Burt Lake Watershed Resource Inventory Summary

Burt Lake - Maple River and its East and West Branches - Douglas Lake - Munro Lake - Vincent Lake - Lancaster Lake - Larks Lake - Van Creek - Cope Creek - Certon Creek - Cold Creek - Crooked Lake - Pickerel Lake - Spring Lake - Mud Lake - Round Lake - McPhee Creek - Mud Creek - Minnehaha Creek - Deer Creek - Berry Creek - Silver Creek - Sturgeon River and its Main and West Branches - Thumb Lake - Huffman Lake - Wildwood Lake - Lance Lake - Silver Lake - Mossback Creek - Club Stream - Stewart Creek

Tip of the Mitt Watershed Council 2016

Summary of Resource Inventories

Over the past two years (2014 and 2015), Tip of the Mitt Watershed Council has been working throughout the Burt Lake Watershed to complete numerous assessments of non-point source pollution. These inventories are designed to measure human impacts to water quality across the entire watershed. The Watershed Council invites you to review our findings. As a project partner, watershed resident, or stakeholder, know that your input is a valuable part of the watershed planning process.

Stormwater

Stormwater is excess water that accumulates on the surface after the ground has become saturated from precipitation (rain, snow, or snowmelt) and begins to flow overland. Stormwater runoff occurs naturally, but increases as a result of landscape development and urbanization. As forests, grasslands, wetlands, and pastures are replaced by constructed (impervious) surfaces such as streets, roofs, sidewalks, and parking lots, the amount of stormwater runoff generated by a storm event increases dramatically. The negative effects of stormwater runoff on aquatic ecosystems have been well documented. Increased stormwater runoff alters the natural flow regime of streams, scouring stream banks and stream beds, increasing sedimentation, and reducing water quality and aquatic habitat for fish, aquatic insects and other aquatic organisms. In addition, stormwater carries many harmful substances found in urban areas, such as bacteria from pet and animal wastes, fertilizers, oil, grease, deicing road salts, sediments, heavy metals and pesticides, which wash into receiving water bodies.

The Burt Lake Watershed contains seven urban areas where stormwater runoff potentially degrades the water quality and aquatic habitat of receiving water bodies. Developed areas of Alanson, Pellston, Indian River, Gaylord, Vanderbilt and Wolverine lie within The Watershed. The commercial corridor of US 31 just east of Petoskey is also of concern. All of these urban areas possess paved streets with curbs, gutters, and subsurface drainage pipes called storm sewers. These storm sewers prevent flooding and water damage within the urban areas, but also have the potential to negatively impact local surface water resources.

As part of the Burt Lake Watershed Management Plan, Watershed Council staff conducted inventories in 2014 and 2015 of storm sewer systems in each of the seven urban areas in the Watershed. The inventories consisted of identifying land uses (e.g., commercial, residential, natural) within the city/village boundaries, reviewing maps of storm sewers provided by local and state governments, delineating different drainage catchment areas, and identifying locations of stormwater inlets and outlets. Limited water testing was conducted at outfalls when possible. Inventory data will be entered into an empirical model to predict pollutant loadings in each urban area for four major pollutants: sediment, nutrients, metals, and bacteria.

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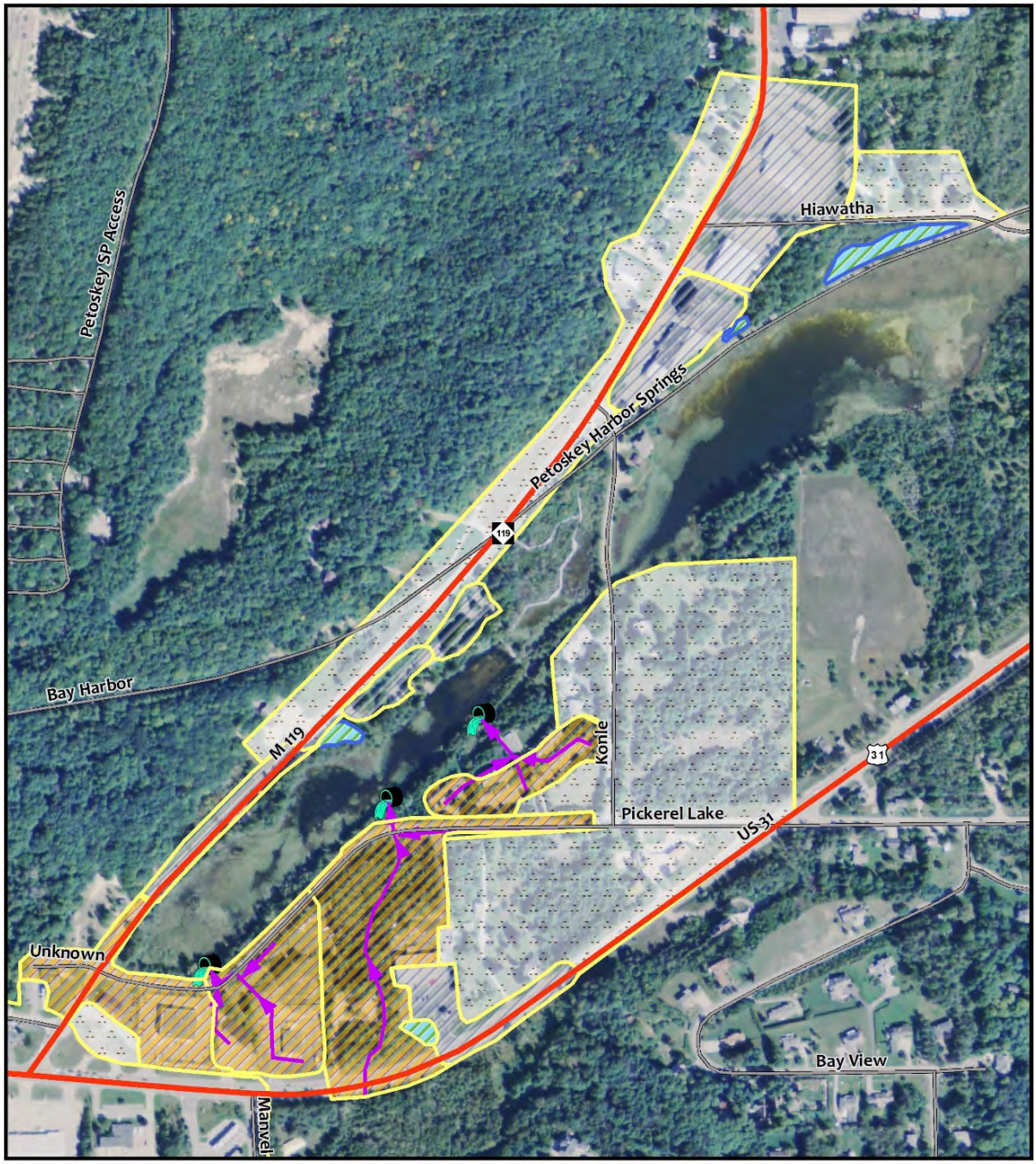
Stormwater Assessment - Spring and Mud Lakes

Tip of the Mitt Watershed Council
Respected Advocacy.
Innovative Education.
Sound Science.



Stormwater Drainage Basins

Drainage Type

- Drains to Waterbody
- Internal Infiltration / Drains to Wetland
- No Stormwater Management
- Wetland

- Stormwater Lines
- Stormwater Outfalls
- State Roads

N
W E
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Data Sources:
Stormwater line, basin, and outfall layers developed by Tip of the Mitt Watershed Council. Aerial Imagery Provided by the USDA National Agriculture Imagery Program. All other data obtained from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/

Stormwater Assessment - Alanson, MI

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Stormwater Drainage Basins

Basin Type

- Direct Drainage to Water Body
- Internal Infiltration
- No Stormwater Management
- Stormwater Lines
- Stormwater Outfalls
- Rivers and Streams
- State Roads and Highways
- Roads
- Alanson Village Limits

0 250 500 1,000 Feet

N W E S

Data Sources:
Stormwater Basins, Outfalls, and Lines layer developed by Tip of the Mitt Watershed Council. Aerial Imagery provided by USDA National Agriculture Imagery Program. All other data acquired from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/.

Stormwater Assessment - North Gaylord, Michigan

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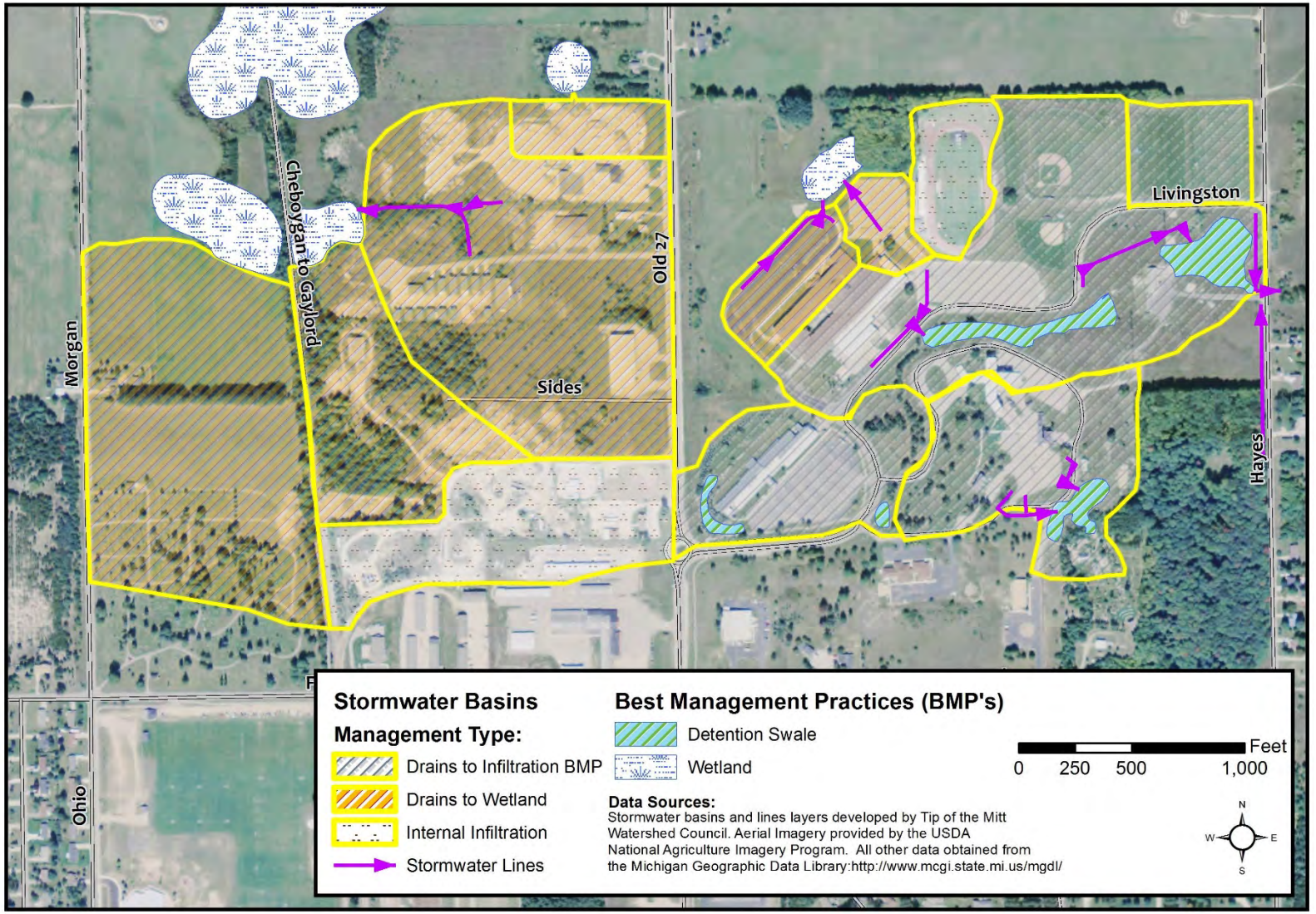

Stormwater Basins

Management Type:

- Drains to Infiltration BMP
- Drains to Wetland
- Internal Infiltration
- Stormwater Lines

Best Management Practices (BMP's)

- Detention Swale
- Wetland

Feet
0 250 500 1,000

Data Sources:
Stormwater basins and lines layers developed by Tip of the Mitt Watershed Council. Aerial Imagery provided by the USDA National Agriculture Imagery Program. All other data obtained from the Michigan Geographic Data Library:http://www.mcgi.state.mi.us/mgdl/

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StormwaterAssessment - Pellston, MI

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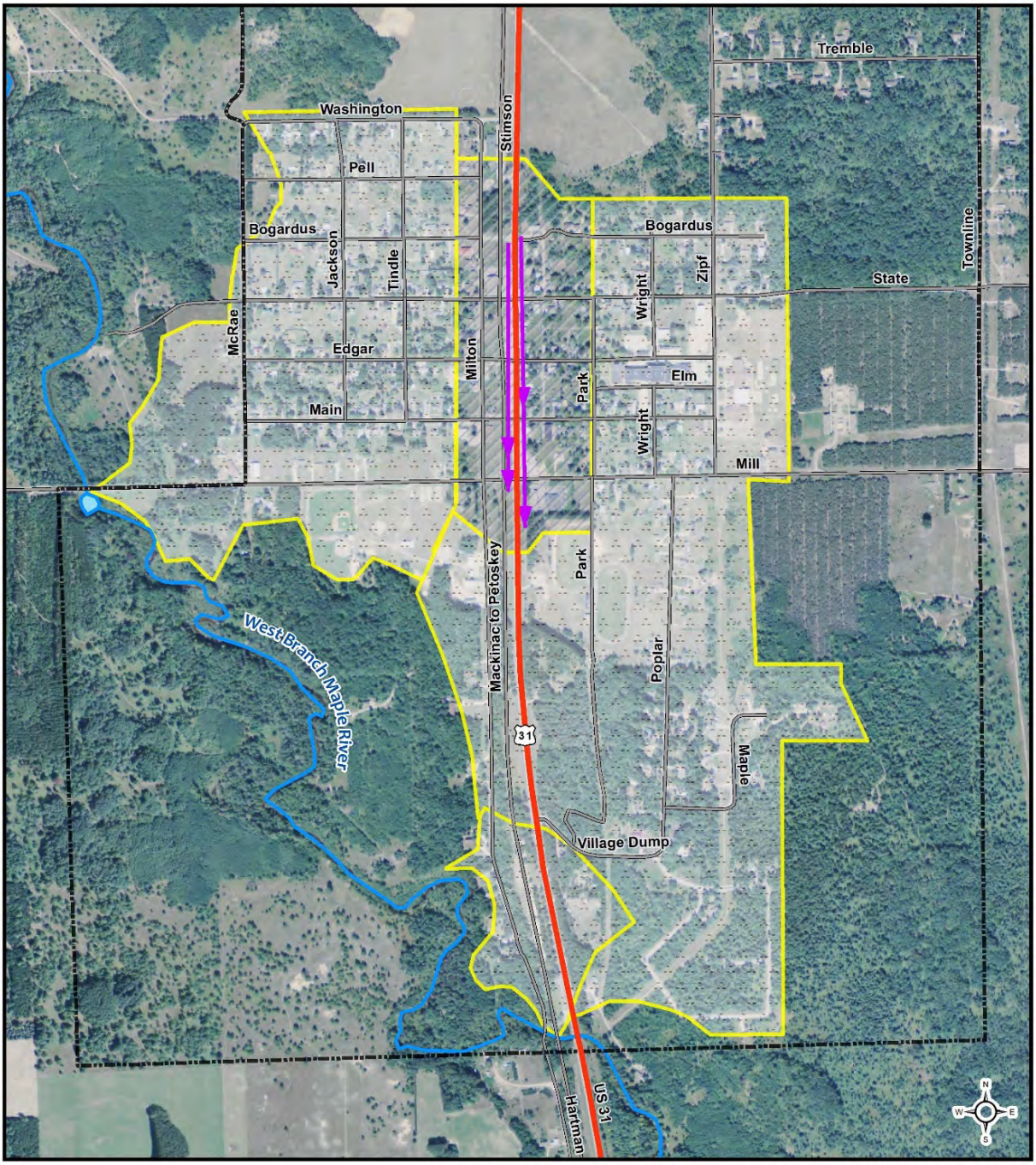

