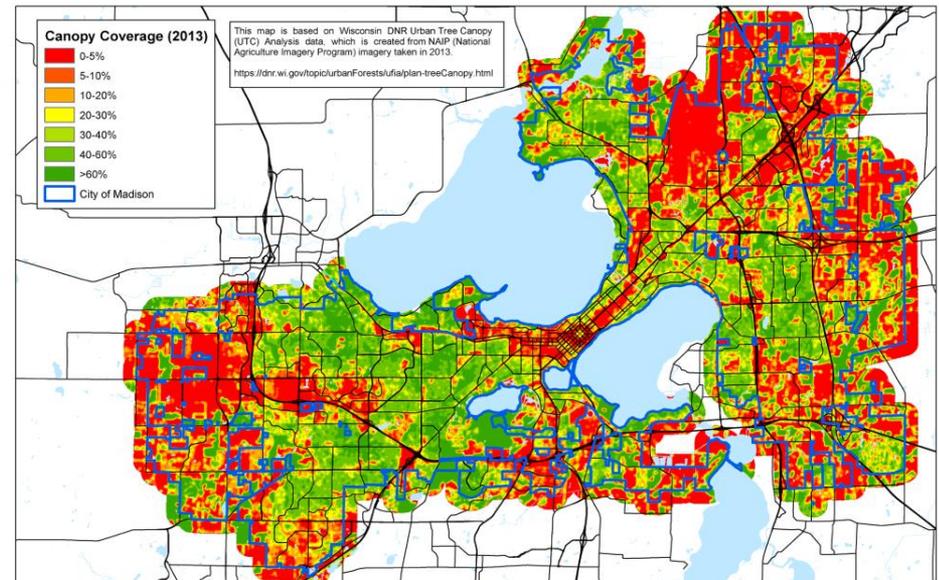


# Analysis Challenges-Regional Differences/Timing



# Future Evolution of TP Leaf Credit

- Additional Credit for Weekly Sweeping
- Expand Eligible Land Uses (Single Family and Multifamily Residential)
- Impact of Leaf Collection on Downstream Wet Ponds
- Percent Street Tree Canopy vs Terrace Trees
- MS4 Leaf Management Study Advisory Group through League of Municipalities
  - Interest in Continued Research
  - Focus of Additional Research
  - Willingness of Communities to Contribute \$



Urban Forest Canopy. The image above was produced using LIDAR data from 2013.

# Lessons Learned

- Manage expectations.
- Iterations are necessary to maximize eligible areas/credit.
- Collaborate with WDNR to explain municipality's programs.
- Provide complete submittal to WDNR.
- Desktop Analysis more cost-effective than constructed BMPs.
- Use as tool to target future tree planting areas to increase eligible area.
- An MS4 can internally trade TP Leaf Credit from upstream reach to downstream reach using a 1:1 trade ratio without formal water quality trading agreement.

# Questions





**STRAND**  
ASSOCIATES®

Excellence in Engineering Since 1946