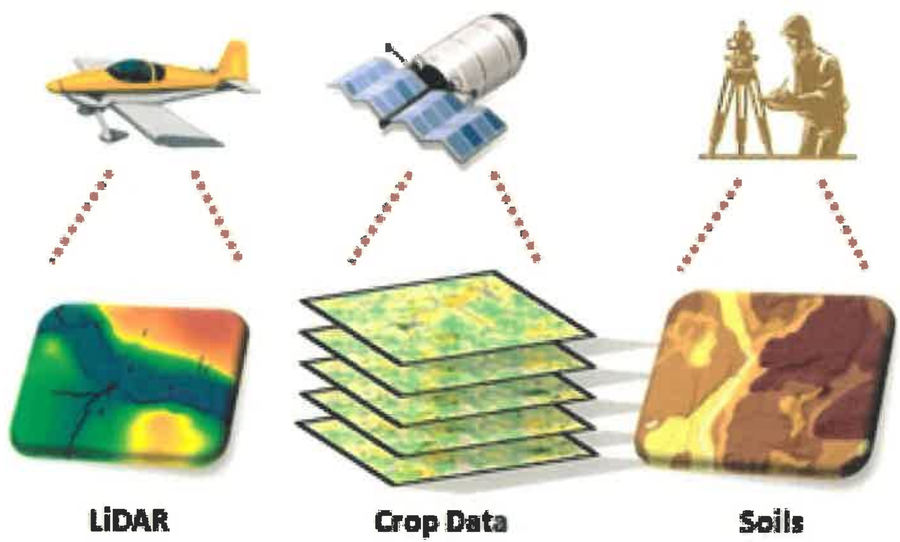
APPENDIX A
WATERSHED INVENTORY

Twin Lakes Watershed Erosion Vulnerability Assessment for Agricultural Lands (EVAAL)

Final Report

June 2018



Developed by Green Lake County, Land Conservation Department

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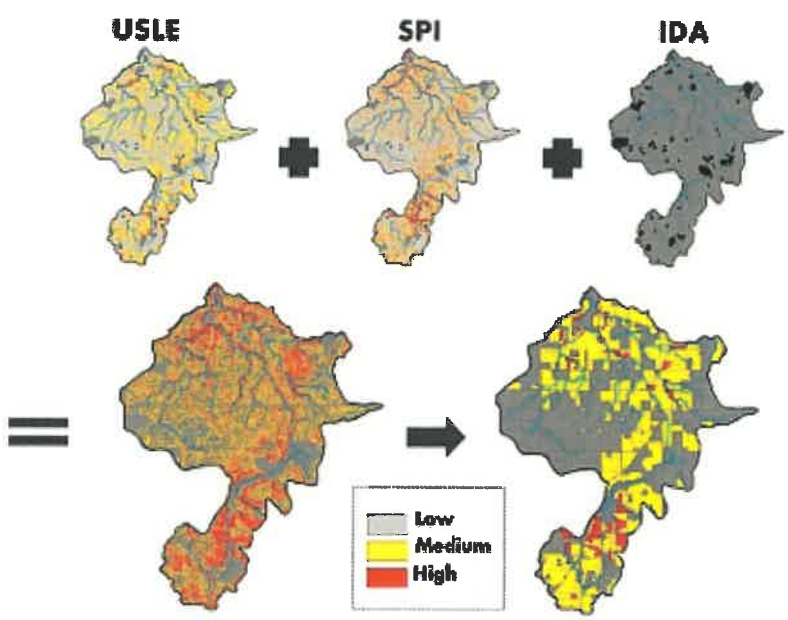
Erosion Vulnerability Assessment for Agricultural Lands (EVAAL)

The Wisconsin Department of Natural Resources Bureau of Water Quality has developed the Erosion Vulnerability Assessment for Agricultural Lands (EVAAL) toolset to assist watershed managers in prioritizing areas within a watershed which may be vulnerable to water erosion (and thus increased nutrient export) and thus may contribute to downstream surface water quality problems. It evaluates locations of relative vulnerability to sheet, rill and gully erosion using information about topography, soils, rainfall and land cover. This tool enables watershed managers to prioritize and focus field-scale data collection efforts, thus saving time and money while increasing the probability of locating fields with high sediment and nutrient export for implementation of best management practices (BMPs).

Erosion Vulnerability Index

EVAAL was designed to quickly identify areas vulnerable to erosion, and thus more likely to export nutrients like phosphorus, using readily available data and a user-friendly interface. This tool estimates vulnerability by separately assessing the risk for sheet and rill erosion (using the Universal Soil Loss Equation, USLE), and gully erosion (using the Stream Power index, SPI), while de-prioritizing those areas that are not hydrologically connected to surface waters (also known as internally drained areas, IDA). These three pieces are combined to produce an erosion vulnerability index value that can be assessed at the grid scale or aggregated to areas, such as field boundaries.



EROSION VULNERABILITY INDEX

How does EVAAL work?

EVAAL was developed using the Python scripting language within ESRI's ArcGIS 10.x Desktop. The tool exists as an ArcToolbox, requiring ArcMap and the Spatial Analyst Extension. It utilizes several readily-available GIS datasets including topography, land cover, and soils. EVAAL was designed to quickly identify areas vulnerable to erosion, and thus more likely to export nutrients like phosphorus, using readily available data and a user-friendly interface. This tool estimates vulnerability by separately assessing the risk for sheet and rill erosion (using the Universal Soil Loss Equation, USLE), and gully erosion (using the Stream Power index, SPI), while deprioritizing those areas that are not hydrologically connected to surface waters (also known as internally drained areas, IDA). These three pieces are combined to produce an erosion vulnerability index value that can be assessed at the grid scale or aggregated to areas, such as field boundaries.

What information does EVAAL provide

The intention of EVAAL is to locate where BMP assessment should be prioritized. Therefore, the results are provided as a series of maps. The primary results of EVAAL are the erosion vulnerability index and then the components of this index: soil loss, stream power index, and internally drained areas. Any of these results can be interpreted at their base resolution or aggregated to the level of an agricultural field or other boundary dataset.

It is important to note that EVAAL is designed to prioritize lands vulnerable to erosion, however an assumption can be made that loss of soil may also coincide with nutrient loss. Water quality monitoring has demonstrated that measured high concentrations of sediment are often associated with high concentrations of total phosphorus.

Overview:

An EVAAL Analysis was completed on the Twin Lakes Watershed, which produced a number of maps to be utilized in future conservation planning.

In addition, representative soil samples were collected on 5-acre grids on all agricultural lands which participated in the project. Overall 95% of the property owners in the watershed participated in the soil sampling project. The full results of the soil samples are available upon written request to the Green Lake County Land Conservation Department. For the purpose of this report, the soil sample results were interpreted for soil-P (phosphorus) levels as recommended by the University of Wisconsin for Corn-grain.

The following maps are included in this report:

Exhibit A – Stream Power Index Map

Exhibit B – Soil K-Factor (Erosion Vulnerability) Map

Exhibit C – Channelized Flow Map (SPI derivative)

Exhibit D – EVAAL Ranking (50-percentile)

Exhibit E – Soil Sampling (Phosphorus/Corn Grain) Map

Exhibit F – Best Management Practices Map

Description:

Stream Power Index (Exhibit A)

The stream power index is used to estimate areas that are susceptible to gully erosion. It utilizes raster data derived from Lidar to generate a series of flow cells. Through a repetitive process, each cell is analyzed for the flow direction and flow accumulation. As more was is accumulated, the greater predicted flow value is generated. By adjusting and field verification of the model outputs, a threshold is set to define channelized flow which likely results in formation of gully erosion. The resulting raster output can be adjusted through GIS settings to display only the channelized flow areas (Exhibit C).

Inputs:

- Conditioned DEM.
- Reconditioned DEM, excluding non-contributing areas.
- Flow Accumulation Threshold, the default value of 50000 is recommended, though the capability is provided for advanced users interested in altering the flow accumulation threshold. Raising this value will include longer flow paths, potentially modeling streamflow as opposed to overland flow. Alternatively, lowering this value will shorten flow paths.