Stormwater Basin Types
- Internal Infiltration
- No Stormwater Management
- Rivers & Streams
- Stormwater Lines
- Pellston Village Limits
- State Roads
- Roads

0 250 500 1,000 Feet

Data Sources:
Watershed and monitoring sites layers developed by Tip of the Mitt Watershed Council. Aerial Imagery provided by the USDA National Agriculture Imagery Program Field Office. All other data obtained from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/

Stormwater Assessment - Vanderbilt, MI

Mitt Watershed Council
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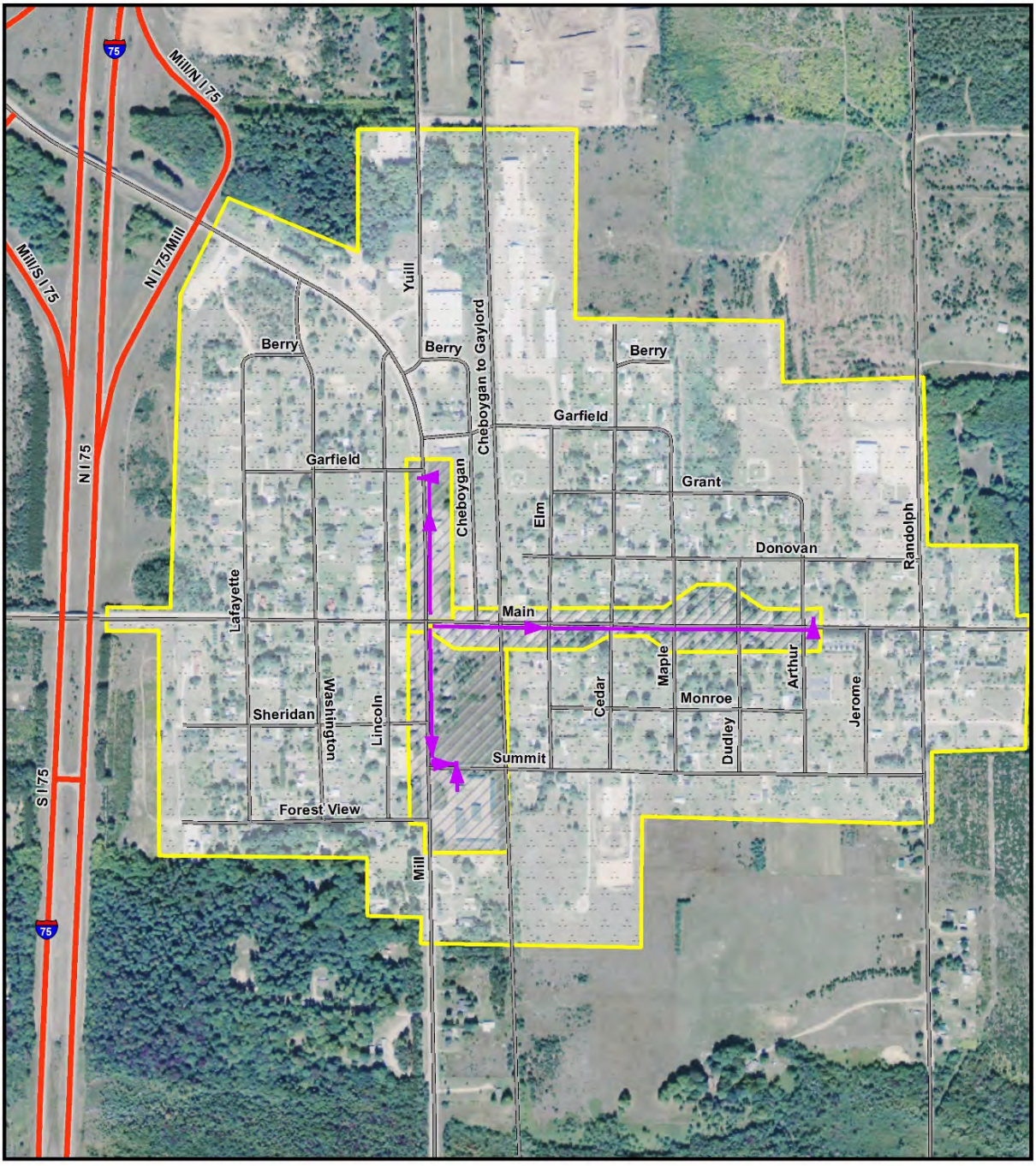

Stormwater Basin Types
- Internal Infiltration
- No Stormwater Management
- Stormwater Lines
- Highways
- Roads

0 250 500 1,000 Feet

N W E S

Data Sources:
Stormwater Basin and Line Layers developed byTip of the Mitt Watershed Council. Aerial Imagery provided by the USDA National Agriculture Imagery Program Field Office. All other data obtained from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/

Stormwater Assessment 2015 - Indian River, MI

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Pipes and Outfalls

Type

- Stormwater Outfall
- Artesian Outlet
- Yard Drain

- State Roads and Highways
- Roads
- Stormwater Lines
- Mullet Lake Watershed

Stormwater Basins

Drainage Type

- Direct Drainage
- No Stormwater Management

Data Sources:
Stormwater Basins and Lines layer developed by Tip of the Mitt Watershed Council. Aerial Imagery provided by USDA National Agriculture Imagery Program. All other data acquired from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/.

N
W E
S

0 250 500 1,000 Feet

Stormwater Assessment - Wolverine, Michigan

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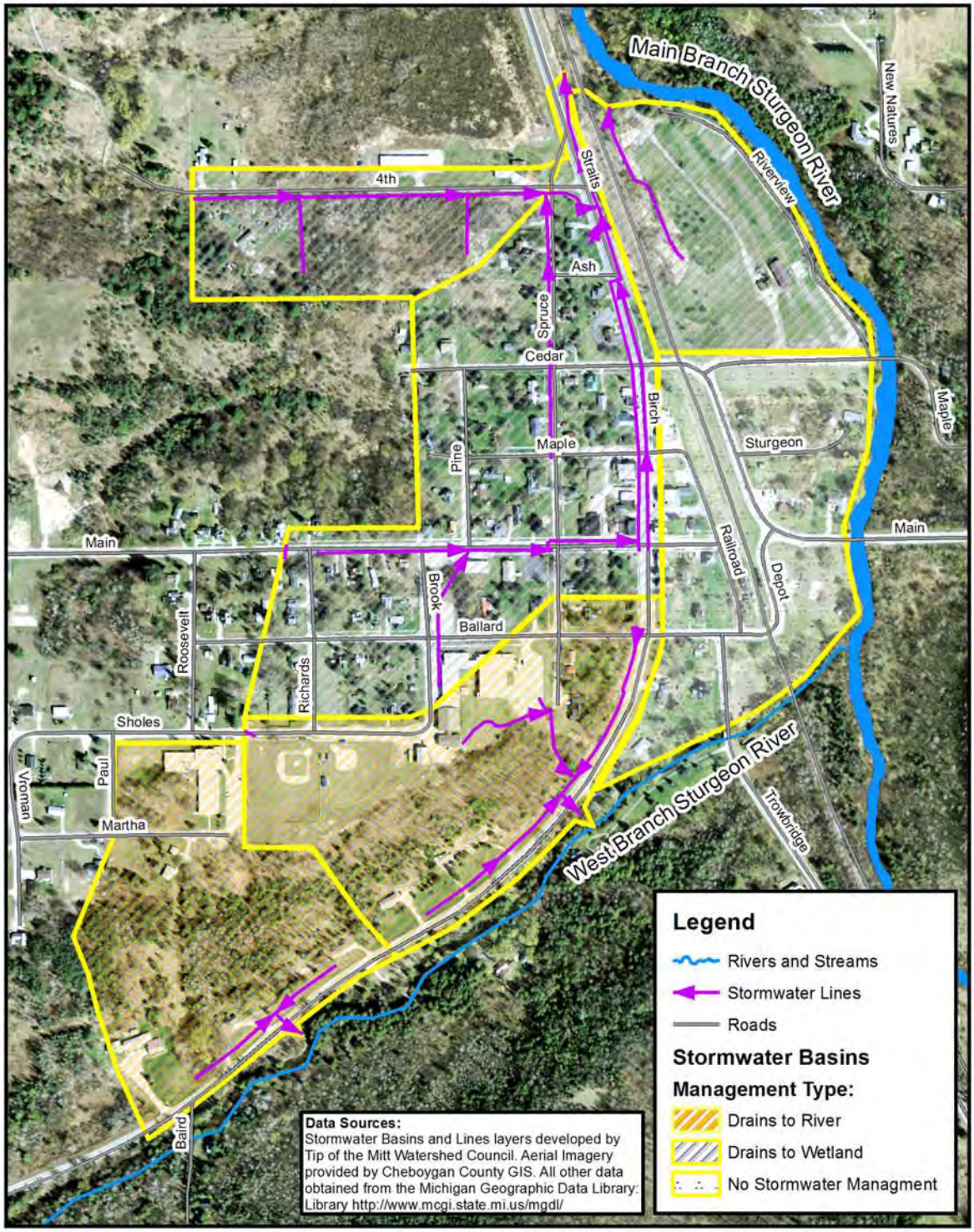


Road-Stream Crossing Inventory

Road-Stream Crossings that are improperly designed or installed, structurally failing, or no longer accommodate current stream conditions can negatively affect stream health. They can alter stream hydrology, prevent fish and other aquatic organisms from accessing upstream reaches, increase water temperatures, and are sources of nutrients, sediments, bacteria, heavy metals, and other nonpoint source pollutants. In Northern Michigan, sediments pose the greatest threat to rivers and streams. Sedimentation can adversely impact fish and aquatic organisms by degrading their habitat and reducing water quality.

TOMWC staff and interns conducted the inventory by evaluating road-stream crossings within the Crooked River, Maple River, and Burt Lake Direct Drainage watersheds. Project partner, Huron Pines, surveyed road-stream crossings within the Sturgeon River watershed. While not a complete inventory, (over 500 crossings were initially identified, many on intermittent streams) all accessible crossings on major rivers and streams were surveyed. The Great Lakes Road Stream Crossing protocol and database were used to conduct these inventories, ensuring data standardization with other projects across the great lakes basin. Using the standardized protocol, over 60 measurements or observations are made at each road-stream crossing. They include culvert(s) or bridge span dimensions, road width, slope, and fill depth. In-stream measurements include water velocity and depth at inlet and outlet, culvert perch height, and an evaluation of substrate conditions. A reference reach outside of the zone of influence for each crossing is taken. The measurements of "natural" conditions are then compared to in-structure conditions using a numeric model. The model evaluates fish passage through the crossing, and places each crossing into one of four categories that range from "passable by all organisms at all flow levels" to "passable by no organisms at any flow level". These classes are represented by values that range from 0 to 1. Erosion is also quantified by a numeric model, which estimates sediment inputs to the stream in tons per year. A combination of the two main parameters, fish passage and erosion, yields an overall severity ranking, either "minor", "moderate", or "severe".

In total, 168 road-stream crossings within the Burt Lake watershed were inventoried. Of the 168, 62 crossings were ranked severe (Table 1). Fish passage was poorest in the Burt Lake Direct Drainage, with 53% of all crossings acting as a complete barrier to fish passage (Value = 0). Fish passage was the best within the Sturgeon River Watershed, with 36% of all crossings posing no threat to fish passage (Value = 1), and 26% acting as a complete barrier (Table 2).

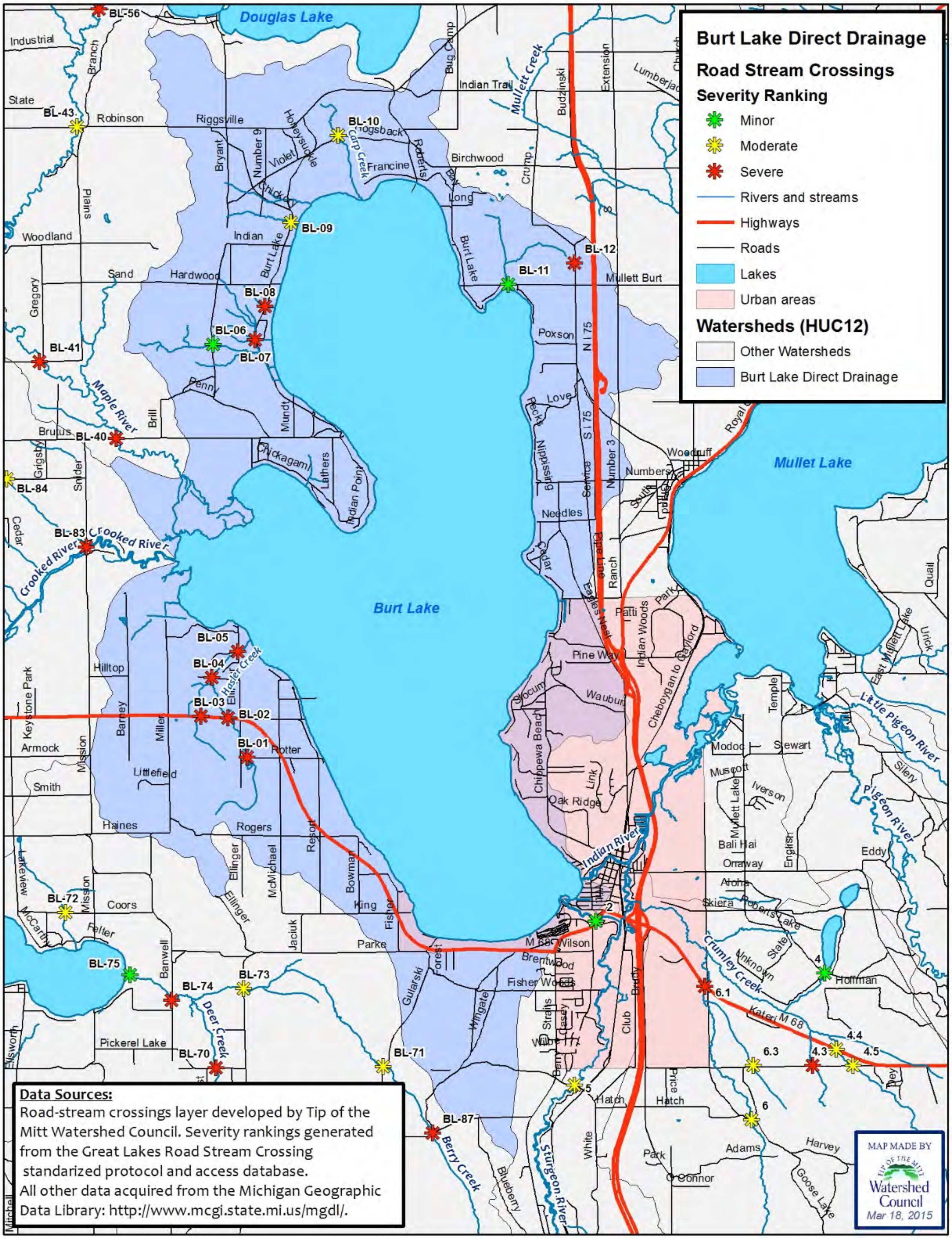
Table 1. Road-Stream Crossings by Subwatershed.

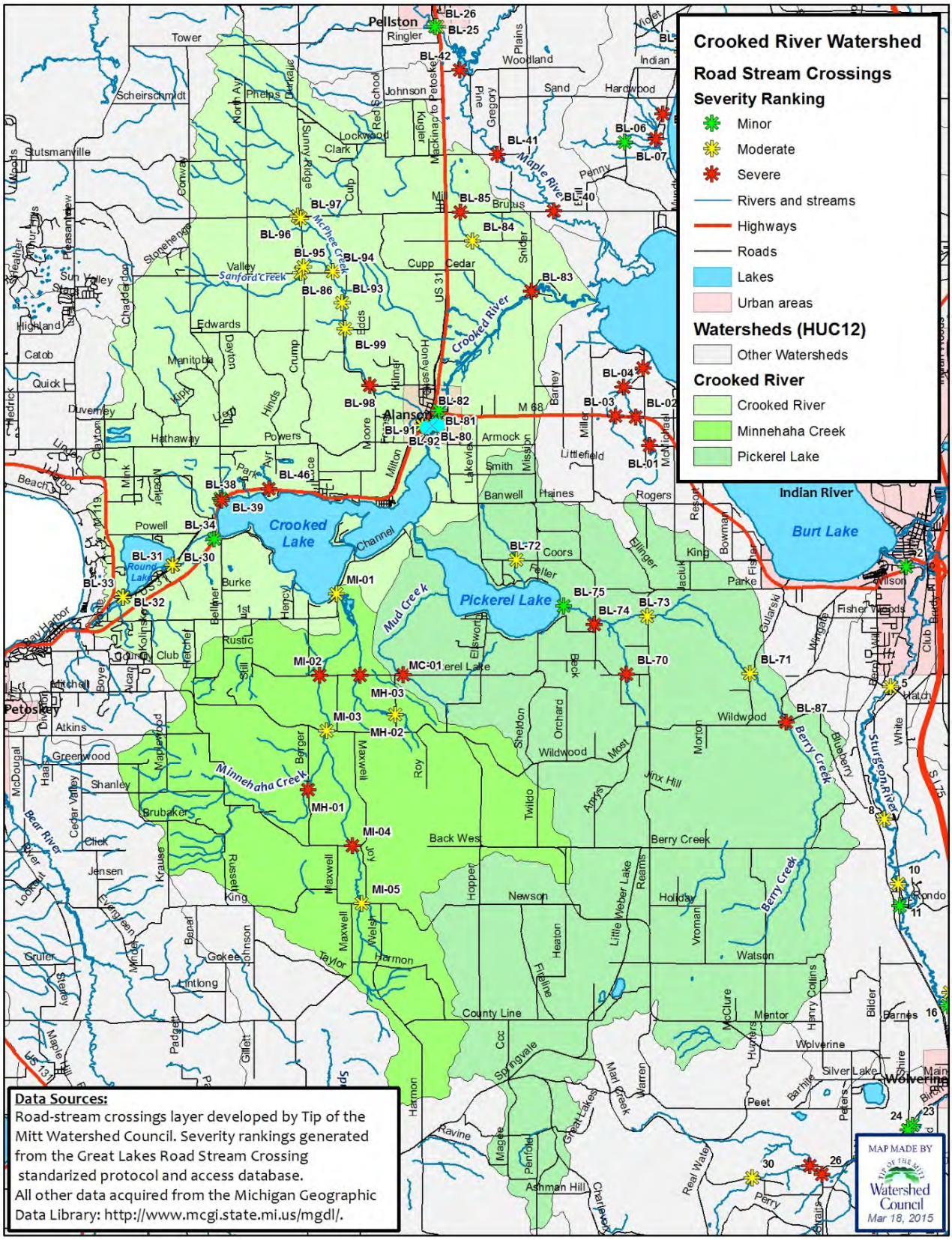
	Road-Stream Crossing Severity Ranking		
Subwatershed	Severe	Moderate	Minor
Burt Lake Direct Drainage	9	2	2
Crooked River	15	19	7
Maple River	9	8	11
Sturgeon River	29	27	30
All Subwatersheds	62	56	50

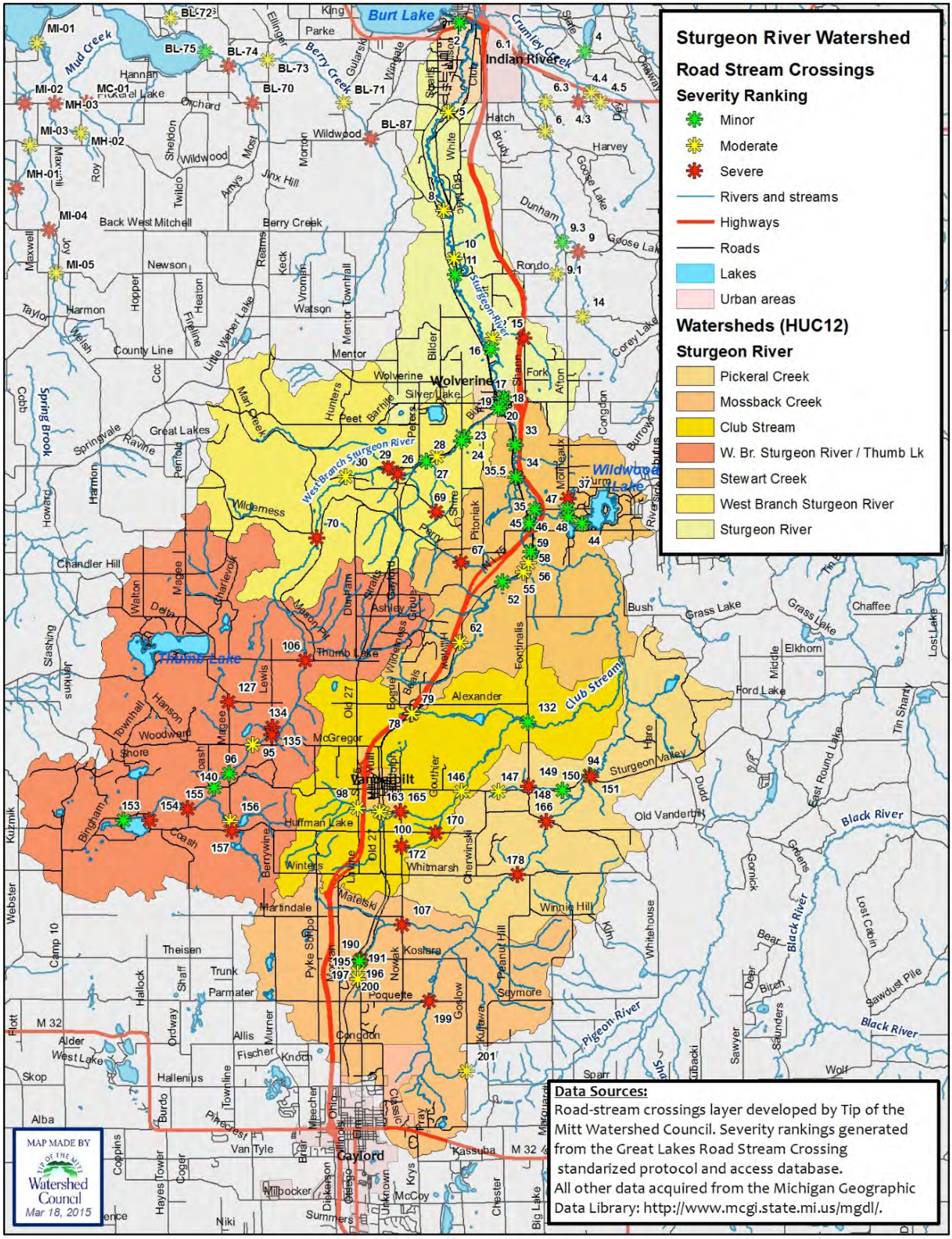
Table 2. Fish passage values for Road-Stream Crossings by Subwatershed.

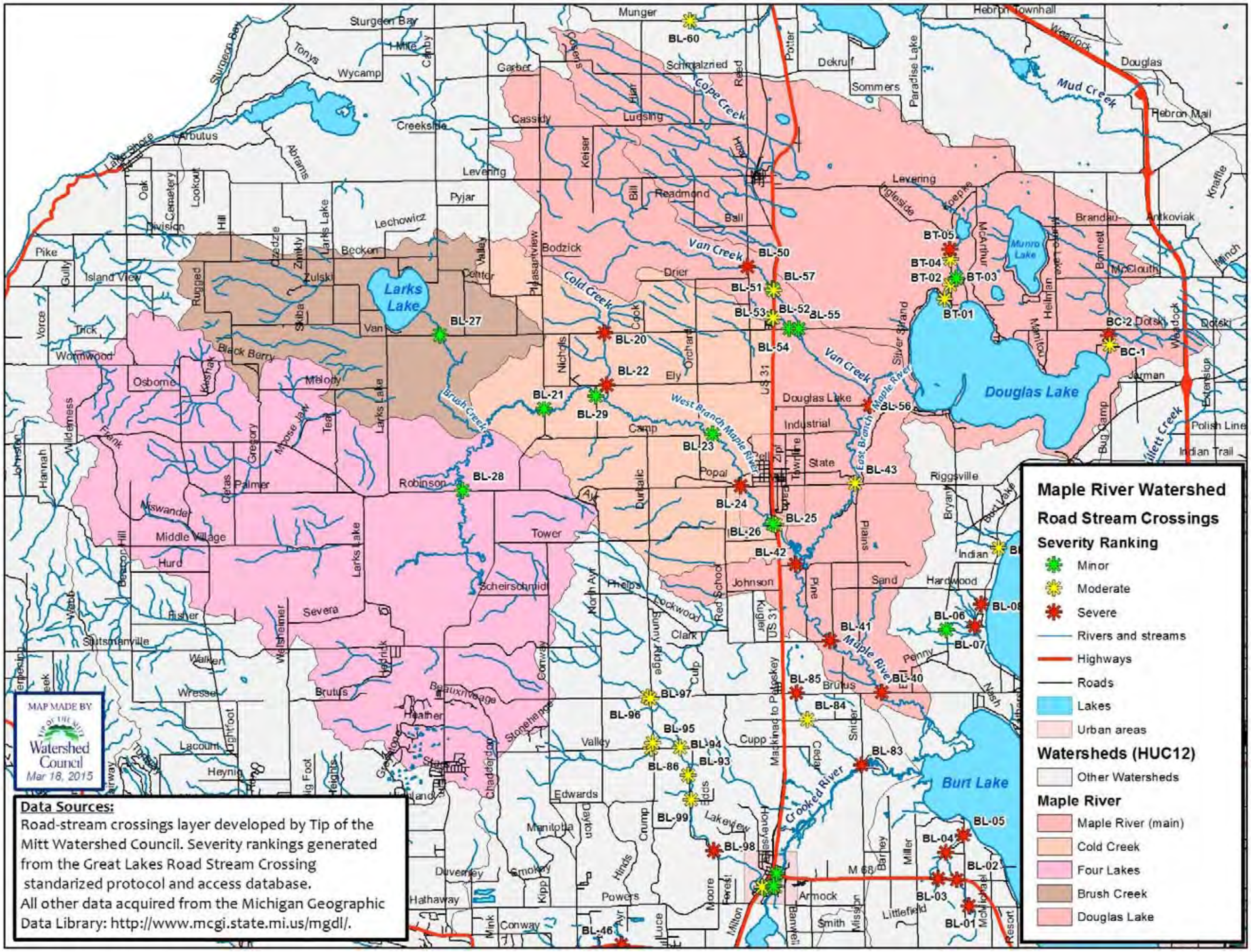
	Fish Passage Values			
Subwatershed	0	0.5	0.9	1
Burt Lake Direct Drainage	7	2	4	0
Crooked River	13	12	13	3
Maple River	7	6	15	0
Sturgeon River	23	19	13	31

The results have been compiled into a GIS, yielding the following maps. An interactive map with severity rankings, photos, and all data collected for this project is available on www.northernmichiganstreams.org.


Burt Lake Direct Drainage
Road Stream Crossings
Severity Ranking
Minor
Moderate
Severe
Rivers and streams
Highways
Roads
Lakes
Urban areas
Watersheds (HUC12)
Other Watersheds
Burt Lake Direct Drainage
Douglas Lake
Burt Lake
Mullet Lake
Crooked River
Maple River
Indian River
Pigeon River
Little Pigeon River
Sturgeon River
Mullett Creek
Crumley Creek
Berry Creek
Deer Creek
Carp Creek
Hasler Creek
BL-56
BL-43
BL-10
BL-09
BL-12
BL-11
BL-08
BL-06
BL-07
BL-41
BL-40
BL-84
BL-83
BL-05
BL-04
BL-03
BL-02
BL-01
BL-72
BL-75
BL-74
BL-73
BL-70
BL-71
BL-87
Data Sources:
Road-stream crossings layer developed by Tip of the Mitt Watershed Council. Severity rankings generated from the Great Lakes Road Stream Crossing standarized protocol and access database.
All other data acquired from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/.
MAP MADE BY
Tip of the Mitt Watershed Council
Mar 18, 2015


Crooked River Watershed
Road Stream Crossings
Severity Ranking
Minor
Moderate
Severe
Rivers and streams
Highways
Roads
Lakes
Urban areas
Watersheds (HUC12)
Other Watersheds
Crooked River
Crooked River
Minnehaha Creek
Pickerel Lake
Data Sources:
Road-stream crossings layer developed by Tip of the Mitt Watershed Council. Severity rankings generated from the Great Lakes Road Stream Crossing standarized protocol and access database.
All other data acquired from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/.
MAP MADE BY
Tip of the Mitt Watershed Council
Mar 18, 2015


Sturgeon River Watershed
Road Stream Crossings
Severity Ranking
Minor
Moderate
Severe
Rivers and streams
Highways
Roads
Lakes
Urban areas
Watersheds (HUC12)
Sturgeon River
Pickeral Creek
Mossback Creek
Club Stream
W. Br. Sturgeon River / Thumb Lk
Stewart Creek
West Branch Sturgeon River
Sturgeon River
Burt Lake
Indian River
Wolverine
Vanderbilt
Gaylord
Thumb Lake
Wildwood Lake
Data Sources:
Road-stream crossings layer developed by Tip of the Mitt Watershed Council. Severity rankings generated from the Great Lakes Road Stream Crossing standarized protocol and access database.
All other data acquired from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/.
MAP MADE BY
Tip of the Mitt Watershed Council
Mar 18, 2015


Maple River Watershed
Road Stream Crossings
Severity Ranking
Minor
Moderate
Severe
Rivers and streams
Highways
Roads
Lakes
Urban areas
Watersheds (HUC12)
Other Watersheds
Maple River
Maple River (main)
Cold Creek
Four Lakes
Brush Creek
Douglas Lake
Data Sources:
Road-stream crossings layer developed by Tip of the Mitt Watershed Council. Severity rankings generated from the Great Lakes Road Stream Crossing standarized protocol and access database.
All other data acquired from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/.
MAP MADE BY
Tip of the Mitt Watershed Council
Mar 18, 2015
Larks Lake
Douglas Lake
Burt Lake
Munro Lake
Van Creek
Cold Creek
Brush Creek
Cope Creek
Mud Creek
Crooked River
Maple River
West Branch Maple River
East Branch Maple River

Streambank Alterations and Erosion Survey

Tip of the Mitt Watershed Council preformed streambank surveys for the Crooked, Maple, and Sturgeon Rivers. Methodologies developed and used extensively by TOMWC staff for similar surveys were employed to document and assess streambank erosion. These surveys were carried out during the late spring of 2014 and 2015.

The streambank surveys aimed to document conditions and activities at every riverside property that potentially impact water quality and the stream ecosystem. Streambank conditions were surveyed in the navigable river sections by traveling in canoes. For non-navigable stream sections, Watershed Council staff and interns walked 500 feet of channel upstream and downstream at road-stream crossings where the stream was accessible.

Greenbelts, streambank alterations, tributary streams, and the presence of invasive species were documented for all streamside properties. Any visible erosion (i.e. lack of vegetation and apparent weathering of the soil surface) was measured, photographed and qualitatively described. Linear streambank alteration features (such as sea walls) were captured with a mapping grade GPS for later incorporation into GIS for data analysis.