Outputs:

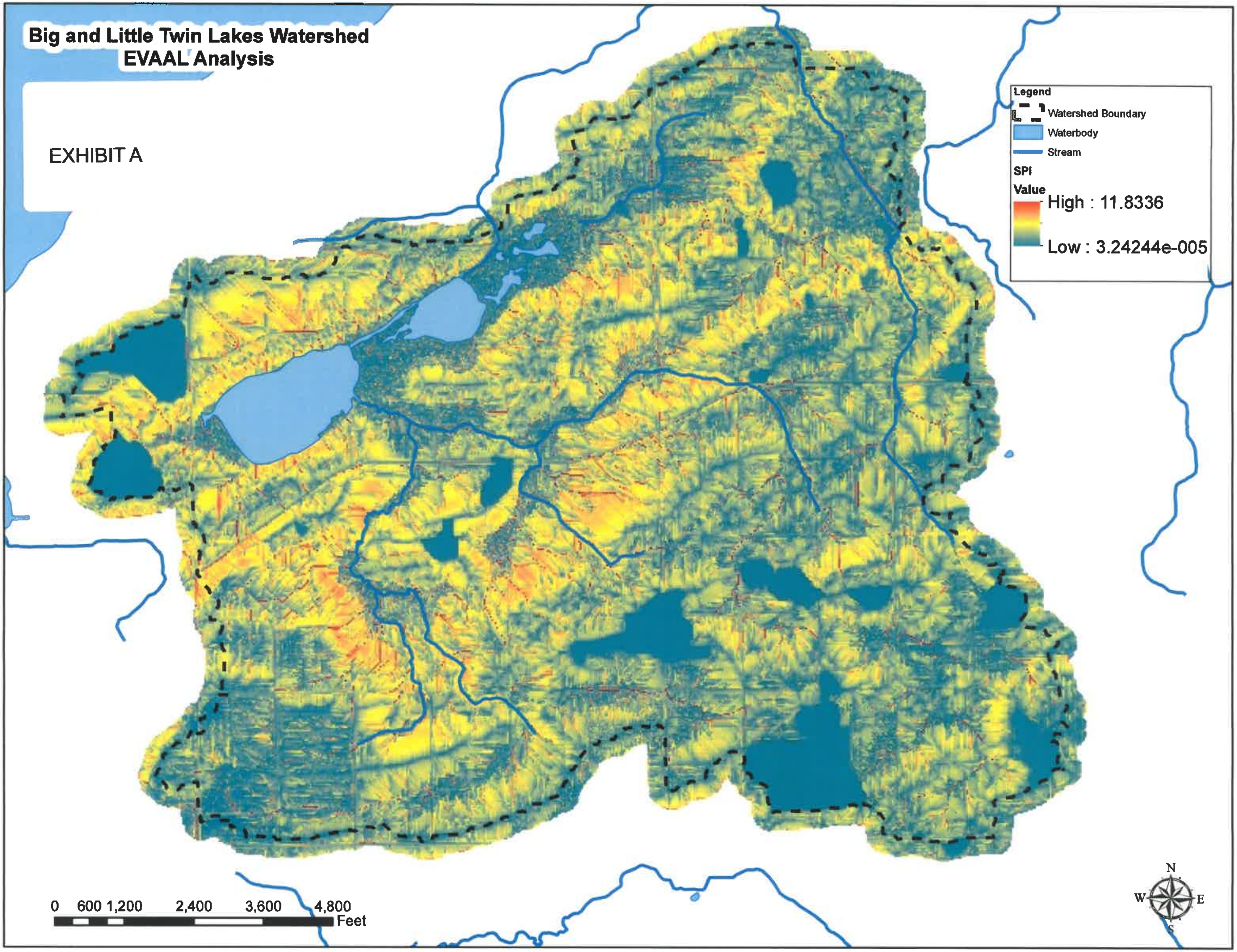
- Stream power index (Raster)

The curve number is an estimate of the runoff potential for a certain soil given a certain land cover. It is based on the hydrologic soil group as well as management factors such as cover type and tillage. Similarly, the C factor in the USLE is derived from the amount of canopy, surface cover, surface roughness, and prior land use. Both the C factor and curve number need field-specific information to know how management factors impact their values. For each of these, best- and-worst case scenarios are assumed, creating high and low curve number and C factor output raster layers. It is left to the user whether the soil erosion vulnerability index should be a worst- or best-case scenario. Or the user can run the index twice, once for best-case and once for worst-case, then look at the difference between the two outcomes; those areas with the greatest difference show areas where there would be the greatest erosion reduction if going from poor to good management practices.

The resulting raster output map (Exhibit A) depicts flow accumulation from low (blue shades) to high (red shades).

Big and Little Twin Lakes Watershed EVAAL Analysis

EXHIBIT A



Description:

Soil K Factor (Exhibit B)

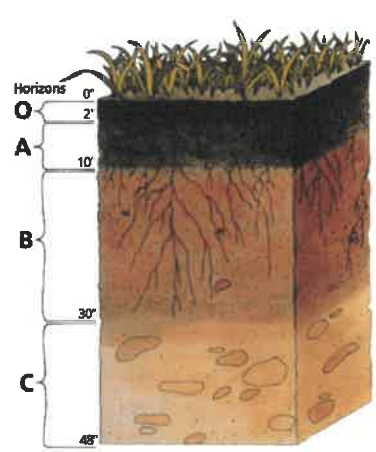
The K-factor is soil erodibility factor which represents both susceptibility of soil to erosion and the rate of runoff, as measured under the standard unit plot condition. Soils high in clay have low K values, about 0.05 to 0.15, because they resistant to detachment. Coarse textured soils, such as sandy soils, have low K values, about 0.05 to 0.2, because of low runoff even though these soils are easily detached. Medium textured soils, such as the silt loam soils, have a moderate K values, about 0.25 to 0.4, because they are moderately susceptible to detachment and they produce moderate runoff. Soils having a high silt content are most erodible of all soils. They are easily detached; tend to crust and produce high rates of runoff. Values of K for these soils tend to be greater than 0.4.

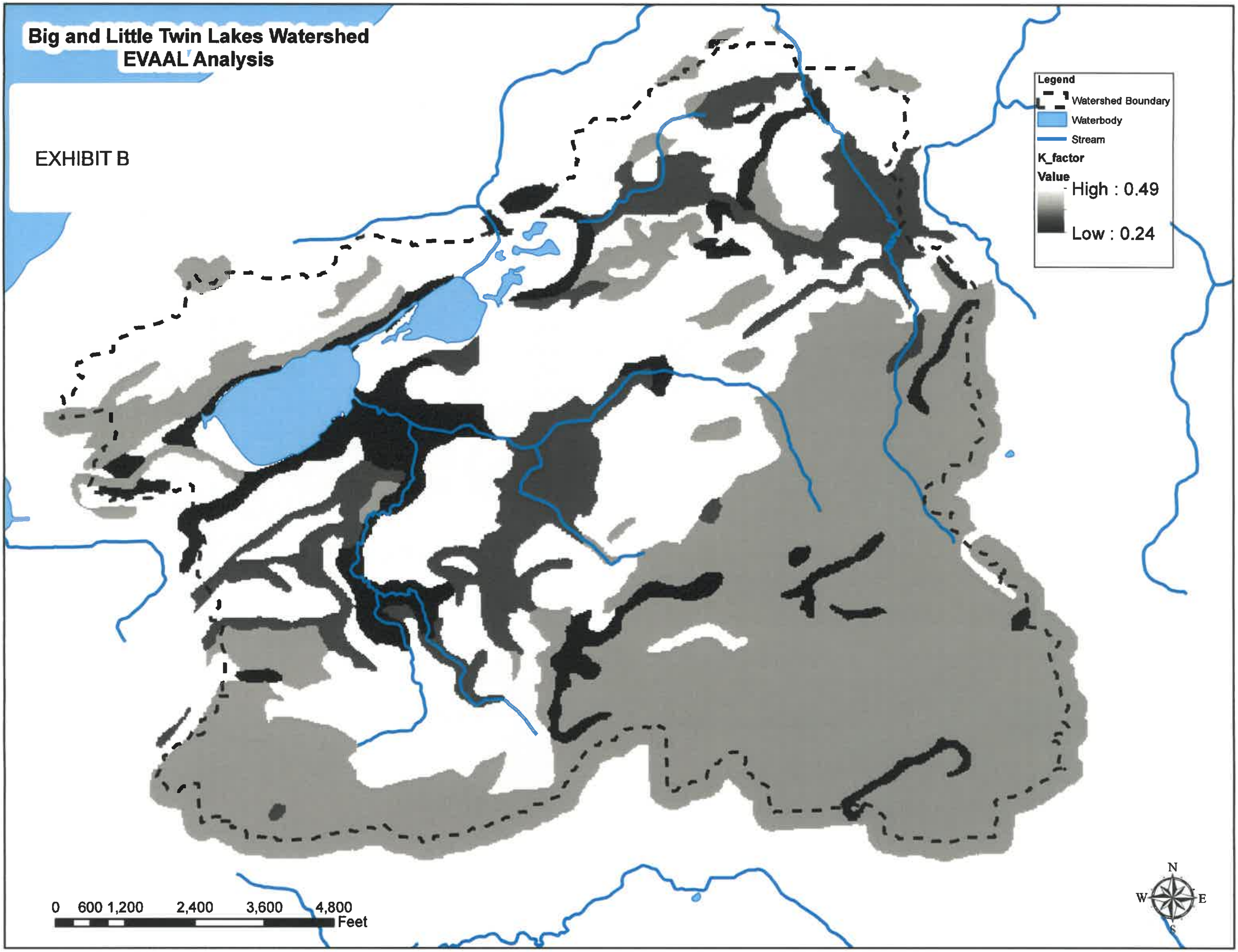
Organic matter reduces erodibility because it reduces the susceptibility of the soil to detachment, and it increases infiltration, which reduce runoff and thus erosion. Addition or accumulation of increased organic matter through management such as incorporation of manure is represented in the C factor rather than the K Factor. Extrapolation of the K factor nomograph beyond an organic matter of 4% is not recommended or allowed in RUSLE. In RUSLE, factor K considers the whole soil and factor Kf considers only the fine-earth fraction, the material of <2.00mm equivalent diameter. For most soils, Kf = K.