The following scoring and annotation systems were used when filling out the datasheet:

Greenbelt Vegetation Score:

Length of Greenbelt: 0 : None, 1: 1-10%, 2: 10-25%, 3: 25-75%, 4: >75%

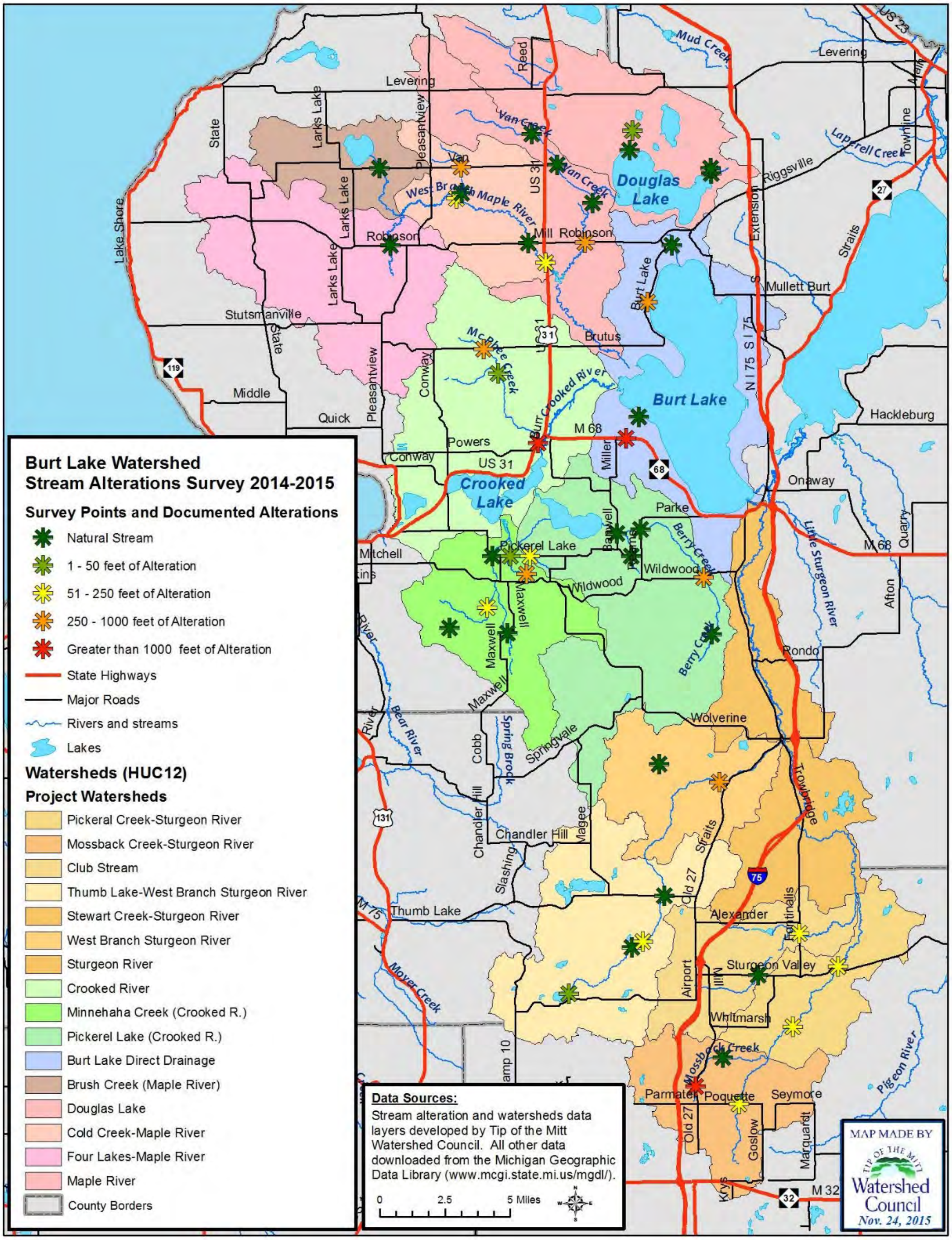
Depth of Greenbelt: 0: None, 1: <10 ft, 2: 10-40 ft, 3: >40 ft

Shoreline alterations were surveyed and noted with the following abbreviated descriptions:

SB = steel bulkhead (i.e., seawall)	BB = boulder bulkhead
CB = concrete bulkhead	RR = rock rip-rap
WB = wood bulkhead	BR = Mixed boulder/rock riprap
BH = permanent boathouse	BS = beach sand
G = groin	DP = discharge pipe

Abbreviations were sometimes mixed or vary from what is listed above.

All spatial data was compiled in a GIS and merged with other data taken for each site. Greenbelt scores were added, along with linear footage of alterations and alteration type. The following maps depict the results, on a watershed wide scale for non-navigable waters, and as a comprehensive inventory for the navigable reaches of the Sturgeon, Crooked, and Maple Rivers.



Burt Lake Watershed
Stream Alterations Survey 2014-2015
Survey Points and Documented Alterations
Natural Stream
1 - 50 feet of Alteration
51 - 250 feet of Alteration
250 - 1000 feet of Alteration
Greater than 1000 feet of Alteration
State Highways
Major Roads
Rivers and streams
Lakes
Watersheds (HUC12)
Project Watersheds
Pickeral Creek-Sturgeon River
Mossback Creek-Sturgeon River
Club Stream
Thumb Lake-West Branch Sturgeon River
Stewart Creek-Sturgeon River
West Branch Sturgeon River
Sturgeon River
Crooked River
Minnehaha Creek (Crooked R.)
Pickerel Lake (Crooked R.)
Burt Lake Direct Drainage
Brush Creek (Maple River)
Douglas Lake
Cold Creek-Maple River
Four Lakes-Maple River
Maple River
County Borders
Data Sources:
Stream alteration and watersheds data layers developed by Tip of the Mitt Watershed Council. All other data downloaded from the Michigan Geographic Data Library (www.mcgi.state.mi.us/mgdl/).
0 2.5 5 Miles
MAP MADE BY
Tip of the Mitt
Watershed Council
Nov. 24, 2015
Douglas Lake
Burt Lake
Crooked Lake
Mud Creek
Van Creek
West Branch Maple River
Laperell Creek
McPhee Creek
Crooked River
Berry Creek
Little Sturgeon River
Bear River
Spring Brook
Mover Creek
Mossback Creek
Pigeon River
Levering
Riggsville
Mullett Burt
Stutsmanville
Brutus
Powers
Conway
Hackleburg
Onaway
Parke
Pickerel Lake
Wildwood
Rondo
Wolverine
Alexander
Sturgeon Valley
Whitmarsh
Parmater
Poquette
Seymore
Mill Robinson
Robinson
US 31
US 23
M 68
M 32
I 75
Thumb Lake
Chandler Hill
Springvale
Maxwell
Afton
Quarry
Middle
Quick
Mitchell

Streambank Erosion and Greenbelt Survey 2014 - 2015

Maple River: Woodland Road to Maple River Road

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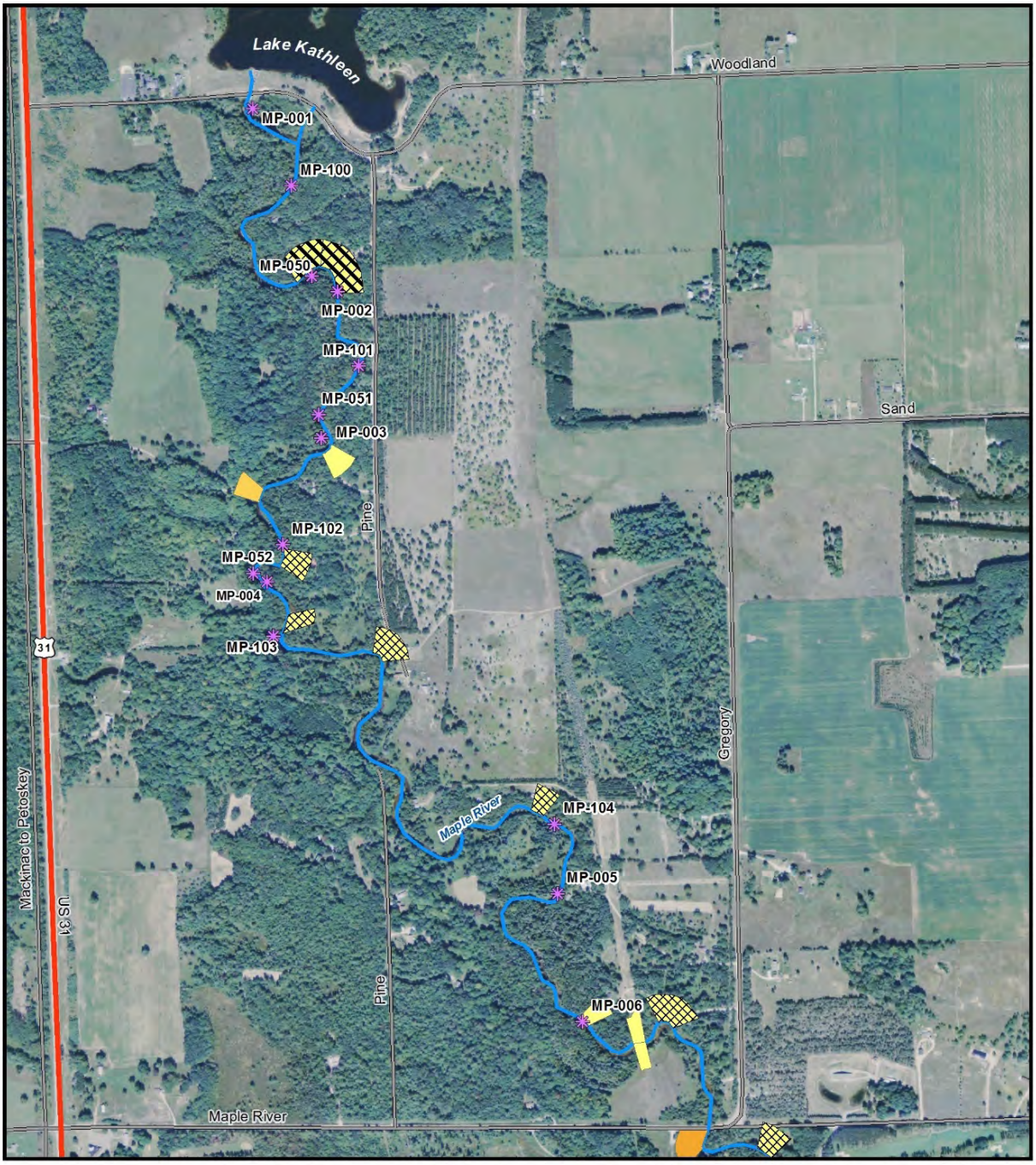

Greenbelt Scores

- 0 - 1 (Very Poor)
- 2 - 3 (Poor)
- 4 (Moderate)
- 5 - 7 (Good)

Unaltered shoreline: no overlay

Shoreline Alteration Overlays

- Boulders
- Wood Bulkhead
- Seawall
- Rip Rap
- Concrete Bulkhead
- Streambank Erosion Sites

- Rivers and Streams
- State Roads & Highways
- Roads

0 500 1,000 2,000 Feet

Data Sources:

Streambank erosion, alteration, and greenbelt layers developed by Tip of the Mitt Watershed Council. Aerial Imagery provided by USDA-FSA Aerial Photography Field Office. All other data obtained from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/

Streambank Erosion and Greenbelt Survey 2014 - 2015

Maple River: Maple River Road to Brutus Road

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Greenbelt Scores

- 0 - 1 (Very Poor)
- 2 - 3 (Poor)
- 4 (Moderate)
- 5 - 7 (Good)

Unaltered shoreline: no overlay

Shoreline Alteration Overlays

- Boulders
- Wood Bulkhead
- Seawall
- Rip Rap
- Concrete Bulkhead
- Streambank Erosion Sites

- Rivers and Streams
- State Roads & Highways
- Roads

0 500 1,000 2,000 Feet

N W E S

Data Sources:

Streambank erosion, alteration, and greenbelt layers developed by Tip of the Mitt Watershed Council. Aerial Imagery provided by USDA-FSA Aerial Photography Field Office. All other data obtained from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/

Streambank Erosion and Greenbelt Survey 2014 - 2015
Crooked River: Alanson Area and Upper Portions

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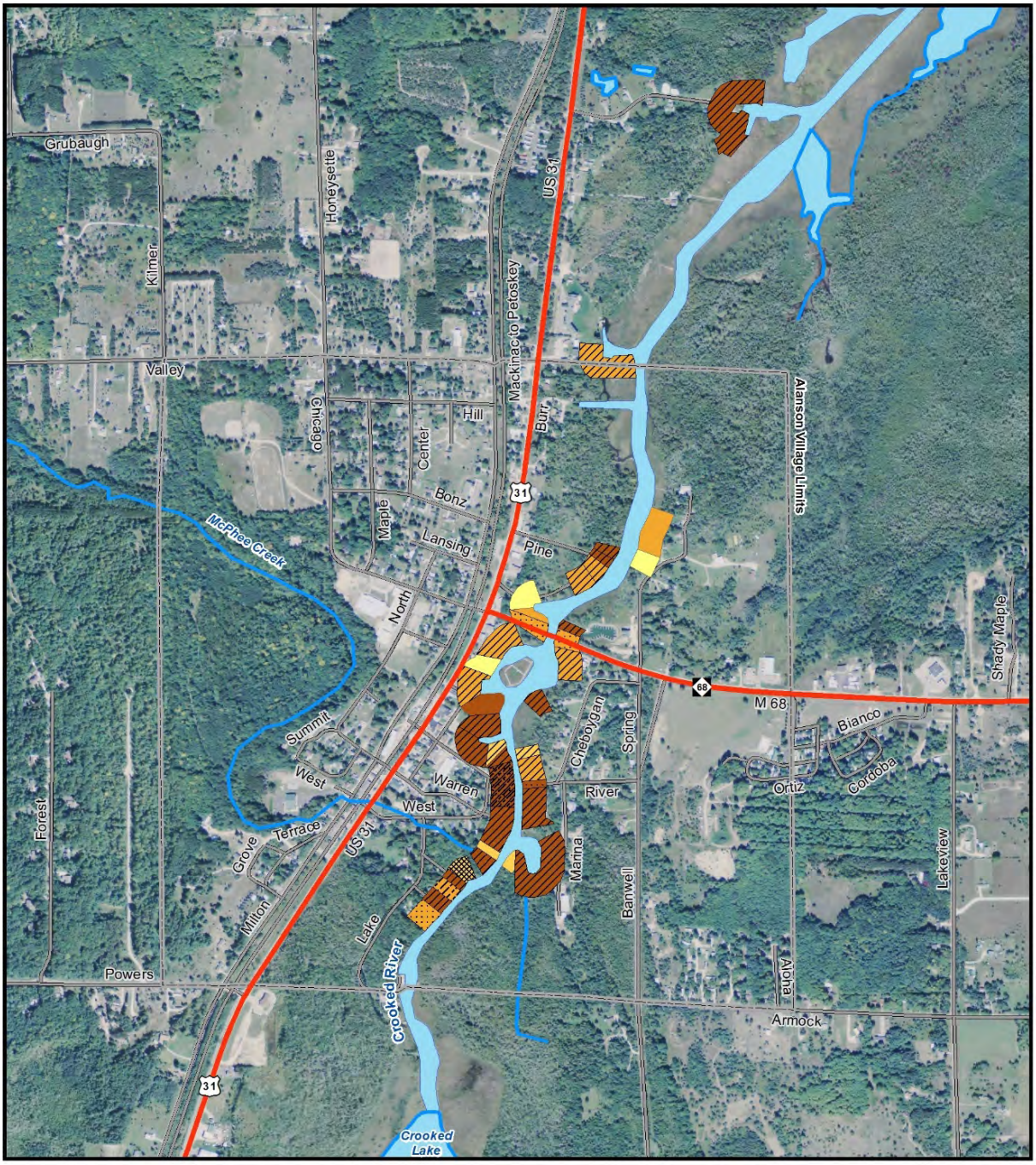

Greenbelt Scores
- 0 - 1 (Very Poor)
- 2 - 3 (Poor)
- 4 (Moderate)
- 5 - 7 (Good)

Unaltered shoreline: no overlay

Shoreline Alteration Overlays
- Boulders
- Wood Bulkhead
- Seawall
- Rip Rap
- Concrete Bulkhead
- Streambank Erosion Sites

- Rivers and Streams
- State Roads & Highways
- Roads

Feet: 0 500 1,000 2,000

Data Sources:
Erosion and Greenbelt layers developed by Tip of the Mitt Watershed Council. Aerial Imagery provided by USDA-FSA Aerial Photography Field Office. All other data obtained from the Michigan Geographic Data Library:
http://www.mcgi.state.mi.us/mgdl/

Streambank Erosion and Greenbelt Assessment 2014 - 2015
Crooked River: Lower and Mouth

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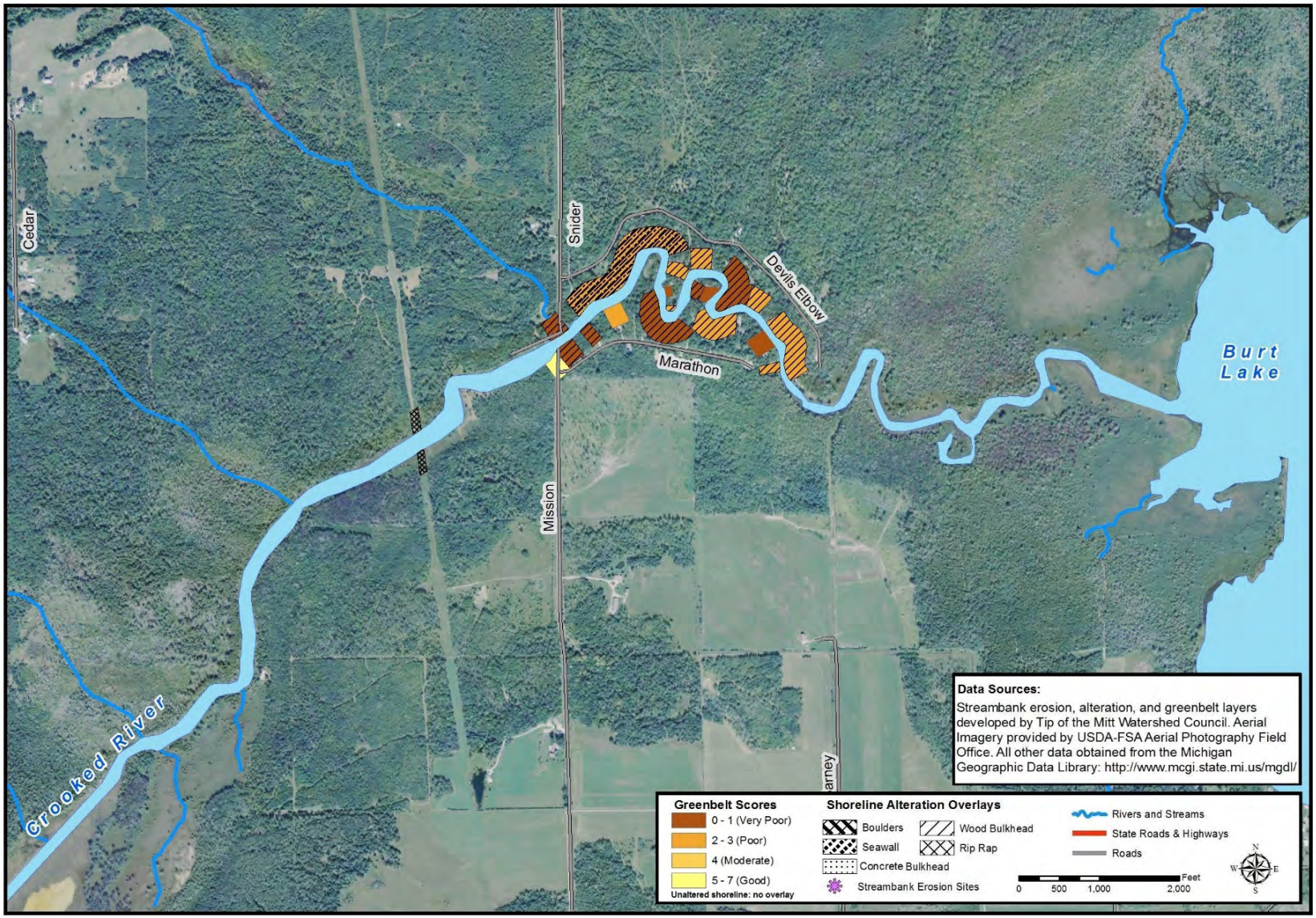

Streambank Erosion and Greenbelt Survey 2014 - 2015

Sturgeon River: Trowbridge Road to Wolverine

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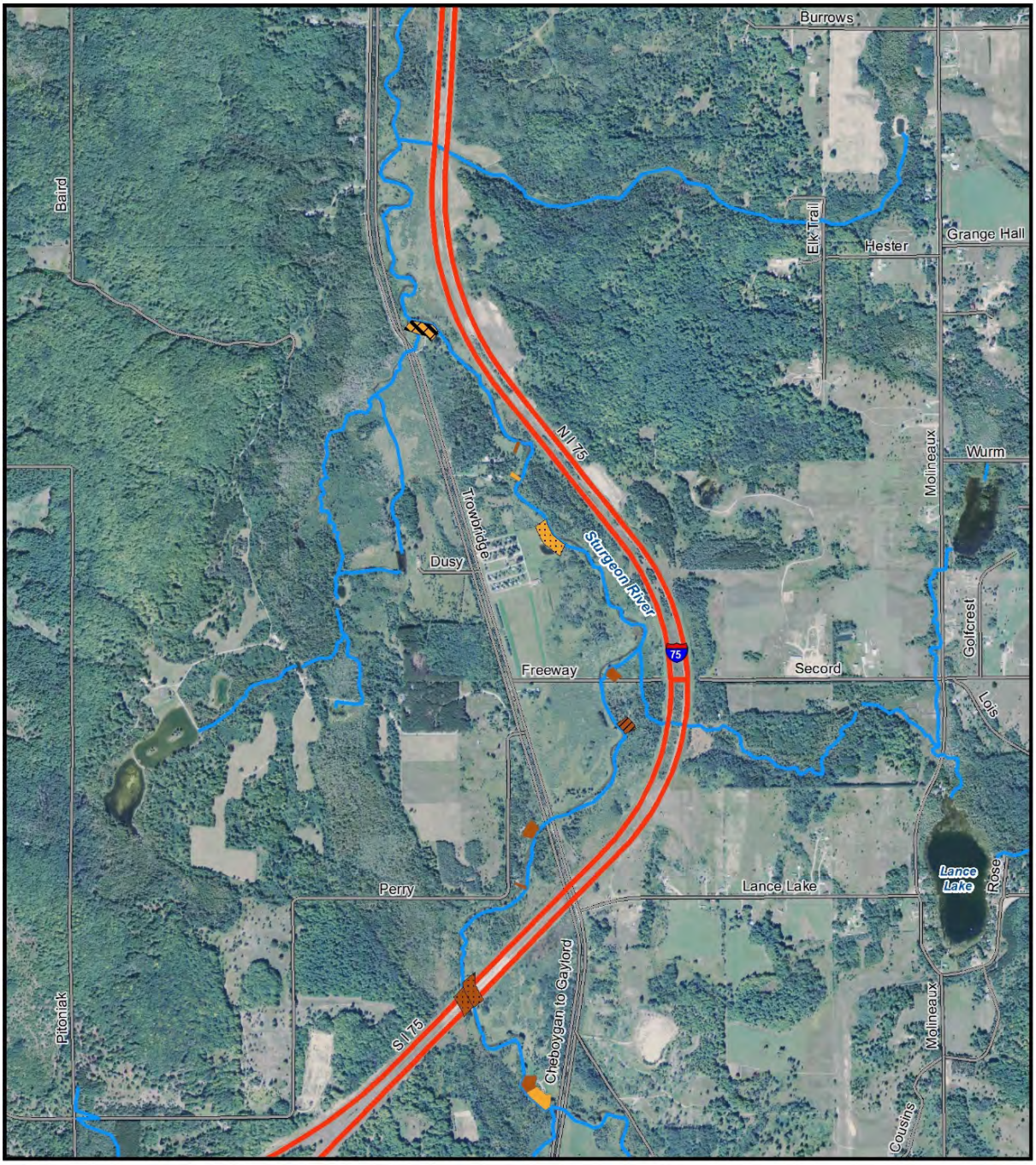

Greenbelt Scores

- 0 - 1 (Very Poor)
- 2 - 3 (Poor)
- 4 (Moderate)
- 5 - 7 (Good)

Unaltered shoreline: no overlay

Shoreline Alteration Overlays

- Boulders
- Wood Bulkhead
- Seawall
- Rip Rap
- Concrete Bulkhead
- Streambank Erosion Sites

- Rivers and Streams
- State Roads & Highways
- Roads

0 500 1,000 2,000 Feet

Data Sources:

Streambank erosion, alteration, and greenbelt layers developed by Tip of the Mitt Watershed Council. Aerial Imagery provided by USDA-FSA Aerial Photography Field Office. All other data obtained from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/

Streambank Erosion and Greenbelt Assessment 2015

West Branch Sturgeon River - Old 27 Roadside Park to Wolverine

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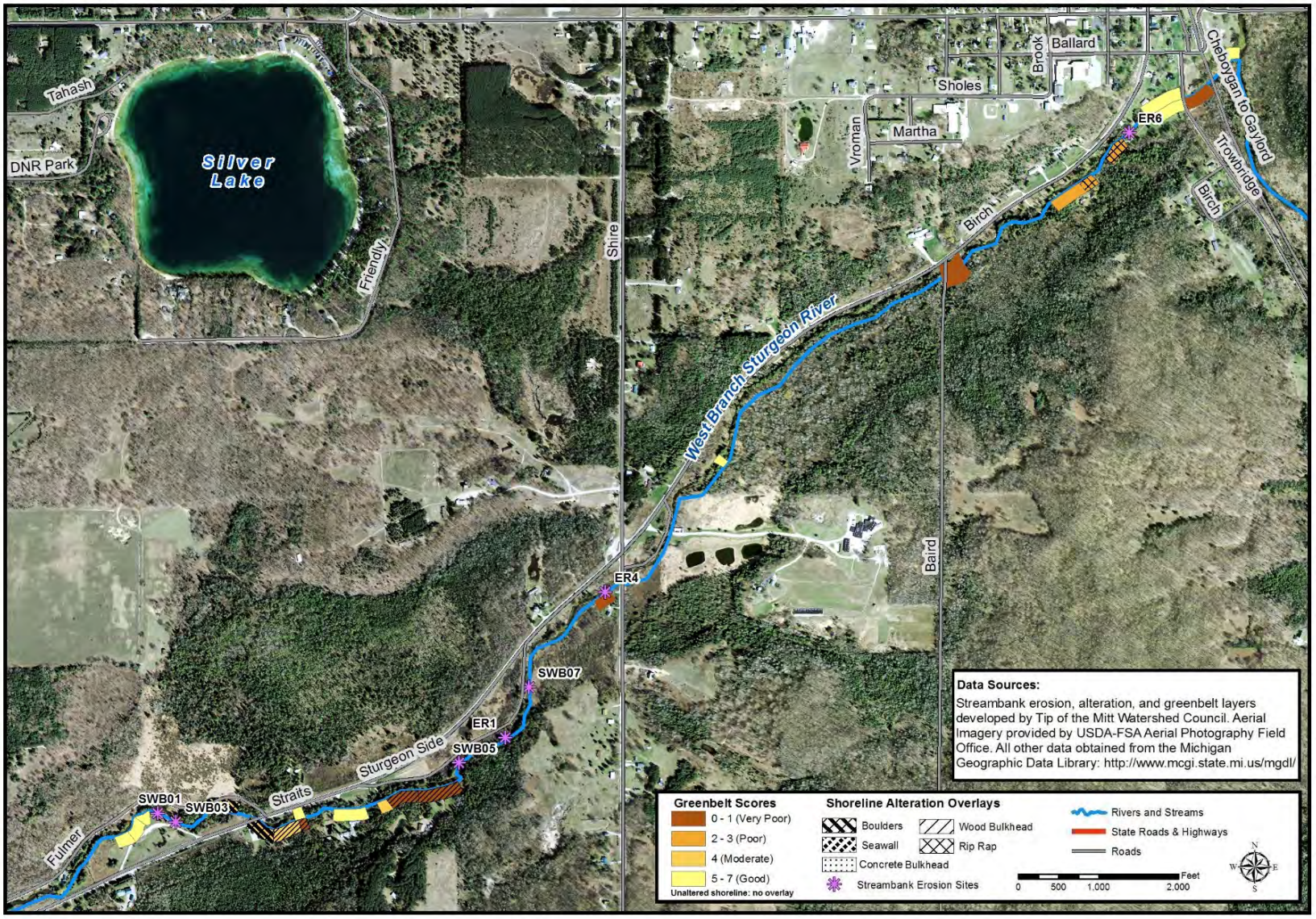

Streambank Erosion and Greenbelt Survey 2014 - 2015

Sturgeon River - Wolverine Area

Tip of the Mitt Watershed Council

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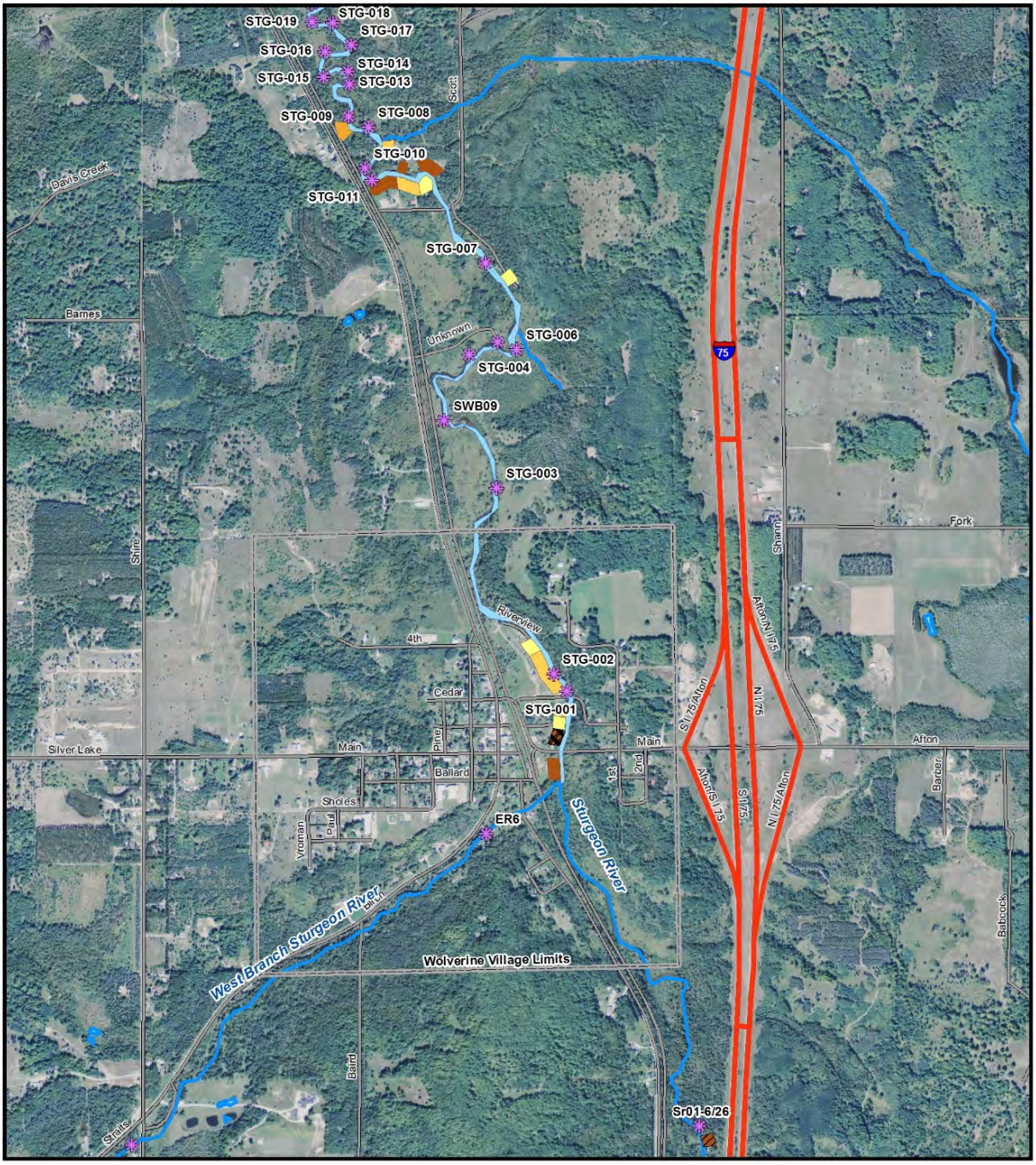

Greenbelt Scores

- 0 - 1 (Very Poor)
- 2 - 3 (Poor)
- 4 (Moderate)
- 5 - 7 (Good)

Unaltered shoreline: no overlay

Shoreline Alteration Overlays

- Boulders
- Wood Bulkhead
- Seawall
- Rip Rap
- Concrete Bulkhead
- Streambank Erosion Sites