Soil structures affects both susceptibility to detachment and infiltration. Permeability of the soil profile affects K because it affects runoff.

Although a K factor was selected to represent a soil in its natural condition, past management or misuse of a soil by intensive cropping can increase a soil's erodibility. The K factor may need to be increased if the subsoil is exposed or where the organic matter has been depleted, the soil's structure destroyed or soil compaction has reduced permeability. A qualified soil scientist can assist in making this interpretation.

Exhibit B indicates that much of the watershed has a relatively high soil K-factor, is under normal conditions is more resistant to erosion.





Big and Little Twin Lakes Watershed
EVAAL Analysis
EXHIBIT B
Legend
Watershed Boundary
Waterbody
Stream
K_factor
Value
High : 0.49
Low : 0.24
0 600 1,200 2,400 3,600 4,800
Feet
N
W
E
S

Description:

Stream Power Index (Channelized Flow) (Exhibit C)

Forms of erosion by water include sheet and rill, ephemeral gully, classic gully and stream bank. Each type is associated with the progressive concentration of runoff water as it moves downstream. Erosion caused by concentrated flow begins where overland flow converges to channelized flow conditions. Erosion caused by channelized flow conditions may contribute significantly to the overall erosion on the planning unit. Detailed criteria for distinguishing rills, ephemeral gullies, and gullies are given below. Differentiating these forms of erosion requires careful judgment. This is especially true where an ephemeral gully results from runoff that follows tillage marks rather than natural depressions. A. Definitions Rills: Rill erosion is minimized using the Revised Universal Soil Loss Equation (RUSLE2) by adjusting crop and tillage systems. Rills may be any size, but are usually less than four inches deep. Rills have one or more of the following characteristics: - parallel on a slope, but may converge - uniform spacing and dimension - appear at different locations on the landscape from year to year - shorter than ephemeral cropland gullies - end at a concentrated flow channel, terrace, or where a slope flattens and deposition occurs - are on the same portion of the slope that is used to determine the length of slope for factor (L) for the RUSLE2

Ephemeral Gullies

Ephemeral gullies may be any size, but are usually larger than rills, with one or more of the following characteristics:

- recur in the same area each time they form rather than random places on the slope - frequently form in well-defined depressions of natural drainage ways
- tend to occur in the upper reaches of a drainage network - usually branch, but may have patterns caused by row alignment or other characteristics of field operations
- generally wider, deeper, and longer that the rills on the field
- occur in depressions into which rows or tillage marks lead
- form along sloping rows or tillage marks
- partially or totally erased and filled by tillage operations
- occur on terraced fields where overtopping of terraces occurs or piping below the terrace embankment occurs
- occur in the channel bottom of gradient and parallel tile outlet (PTO) terraces

Gullies

Permanent gullies are channels too deep for normal tillage operations to erase. Special operations are required to fill them. Gullies also have one or more of the following characteristics:

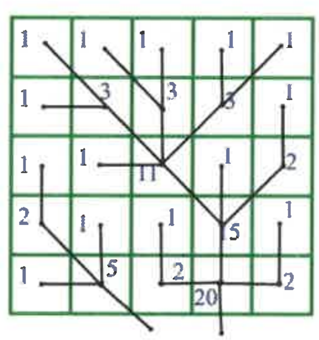
- may grow or enlarge from year to year by head cutting and lateral enlarging - occur in depressions or natural drainage ways
- may begin as ephemeral gully that was left in the field and not erased by tillage or other operations
- may become partially stabilized by grass, weeds, or woody vegetation

The soil loss from ephemeral gullies, classic gullies, and other similar types of erosion can be determined by calculating the volume of soil removed from the eroded area. The tons of soil loss can then be determined by multiplying the volume removed by the unit weight of soil. If the time period of the erosion exceeds one year, the quantity should be divided by the number of years the gully has existed to get an average annual rate.

Exhibit C depicts locations of channelized flow that are likely to result in classic gully on a regular basis, if not annually.

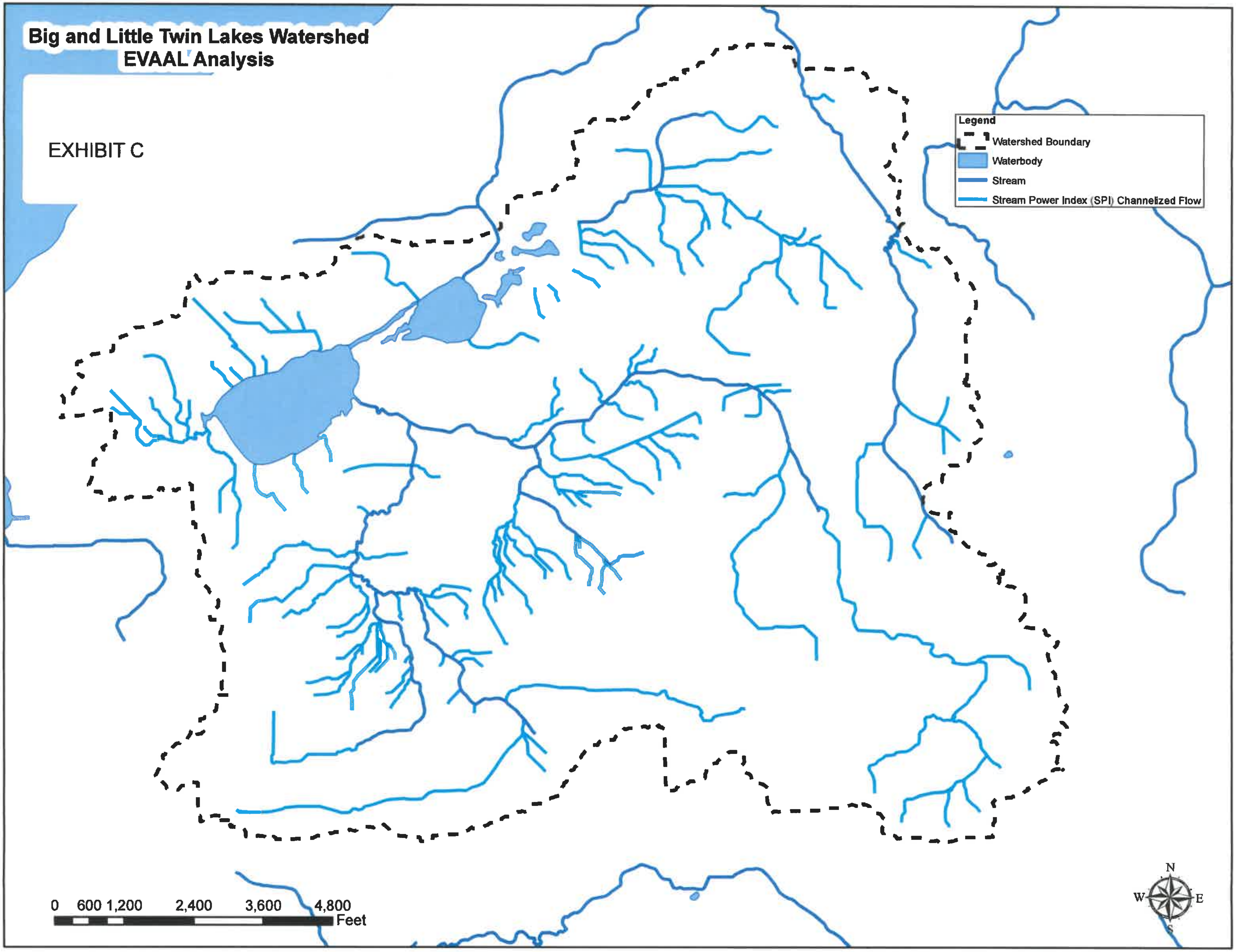
Contributing Area (Flow Accumulation)

1	1	1	1	1
1	3	3	3	1
1	1	11	1	2
2	1	1	15	1
1	5	2	20	2



The area draining each grid cell includes the grid cell itself.

Diagram: Cell Flow Accumulation

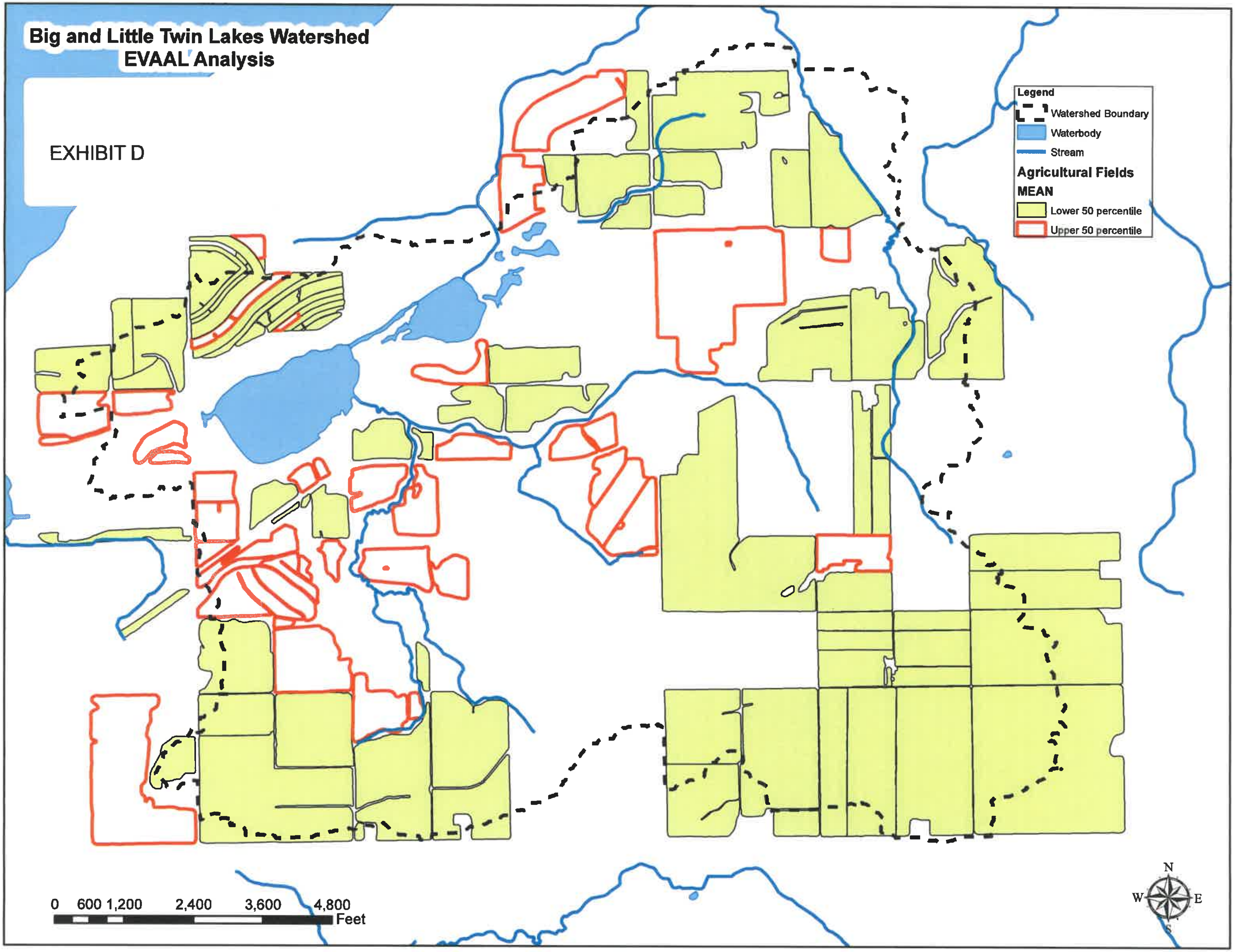

Big and Little Twin Lakes Watershed
EVAAL Analysis
EXHIBIT C
Legend
Watershed Boundary
Waterbody
Stream
Stream Power Index (SPI) Channelized Flow
0 600 1,200 2,400 3,600 4,800
Feet
N
W
E
S

Description:

EVAAL Model Field Ranking (Exhibit D)

The results of the EVAAL model depict a raster image that spans the entire watershed, and can be challenging to interpret for conservation planning purposes. In order to create a map that provides targeted information, the EVAAL outputs are intersected with existing field boundaries. A mean EVAAL number is generated within each field boundary to provide an index number for comparative purposes.

The goal of the project was to identify the upper 50-percentile of field likely to contribute to soil erosion. A limit was input, and the field resampled until a 50-50 threshold was reach based on the number of agricultural fields. These upper 50-percentile fields are highlighted in red (exhibit D).


Big and Little Twin Lakes Watershed
EVAAL Analysis
EXHIBIT D
Legend
Watershed Boundary
Waterbody
Stream
Agricultural Fields
MEAN
Lower 50 percentile
Upper 50 percentile
0 600 1,200 2,400 3,600 4,800
Feet
N
W
E
S

Description:

Soil Test (P) Interpretations for Corn Grain (Exhibit E)

Representative soil samples were collected on 5-acre grids on all agricultural lands which participated in the project. Overall 95% of the property owners in the watershed participated in the soil sampling project. The full results of the soil samples are available upon written request to the Green Lake County Land Conservation Department. For the purpose of this report, the soil sample results were interpreted for soil-P (phosphorus) levels as recommended by the University of Wisconsin for Corn-grain. The categories utilized by the University of Wisconsin include: Very Low, Low, Optimal, High, and Very High. Some of the results in the samples indicated soil-P levels well beyond the standard Very High range, therefore an additional category "Extremely High" was utilized in these circumstances to identify the areas.

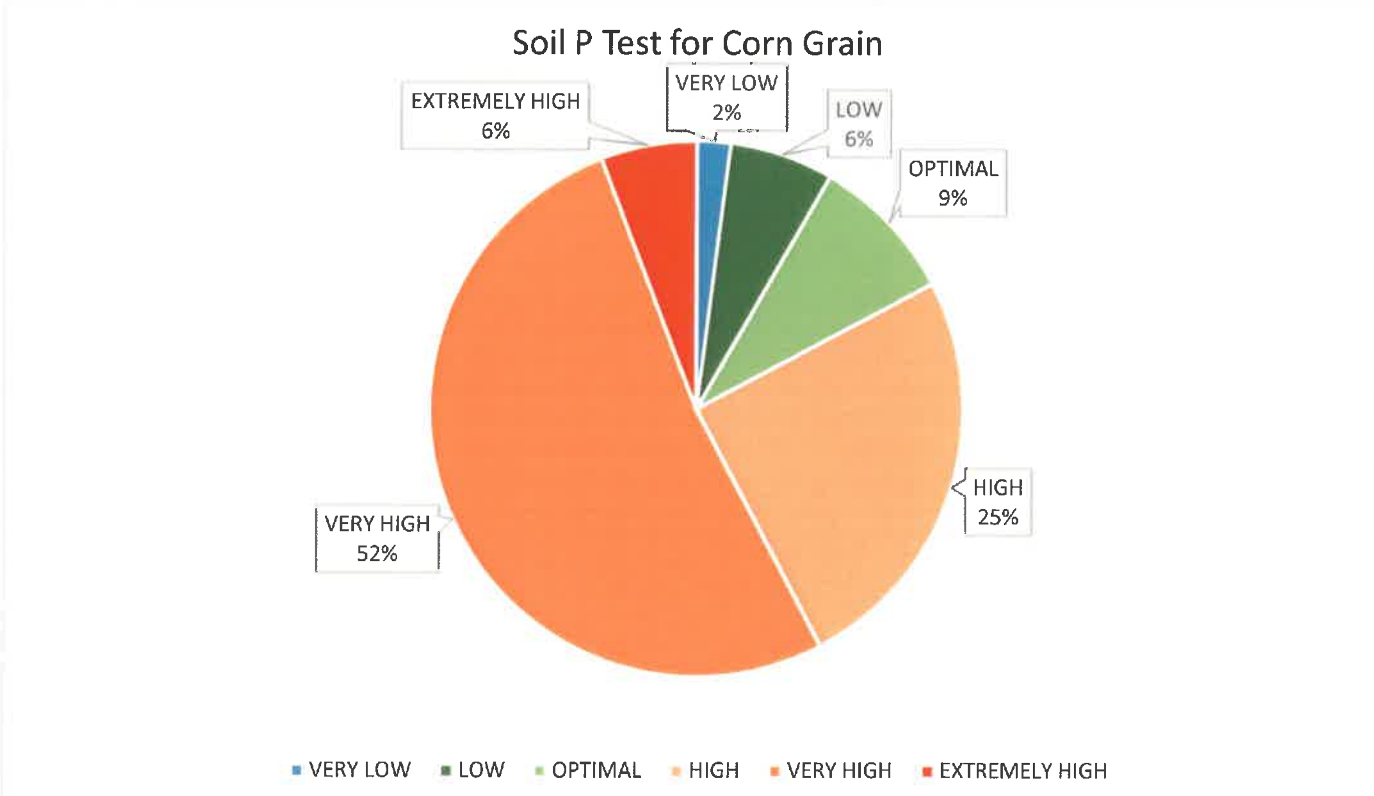
Categories (P – Corn Grain)