- Rivers and Streams
- State Roads & Highways
- Roads

0 500 1,000 2,000 Feet

N W E S

Data Sources:

Erosion and Greenbelt layers developed by Tip of the Mitt Watershed Council. Aerial Imagery provided by USDA-FSA Aerial Photography Field Office. All other data obtained from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/

Streambank Erosion and Greenbelt Survey 2014 - 2015

Sturgeon River: Rondo Road Area

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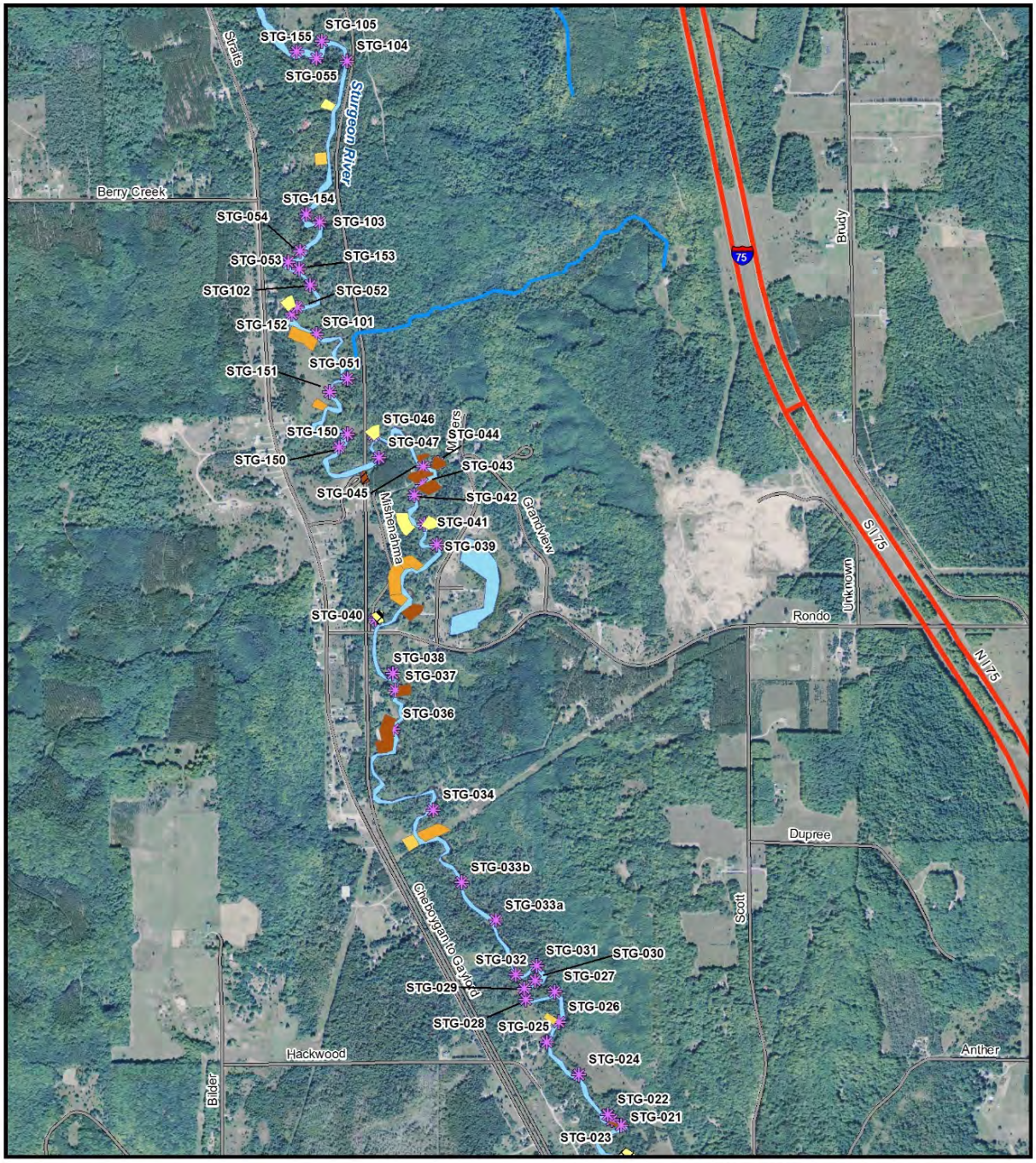

Greenbelt Scores
- 0 - 1 (Very Poor)
- 2 - 3 (Poor)
- 4 (Moderate)
- 5 - 7 (Good)

Unaltered shoreline: no overlay

Shoreline Alteration Overlays
- Boulders
- Wood Bulkhead
- Seawall
- Rip Rap
- Concrete Bulkhead
- Streambank Erosion Sites

- Rivers and Streams
- State Roads & Highways
- Roads

0 500 1,000 2,000 Feet

N W E S

Data Sources:
Erosion and Greenbelt layers developed by Tip of the Mitt Watershed Council. Aerial Imagery provided by USDA-FSA Aerial Photography Field Office. All other data obtained from the Michigan Geographic Data Library:
http://www.mcgi.state.mi.us/mgdl/

Streambank Erosion and Greenbelt Survey 2014 - 2015

Sturgeon River: White Road (South) to White Road (North)

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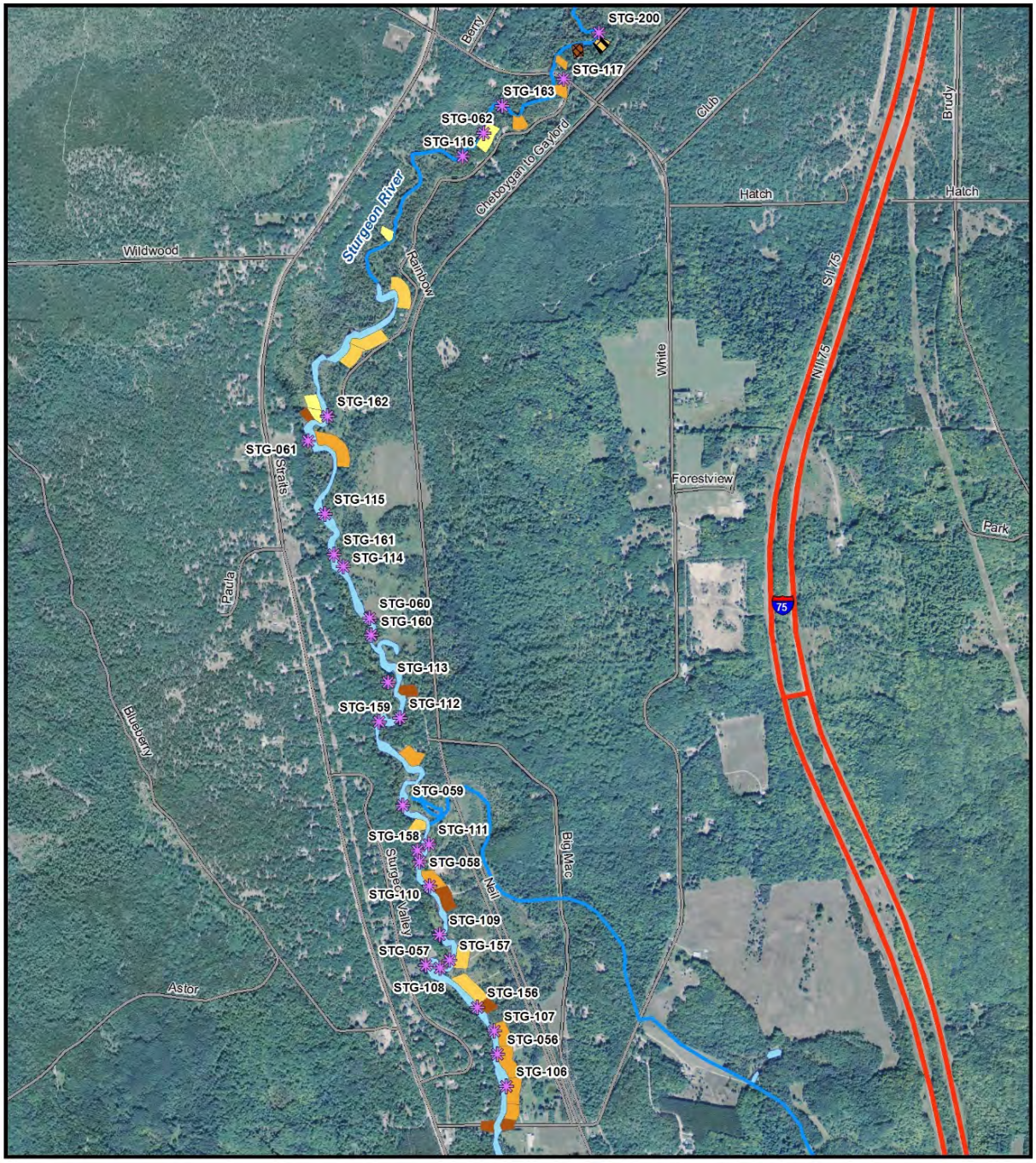

Greenbelt Scores
- 0 - 1 (Very Poor)
- 2 - 3 (Poor)
- 4 (Moderate)
- 5 - 7 (Good)

Unaltered shoreline: no overlay

Shoreline Alteration Overlays
- Boulders
- Wood Bulkhead
- Seawall
- Rip Rap
- Concrete Bulkhead
- Streambank Erosion Sites

- Rivers and Streams
- State Roads & Highways
- Roads

0 500 1,000 2,000 Feet

N W E S

Data Sources:
Erosion and Greenbelt layers developed by Tip of the Mitt Watershed Council. Aerial Imagery provided by USDA-FSA Aerial Photography Field Office. All other data obtained from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/

Streambank Erosion and Greenbelt Survey 2014 - 2015
Sturgeon River: White Road (North) to Burt Lake

Tip of the Mitt Watershed Council
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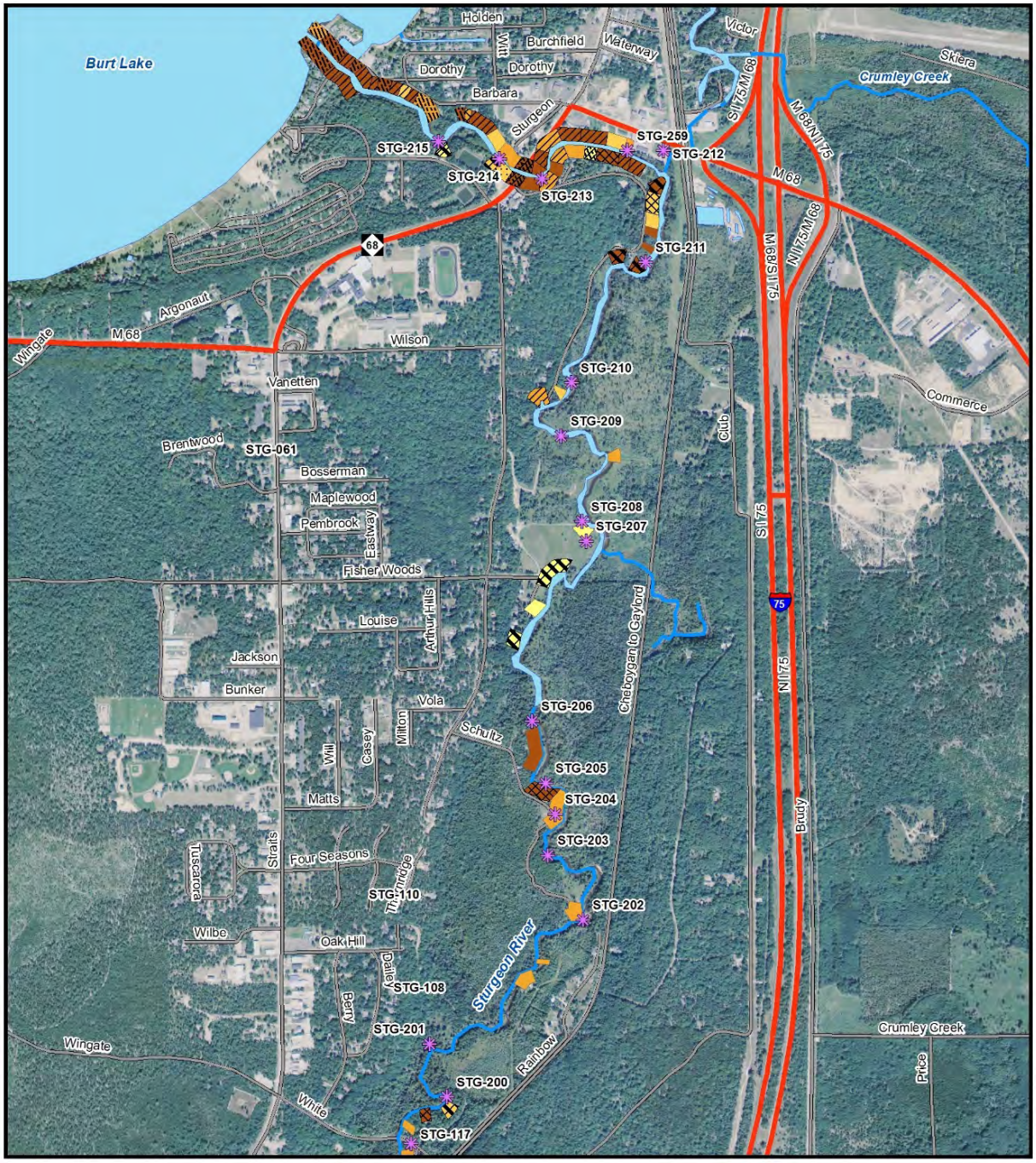


Greenbelt Scores
- 0 - 1 (Very Poor)
- 2 - 3 (Poor)
- 4 (Moderate)
- 5 - 7 (Good)

Unaltered shoreline: no overlay

Shoreline Alteration Overlays
- Boulders
- Wood Bulkhead
- Seawall
- Rip Rap
- Concrete Bulkhead
- Streambank Erosion Sites

- Rivers and Streams
- State Roads & Highways
- Roads

0 500 1,000 2,000 Feet

N W E S

Data Sources:
Erosion and Greenbelt layers developed by Tip of the Mitt Watershed Council. Aerial Imagery provided by USDA-FSA Aerial Photography Field Office. All other data obtained from the Michigan Geographic Data Library:
http://www.mcgi.state.mi.us/mgdl/

Agriculture Inventory

Agricultural operations can contribute nonpoint source pollution to surface waters. Potential inputs to water bodies, usually from runoff, include nutrients, sediment, fecal bacteria, and other contaminates. In 2015, the Tip of the Mitt Watershed Council performed a three-part inventory of agriculture in the Burt Lake Watershed. The components of this inventory were:

1) A spatial inventory of agricultural lands in the Watershed in a Geographic Information System, using Coastal Change Analysis Program landcover data from the National Oceanic and Atmospheric Administration.
2) A windshield survey of select agricultural lands in the Watershed, using methodology developed by the University of Michigan, School of Natural Resources and the Environment based off the Watershed Inventory Workbook for Indiana. This inventory scored farms based on proximity to water bodies, slopes, use of pesticides, use of tillage, livestock access to streams, vegetation buffers along the perimeter, mowing between orchard rows, and riparian vegetation.
3) Consultations with agriculture managers such as local Conservation Districts about agricultural activities in the Watershed were conducted. MAEAP certified farms were were identified within the watershed.
4) All data was compiled into a GIS to render the maps below.

The Burt Lake Watershed has 33,644 acres of agricultural landcover, representing 9.07% of the total watershed area (Table 1). Of the agricultural landcover, 28,970 acres (86.11%) is cropland while 4,674 acres (13.89%) is pasture or hay (Table 2). Common agricultural activities include growing corn, cows, horses, hay, grapes, maple trees, wheat, bees, and ornamental trees. In 1985, the Watershed had 30,742 acres of agricultural landcover representing 8.28% of the total watershed area. Between 1985 and 2010, agricultural landcover increased by 2,902 acres (0.78%) (Table 4).