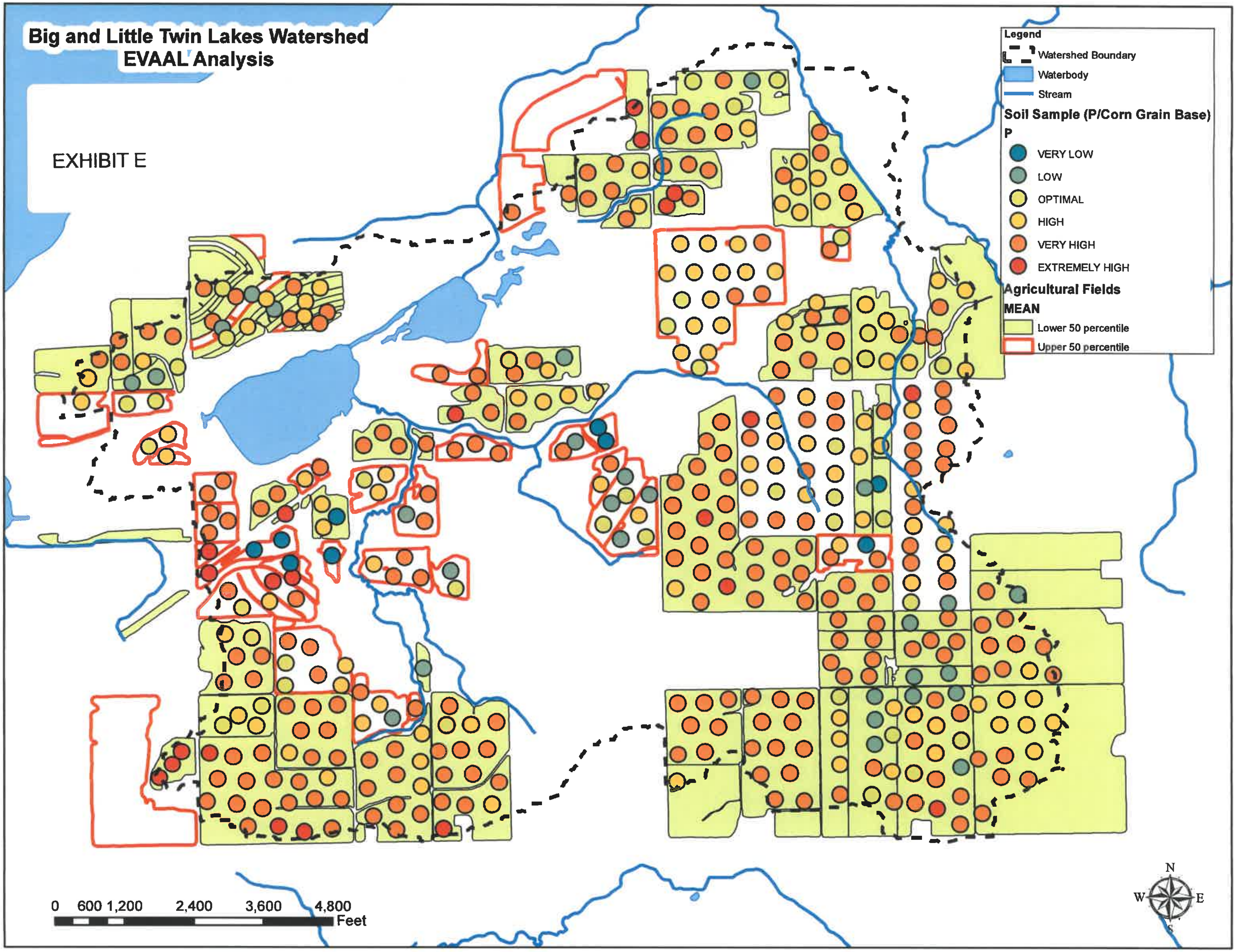
0-10 ppm	*Very Low*
10-15 ppm	*Low*
15-20 ppm	*Optimal*
20-30 ppm	*High*
30-100 ppm	*Very High*
>100 ppm	*Extremely High*

During field sampling 451 composite samples (5400 cores) were collected by an independent consulting firm and analyzed by a state-certified lab (AgSource, Bonduel WI).

Soil Test (P) Interpretations for Corn Grain (Exhibit E) (continued)

The results indicate that 83% of the samples collected tested High to Extremely High for Phosphorus (Corn-Grain recommendation, UW).




Big and Little Twin Lakes Watershed
EVAAL Analysis
EXHIBIT E
Legend
Watershed Boundary
Waterbody
Stream
Soil Sample (P/Corn Grain Base)
P
VERY LOW
LOW
OPTIMAL
HIGH
VERY HIGH
EXTREMELY HIGH
Agricultural Fields
MEAN
Lower 50 percentile
Upper 50 percentile
0 600 1,200 2,400 3,600 4,800
Feet
N
W
E
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Description:

EVAAL Model Field Ranking (Exhibit F)

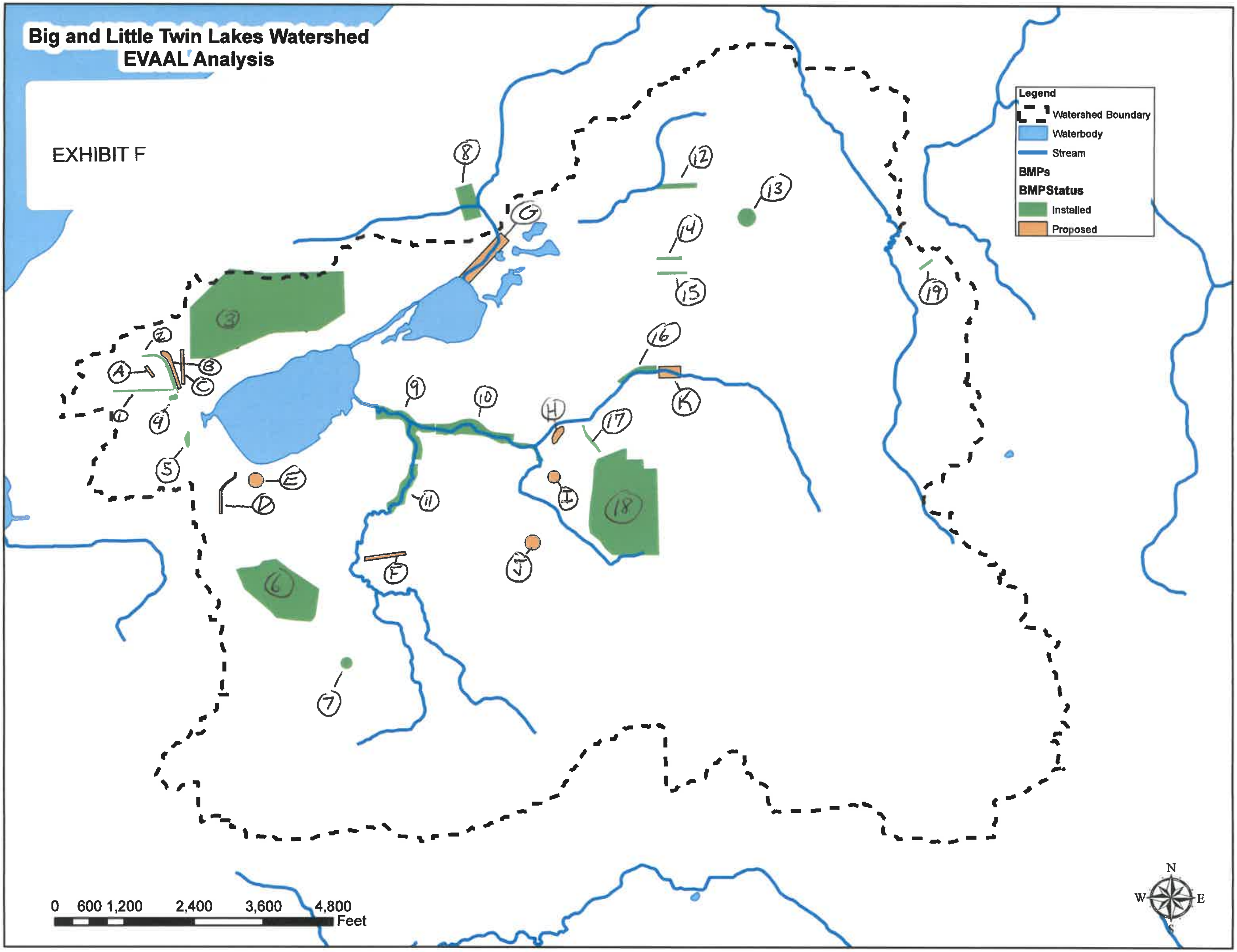
Field staff from the Green Lake County Land Conservation Department conducted evaluations of the agricultural fields within the Twin Lakes Watershed. Existing Best Management Practices (BMPs) and recommended BMPs were mapped for future conservation planning. (Exhibit F)

Existing/Implemented BMPs

1. Diversion
2. Grassed Waterway
3. Contour Strip Cropping
4. Sediment Basin
5. Sediment Basin
6. Contour Farming
7. Sediment Basin
8. Sediment Basin
9. Streambank Restoration
10. Streambank Restoration
11. Streambank Restoration
12. Grassed Waterway
13. Sediment Basin
14. Terrace
15. Terrace
16. Streambank Restoration
17. Grassed Waterway
18. Contour Farming
19. Grassed Waterway

Recommended BMPs

A. Grassed Waterway/Diversion
B. Grassed Waterway/Diversion
C. Grassed Waterway/Diversion
D. Grassed Waterway
E. Grade Stabilization Structure
F. Grassed Waterway
G. Channel Maintenance
H. Sediment Basin
I. Sediment Basin
J. Sediment Basin
K. Stream Restoration


Big and Little Twin Lakes Watershed
EVAAL Analysis
EXHIBIT F
Legend
Watershed Boundary
Waterbody
Stream
BMPs
BMPStatus
Installed
Proposed
0 600 1,200 2,400 3,600 4,800
Feet
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ACRONYMS

- BMP: Best Management Practice
- CDL: Cropland Data Layer
- CLU: Common Land Unit
- DEM: Digital Elevation Model
- EVAAL: Erosion Vulnerability Assessment for Agricultural Lands
- GIS: Geographic Information System
- gSSURGO: gridded Soil Survey Geographic Database
- HUC: Hydrologic Unit Code
- LiDAR: Light Detection And Ranging
- NASS: National Agricultural Statistics Service
- NRCS: Natural Resource Conservation Service
- SPI: Stream Power Index
- TMDL: Total Maximum Daily Load
- USDA: United States Department of Agriculture
- USLE: Universal Soil Loss Equation
- WDNR: Wisconsin Department of Natural Resources

References:

Erosion Vulnerability Assessment for Agricultural Lands Tutorial, Version 1.0, September 2014, Wisconsin Department of Natural Resources, State of Wisconsin

Nutrient Application Guidelines for Field, Vegetable, and Fruit Crops in Wisconsin (A2809), Carrie A.M. Laboski and John B. Peters, University of Wisconsin Extension. November 2012.

Contact:

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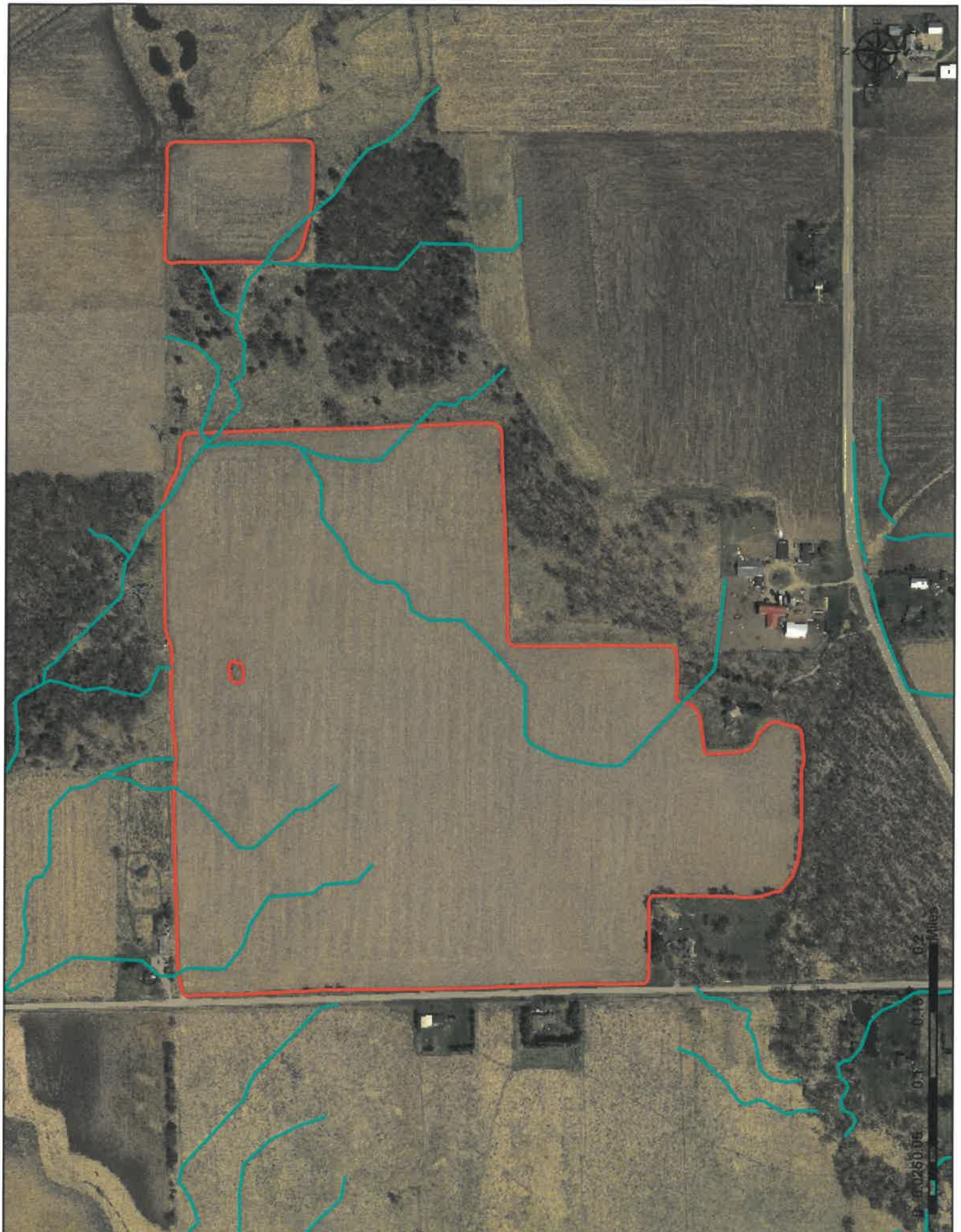
N
E
S
W
0
0.0125
0.025
0.05
0.075
Miles