Table 1. Agricultural lands by subwatershed IN 2010 (NOAA 2010)

Subwatershed Name	Size (acres)	Agriculture (acres)	Agriculture (%)
Burt Lake Immediate Watershed	40,753	1,982	4.86%
Crooked River Watershed	97,343	9,437	9.70%
Maple River Watershed	107,061	13,184	12.31%
Sturgeon River Watershed	125,974	9,041	7.18%
BURT LAKE WATERSHED	371,131	33,644	9.07%

Table 2. Cropland and pasture/hay by subwatershed (NOAA 2010)

Subwatershed Name	Cropland (acres)	Cropland (%)*	Pasture / Hay (acres)	Pasture / Hay (%)*
Burt Lake Immediate Watershed	1,723	86.93%	259	13.07%
Crooked River Watershed	8,127	86.11%	1,310	13.89%
Maple River Watershed	10,968	83.19%	2,216	16.81%
Sturgeon River Watershed	8,152	90.17%	889	9.83%
BURT LAKE WATERSHED	28,970	86.11%	4,674	13.89%

*As a percentage of total agricultural land.

Table 3. Agricultural lands by subwatershed in 1985 (NOAA 1985)

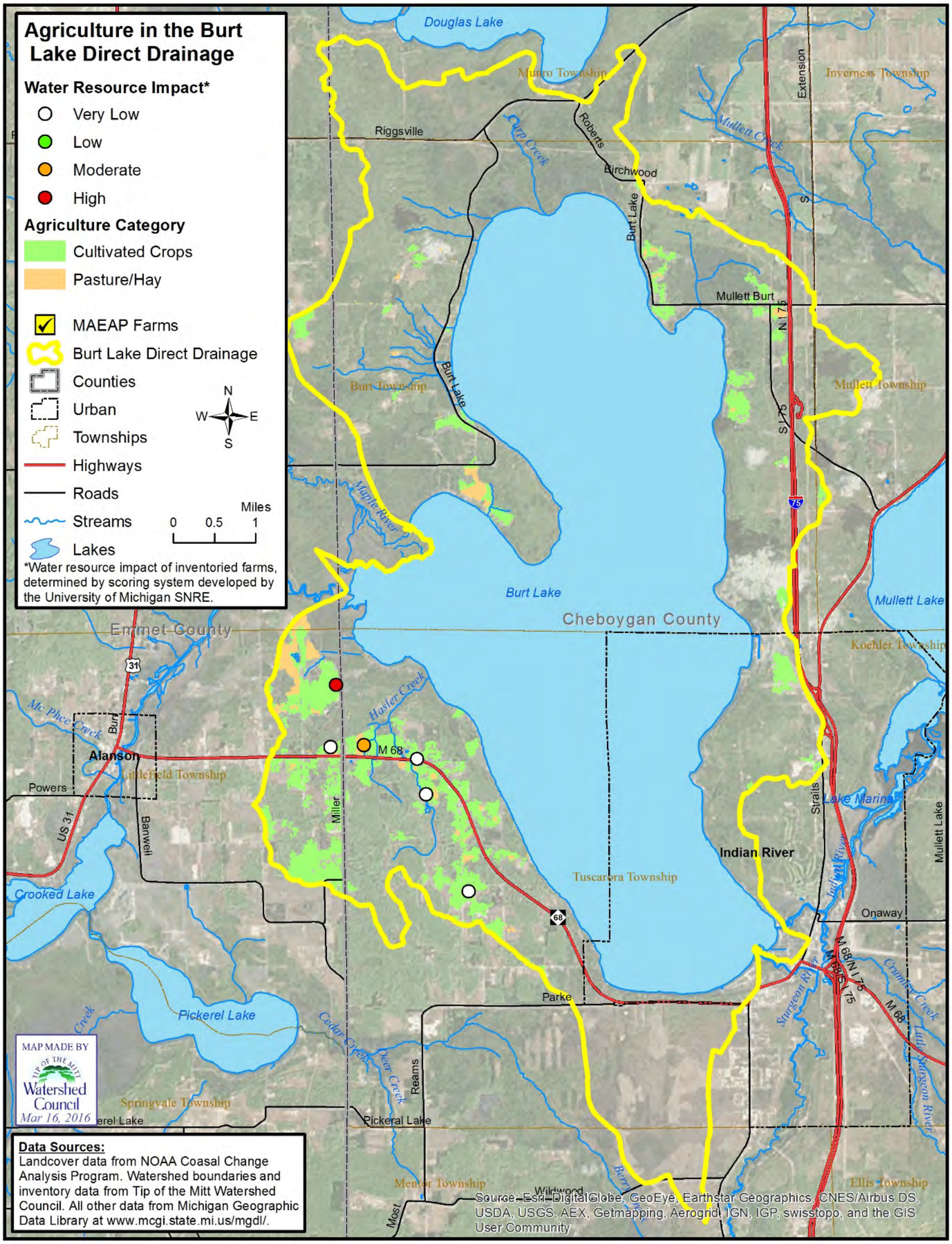
Subwatershed Name	Size (acres)	Agriculture (acres)	Agriculture (%)
Burt Lake Immediate Watershed	40,753	1,700	4.17%
Crooked River Watershed	97,343	7,855	8.07%
Maple River Watershed	107,061	12,405	11.59%
Sturgeon River Watershed	125,974	8,782	6.97%
BURT LAKE WATERSHED	371,131	30,742	8.28%

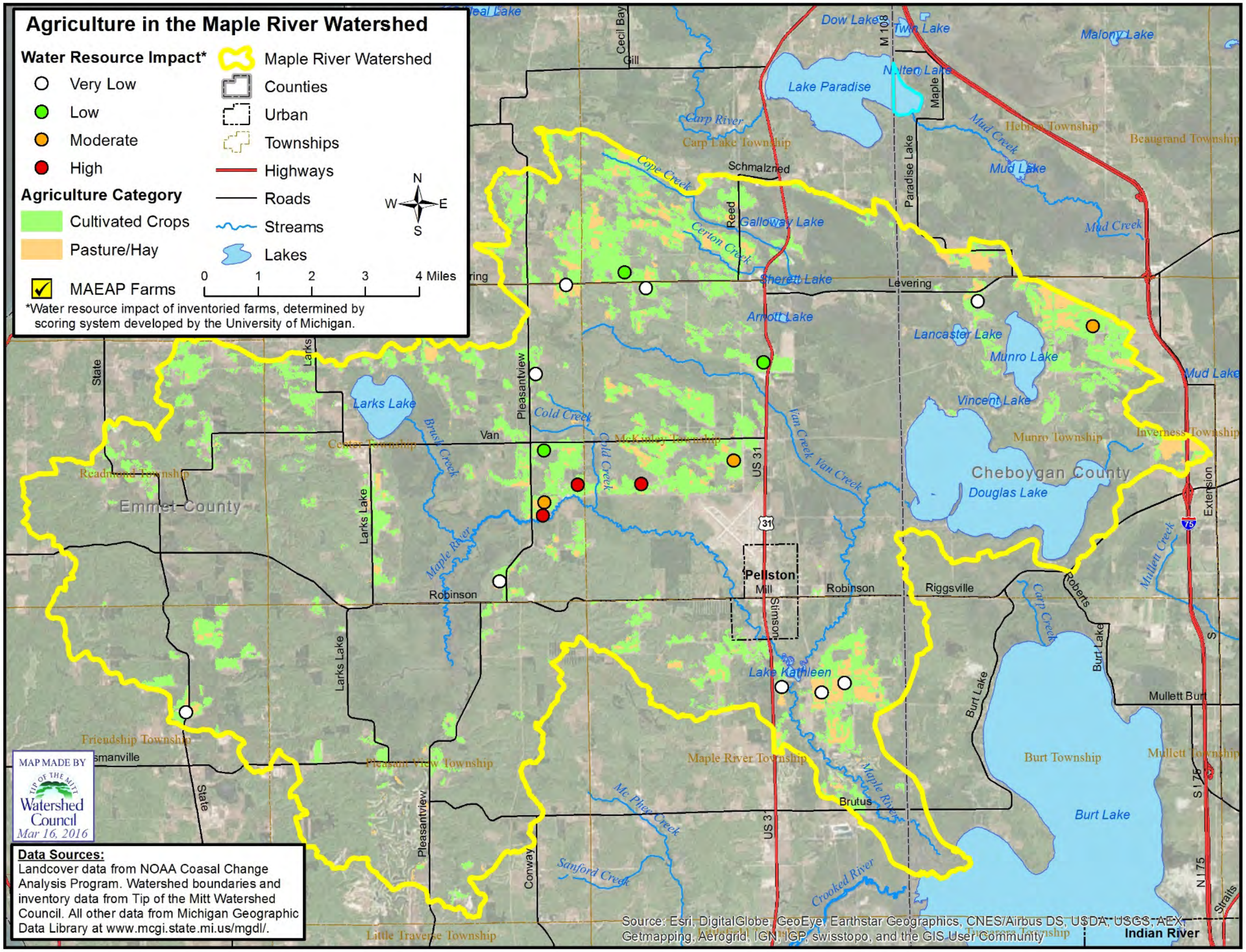
Table 4. Agricultural landcover change by subwatershed 1985-2010 (NOAA 1985, 2010)

Subwatershed Name	Agriculture Change 1985-2010 (acres)	Agriculture Change 1985-2010 (%)*
Burt Lake Immediate Watershed	282	0.69%
Crooked River Watershed	1,582	1.63%
Maple River Watershed	780	0.73%
Sturgeon River Watershed	259	0.21%
BURT LAKE WATERSHED	2,902	0.78%

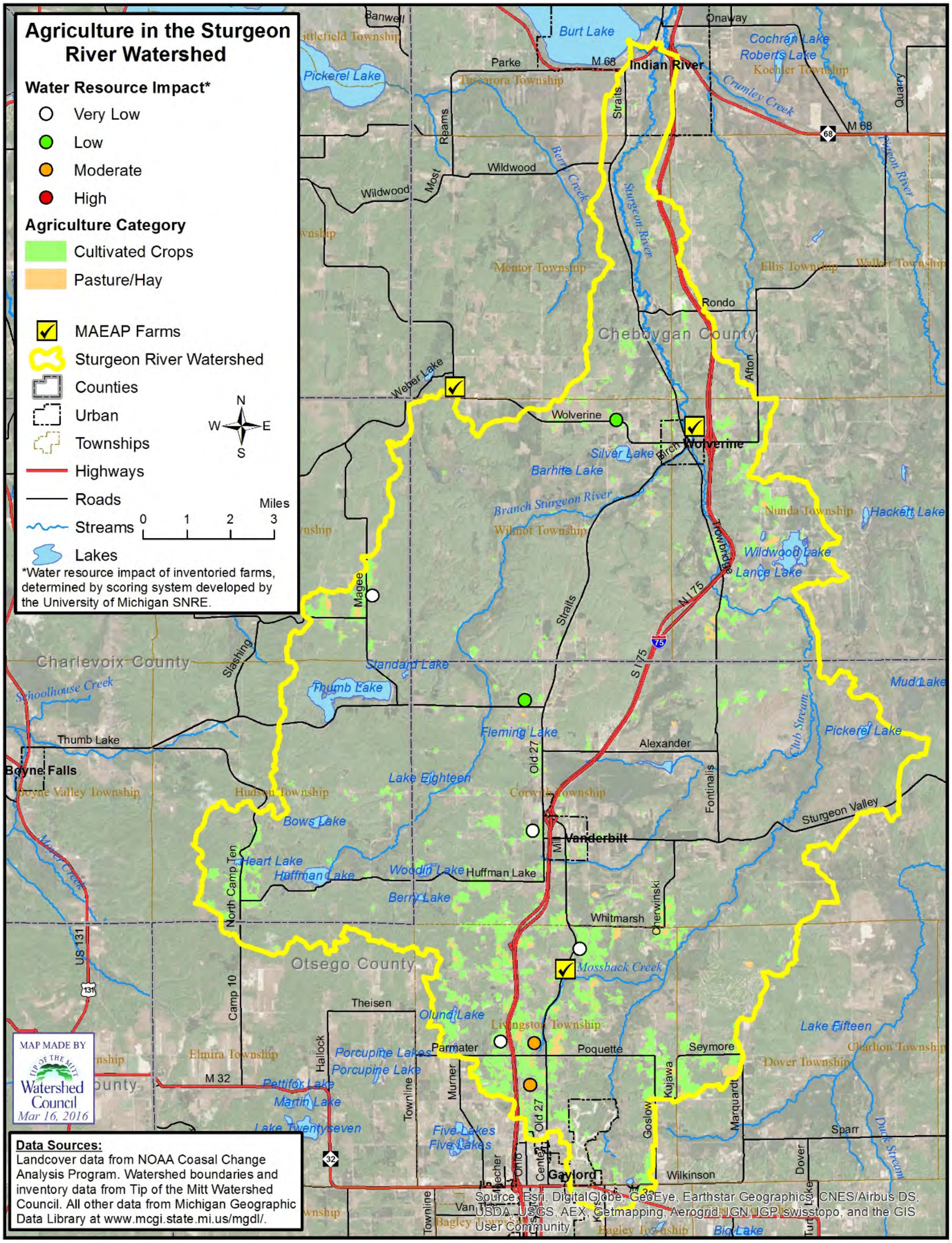
*As a percentage of subwatershed agricultural landcover acreage.

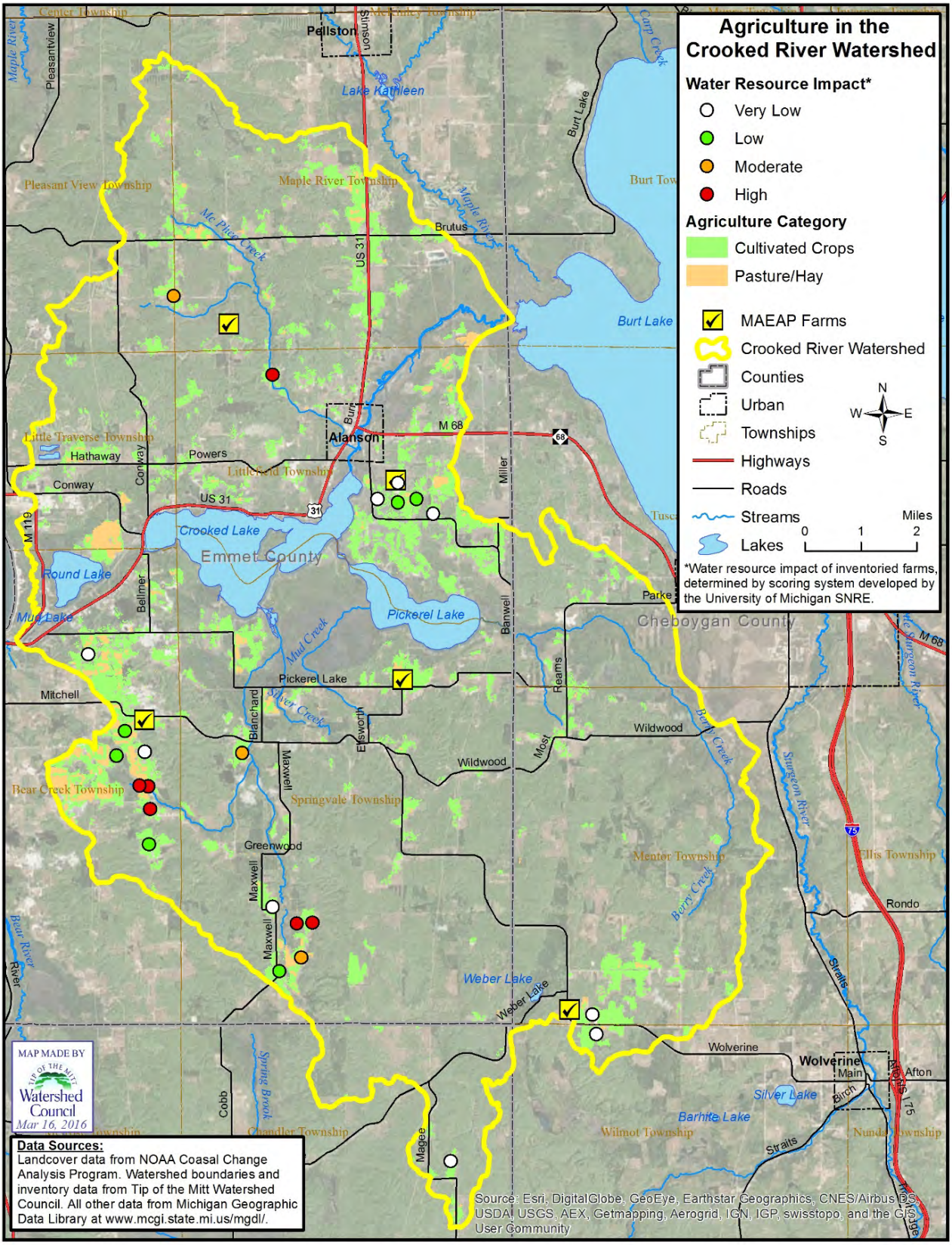
Eight farms in the Burt Lake Watershed are verified by the Michigan Agriculture Environmental Assurance Program (MAEAP). MAEAP is a voluntary program that ensures farms are engaging in pollution prevention practices that are cost-effective, pollution-minimizing, and complying with environmental regulations. The MAEAP program promotes scientific farming standards designed to protect natural resources, including maximizing fertilizer use and ensuring safe storage of fuel and chemicals.