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Miles
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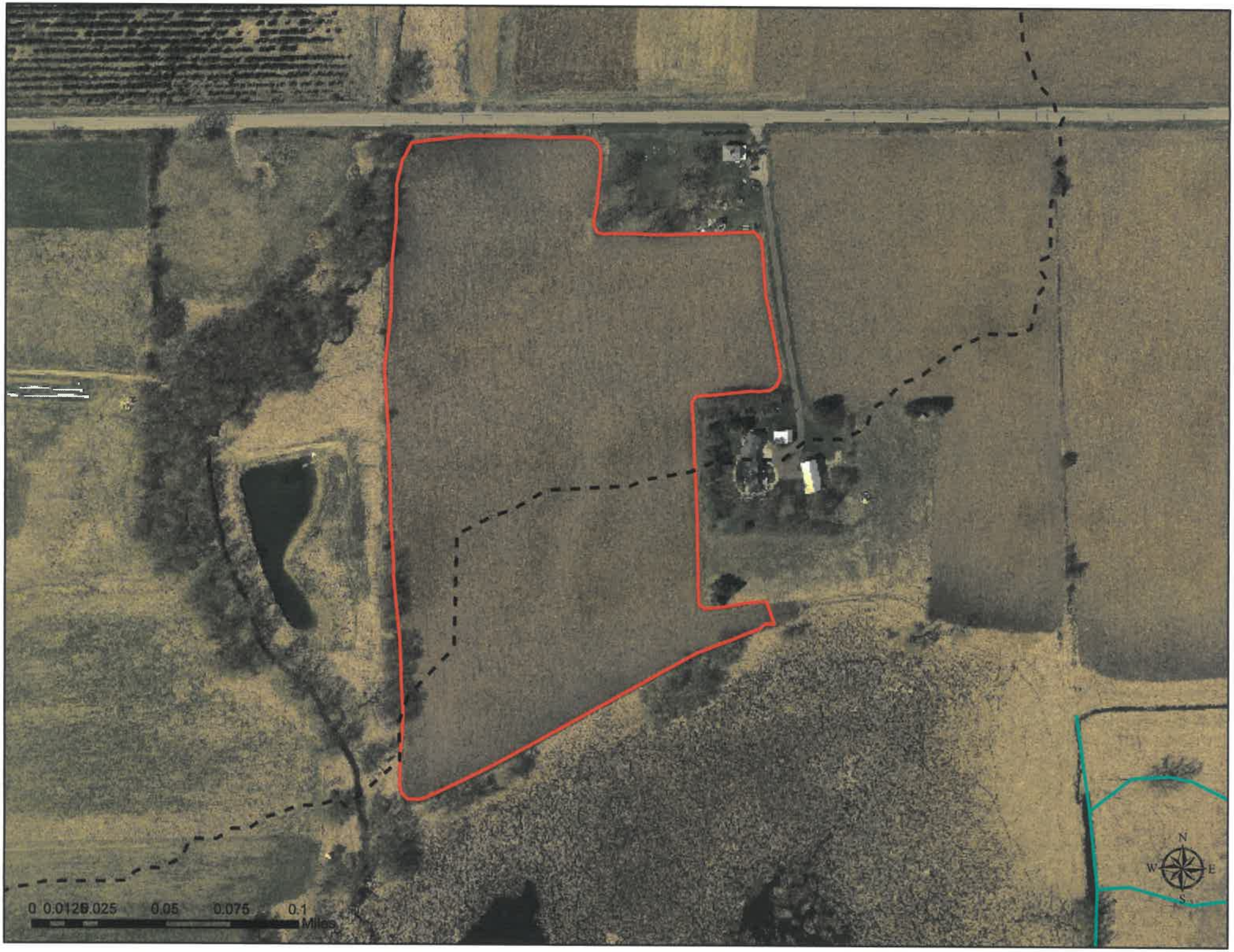
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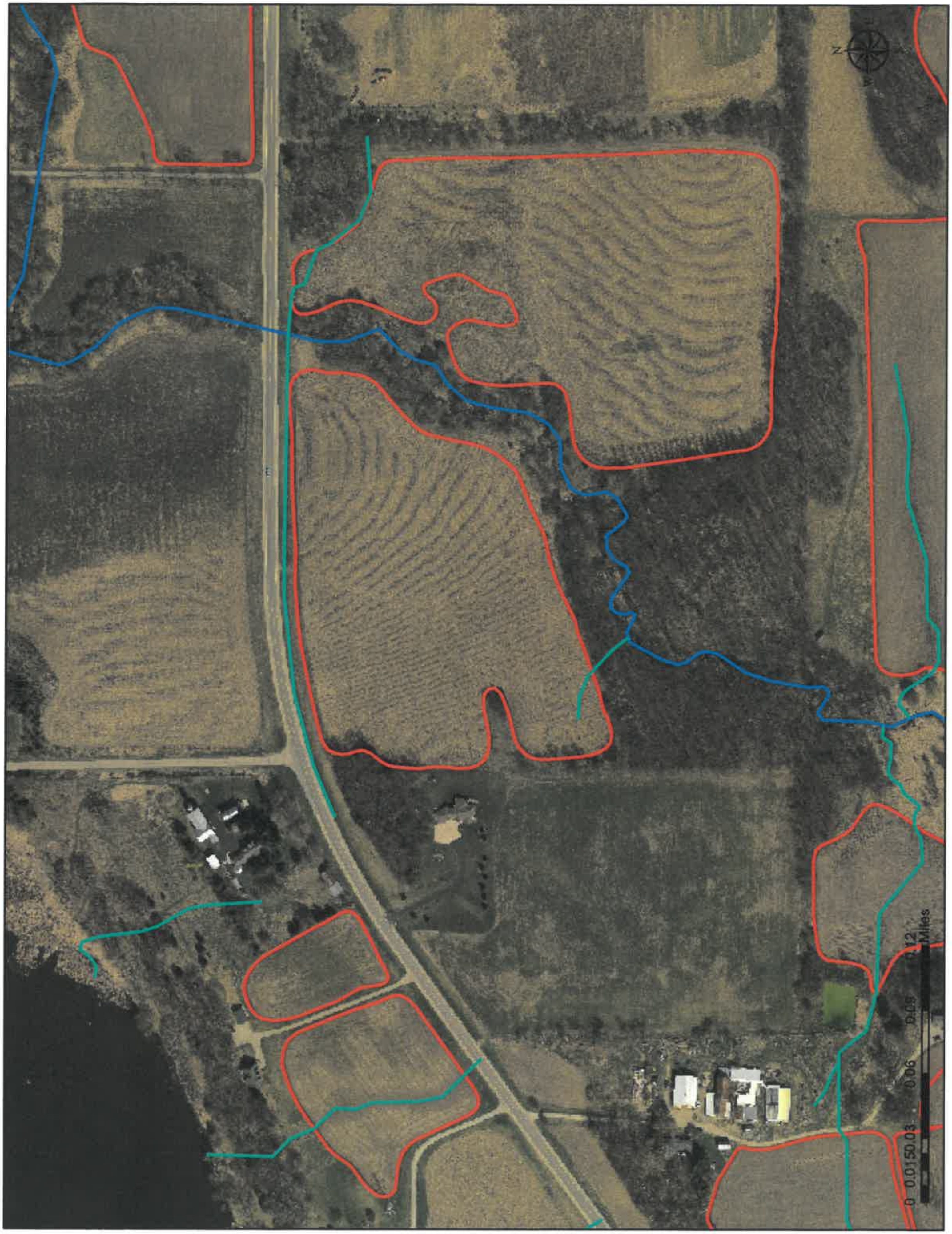
0.09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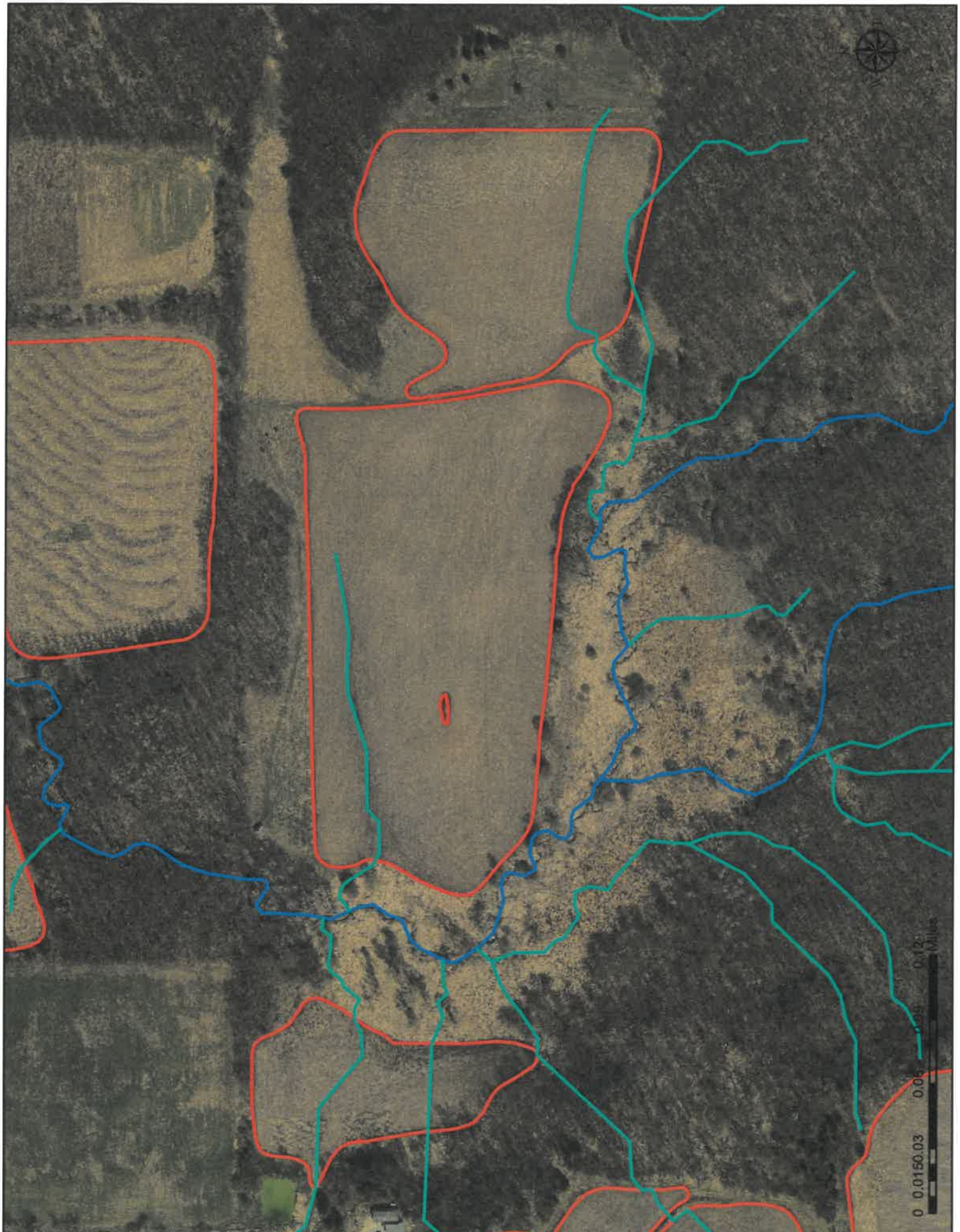