Agriculture in the Burt Lake Direct Drainage
Water Resource Impact*
Very Low
Low
Moderate
High
Agriculture Category
Cultivated Crops
Pasture/Hay
MAEAP Farms
Burt Lake Direct Drainage
Counties
Urban
Townships
Highways
Roads
Streams
Lakes
N
W
E
S
Miles
0 0.5 1
*Water resource impact of inventoried farms, determined by scoring system developed by the University of Michigan SNRE.
Douglas Lake
Munro Township
Inverness Township
Riggsville
Roberts
Carp Creek
Mullett Creek
Extension
Birchwood
Burt Lake
Mullett Burt
Burt Township
Mullett Township
Maple River
Burt Lake
Cheboygan County
Mullett Lake
Emmet County
Koehler Township
Mc Phee Creek
Hasler Creek
Alanson
M 68
Littlefield Township
Powers
Miller
Banwell
US 31
Lake Marina
Indian River
Crooked Lake
Tuscarora Township
Onaway
Parke
Pickerel Lake
Cedar Creek
Deer Creek
Reams
Sturgeon River
Springvale Township
Pickeral Lake
Mentor Township
Wildwood
Ellis Township
MAP MADE BY
TIP OF THE MITT
Watershed Council
Mar 16, 2016
Data Sources:
Landcover data from NOAA Coasal Change Analysis Program. Watershed boundaries and inventory data from Tip of the Mitt Watershed Council. All other data from Michigan Geographic Data Library at www.mcgi.state.mi.us/mgdl/.
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Agriculture in the Maple River Watershed
Water Resource Impact*
Very Low
Low
Moderate
High
Agriculture Category
Cultivated Crops
Pasture/Hay
MAEAP Farms
Maple River Watershed
Counties
Urban
Townships
Highways
Roads
Streams
Lakes
N
W
E
S
0
1
2
3
4 Miles
*Water resource impact of inventoried farms, determined by scoring system developed by the University of Michigan.
Emmet County
Cheboygan County
Pellston
Lake Paradise
Douglas Lake
Burt Lake
Larks Lake
Munro Lake
Lancaster Lake
Vincent Lake
Galloway Lake
Sherett Lake
Arnott Lake
Lake Kathleen
Maple River
Cold Creek
Van Creek
Brush Creek
Cope Creek
Certon Creek
Carp River
Mud Creek
Mud Lake
Mullett Creek
Carp Creek
Crooked River
Sanford Creek
Mc Phee Creek
Dow Lake
Twin Lake
Nolten Lake
Malony Lake
Readmond Township
Center Township
McKinley Township
Carp Lake Township
Hebron Township
Beaugrand Township
Munro Township
Inverness Township
Friendship Township
Pleasant View Township
Maple River Township
Burt Township
Mullett Township
Little Traverse Township
Levering
Schmalzried
Reed
Pleasantview
Van
Robinson
Riggsville
Roberts
Larks Lake
Paradise Lake
Cecil Bay
Gill
State
Conway
Brutus
Mill
Stimson
Extension
Mullett Burt
Indian River
US 31
M 108
Maple
N I 75
S I 75
Straits
MAP MADE BY
TIP OF THE MITT
Watershed Council
Mar 16, 2016
Data Sources:
Landcover data from NOAA Coastal Change Analysis Program. Watershed boundaries and inventory data from Tip of the Mitt Watershed Council. All other data from Michigan Geographic Data Library at www.mcgi.state.mi.us/mgdl/.
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Agriculture in the Sturgeon River Watershed
Water Resource Impact*
Very Low
Low
Moderate
High
Agriculture Category
Cultivated Crops
Pasture/Hay
MAEAP Farms
Sturgeon River Watershed
Counties
Urban
Townships
Highways
Roads
Streams
Lakes
Miles
0
1
2
3
N
W
E
S
*Water resource impact of inventoried farms, determined by scoring system developed by the University of Michigan SNRE.
MAP MADE BY
Tip of the Mitt Watershed Council
Mar 16, 2016
Data Sources:
Landcover data from NOAA Coasal Change Analysis Program. Watershed boundaries and inventory data from Tip of the Mitt Watershed Council. All other data from Michigan Geographic Data Library at www.mcgi.state.mi.us/mgdl/.
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Burt Lake
Indian River
Onaway
Cochran Lake
Roberts Lake
Koehler Township
Crumley Creek
Pickerel Lake
Tuscarora Township
Parke
M 68
Straits
Reams
Wildwood
Most
Berry Creek
Sturgeon River
Mentor Township
Ellis Township
Walker Township
Rondo
Cheboygan County
Afton
Weber Lake
Wolverine
Silver Lake
Birch
Barhite Lake
Branch Sturgeon River
Wilmot Township
Nunda Township
Hackett Lake
Trowbridge
Wildwood Lake
Lance Lake
N I 75
Magee
Charlevoix County
Schoolhouse Creek
Slashing
Standard Lake
Thumb Lake
S I 75
Mud Lake
Fleming Lake
Club Stream
Pickerel Lake
Alexander
Old 27
Boyne Falls
Boyne Valley Township
Hudson Township
Lake Eighteen
Corwith Township
Fontinalis
Sturgeon Valley
Bows Lake
Vanderbilt
Mill
Heart Lake
Huffman Lake
Woodin Lake
Berry Lake
North Camp Ten
Cherwinski
Whitmarsh
US 131
Otsego County
Mossback Creek
Camp 10
Theisen
Oluna Lake
Livingston Township
Lake Fifteen
Chester Township
Dover Township
Elmira Township
Porcupine Lakes
Porcupine Lake
Parmater
Poquette
Seymore
Hallock
M 32
Pettifor Lake
Martin Lake
Townline
Murner
Kujawa
Marquardt
Lake Twentyseven
Five Lakes
Goslow
Sparr
Dover
Duck Stream
Gaylord
Wilkinson
Bagley Township
Big Lake


Agriculture in the Crooked River Watershed
Water Resource Impact*
Very Low
Low
Moderate
High
Agriculture Category
Cultivated Crops
Pasture/Hay
MAEAP Farms
Crooked River Watershed
Counties
Urban
Townships
Highways
Roads
Streams
Lakes
Miles
0 1 2
N
W E
S
*Water resource impact of inventoried farms, determined by scoring system developed by the University of Michigan SNRE.
Pellston
Lake Kathleen
Burt Lake
Maple River Township
Pleasant View Township
Brutus
US 31
M 68
Alanson
Little Traverse Township
Hathaway
Powers
Littlefield Township
Conway
Crooked Lake
Emmet County
Round Lake
Mud Lake
Pickerel Lake
Cheboygan County
Mitchell
Wildwood
Bear Creek Township
Springvale Township
Greenwood
Mentor Township
Ellis Township
Rondo
Weber Lake
Wolverine
Silver Lake
Barhite Lake
Wilmot Township
Nunda Township
Chandler Township
Afton
MAP MADE BY
Tip of the Mitt Watershed Council
Mar 16, 2016
Data Sources:
Landcover data from NOAA Coasal Change Analysis Program. Watershed boundaries and inventory data from Tip of the Mitt Watershed Council. All other data from Michigan Geographic Data Library at www.mcgi.state.mi.us/mgdl/.
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Forestry Inventory

Forestlands make up the majority of the Burt Lake Watershed. Mixed ownership between State of Michigan and private landowners accounts for the majority of forestlands. Other landholders include the University of Michigan Biological Station, Little Traverse Conservancy, and local government units (Table 1). Forest management under any of the listed entities varies from preservation minded to harvest oriented. Maintenance of unique forest types including old growth, late successional, or minimally altered communities is essential for the ecological health of Northern Michigan. However, logging and other extraction oriented activities are essential to the economic health of Northern Michigan. Applying sustainable and ecologically minded forest management principles to logging operations can provide a balance between economic gains and ecologic integrity. A Meeting with MDNR Forest Resources Division officials was conducted as part of the initial information gathering process. The information obtained in this meeting was used to prioritize survey areas within the watershed, as well as create the survey methods used in this Watershed Management Plan.

The management goals of the MDNR were outlined. Sustainability is paramount in many aspects of their operation, including forest productivity, soil management, and water resources management. Although the state government does little of the actual harvesting, their contracting logging companies are held to these standards through MDNR planning and oversite. The publication *Sustainable Soil and Water Quality Practices on Forest Land* serves as a guide for implementation of BMP's and outlines water resource regulations that apply to logging operations. Many of these BMP's are not mandatory, but are encouraged by the state, and are leveraged through contract negotiation and selection.

Table 1. Forest Ownership within the Burt Lake Watershed

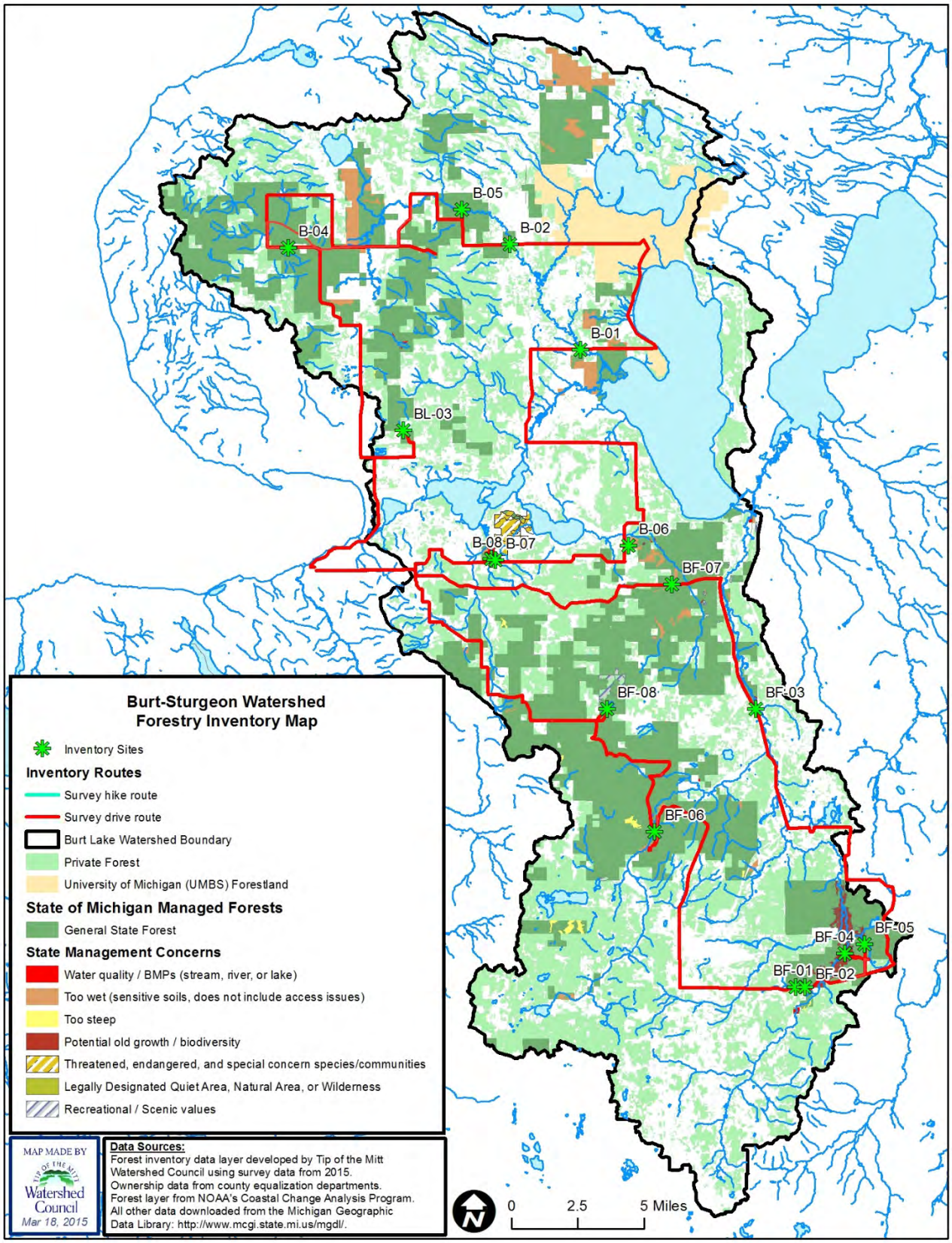
Ownership Type	Acreage	Percentage of All Forest
Private	111442.8	59.2%
State of Michigan	65431.7	34.8%
University of Michigan (UMBS)	7288.8	3.9%
Little Traverse Conservancy	3632.9	1.9%
Other Protected Lands*	425.08	0.2%

*Other protected ownership includes local and tribal government, other conservancies, and counties.

The field component of the forestry inventory involved a watershed-wide windshield survey, and to a lesser degree, survey on foot. While traveling through any forest land in the watershed, observations were made when forestry activity was taking place. A survey route line was recorded using a Trimble Juno SB GPS. Specific survey locations were inspected more closely, with pictures taken, and an in-depth assessment of water resource implications was carried out. These survey locations are included on the map below. State forests were surveyed due to accessibility, prevalence of harvest, and consistency of management principles.

Many special management areas related to water resource protection (as designated by MDNR foresters) were verified in the field. Forestry activities on private land were observed from public road right-of-way whenever possible.

In general, forestry in the Burt Lake Watershed was found to have very little impact on aquatic resources. Many logging operations are situated in upland areas, where soil nutrient and drainage characteristics yield the highest productivity forests. Lowland areas (which often host rivers, streams, and lakes) are generally less productive than uplands and offer greater logistical challenges to timber harvest. This geographic separation helps to reduce the number of logging operations that occur adjacent to water bodies, and therefore reduces the risk of aquatic resource impacts. Nevertheless, this distinction does not apply to every water body, as some rivers, lakes, and streams are situated in prime timber producing forests with little wetland buffer. During the survey, no major streams were found to have logging activity immediately adjacent. No fords for logging equipment were found. Infrastructure related to logging was found to be impactful to aquatic resources in some cases. Logging operations in uplands adjacent to water resources posed a risk due to erosion and channel formation, which has the potential to carry sediments to the water body. Road creation in intermittent or ephemeral drainages is the primary example of this type of high-risk activity.


B-05
B-04
B-02
B-01
BL-03
B-08
B-07
B-06
BF-07
BF-08
BF-03
BF-06
BF-04
BF-05
BF-01
BF-02
Burt-Sturgeon Watershed
Forestry Inventory Map
Inventory Sites
Inventory Routes
Survey hike route
Survey drive route
Burt Lake Watershed Boundary
Private Forest
University of Michigan (UMBS) Forestland
State of Michigan Managed Forests
General State Forest
State Management Concerns
Water quality / BMPs (stream, river, or lake)
Too wet (sensitive soils, does not include access issues)
Too steep
Potential old growth / biodiversity
Threatened, endangered, and special concern species/communities
Legally Designated Quiet Area, Natural Area, or Wilderness
Recreational / Scenic values
MAP MADE BY
Watershed Council
Mar 18, 2015
Data Sources:
Forest inventory data layer developed by Tip of the Mitt Watershed Council using survey data from 2015.
Ownership data from county equalization departments.
Forest layer from NOAA's Coastal Change Analysis Program.
All other data downloaded from the Michigan Geographic Data Library: http://www.mcgi.state.mi.us/mgdl/.
0
2.5
5 Miles