0 0.0150.03
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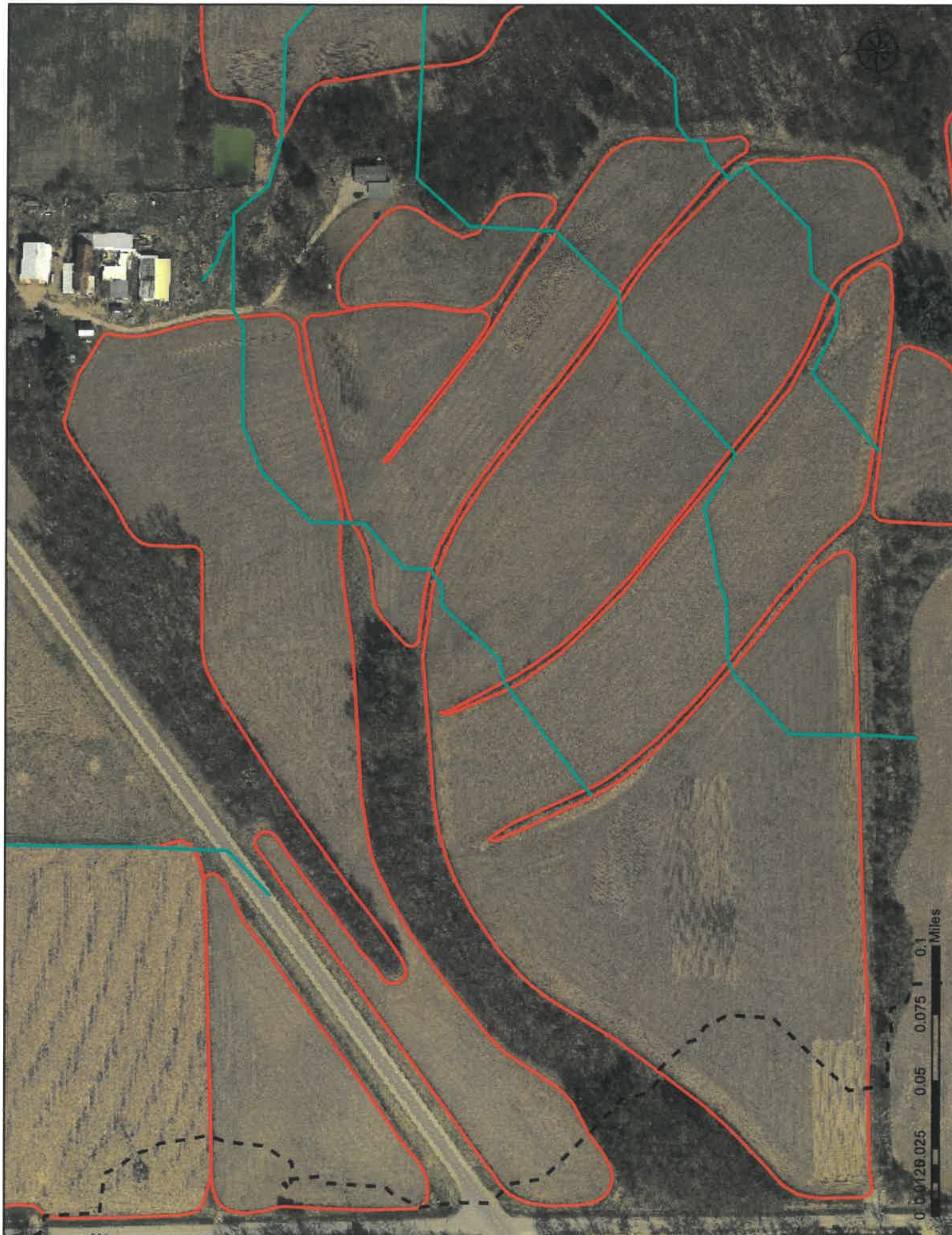
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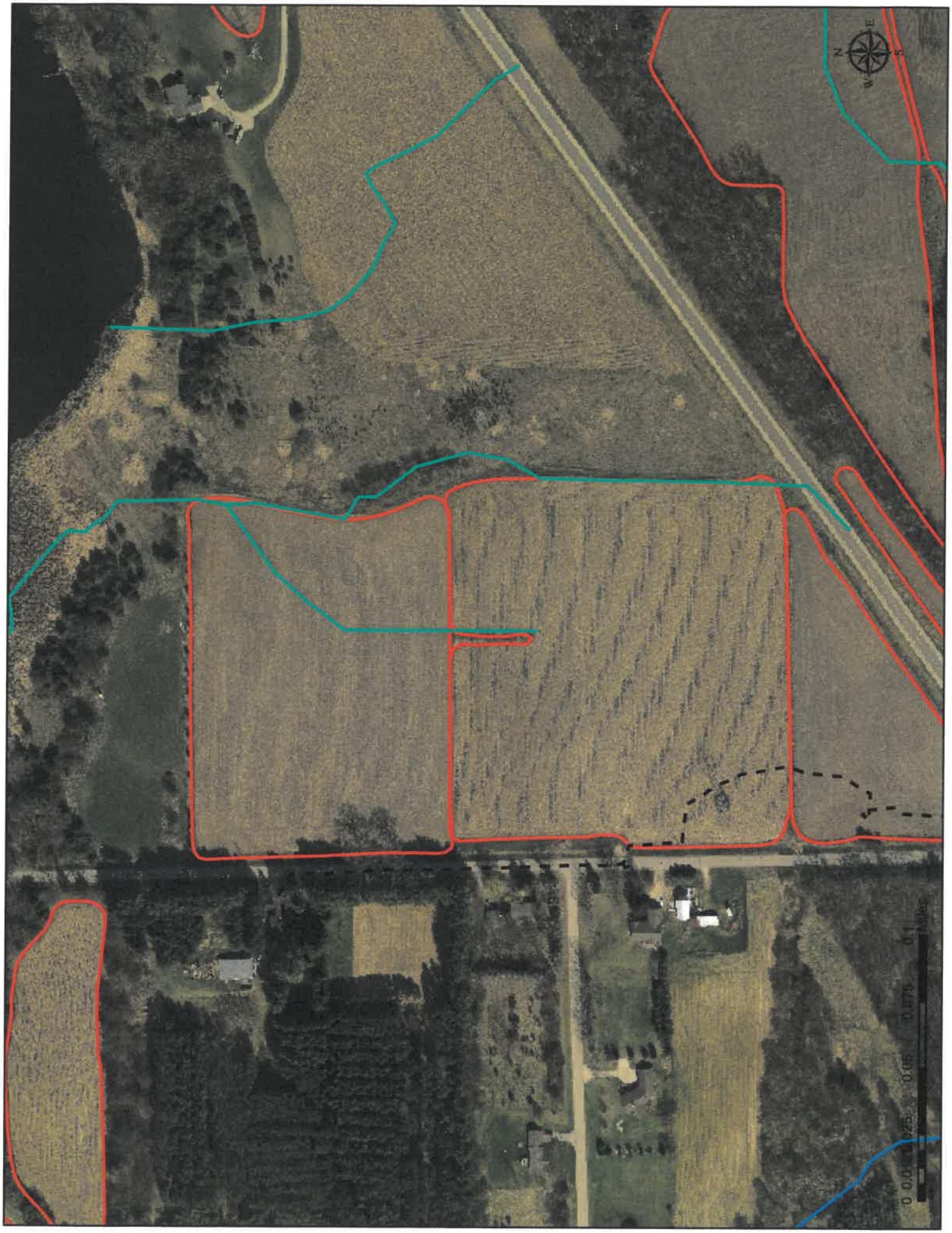
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Miles


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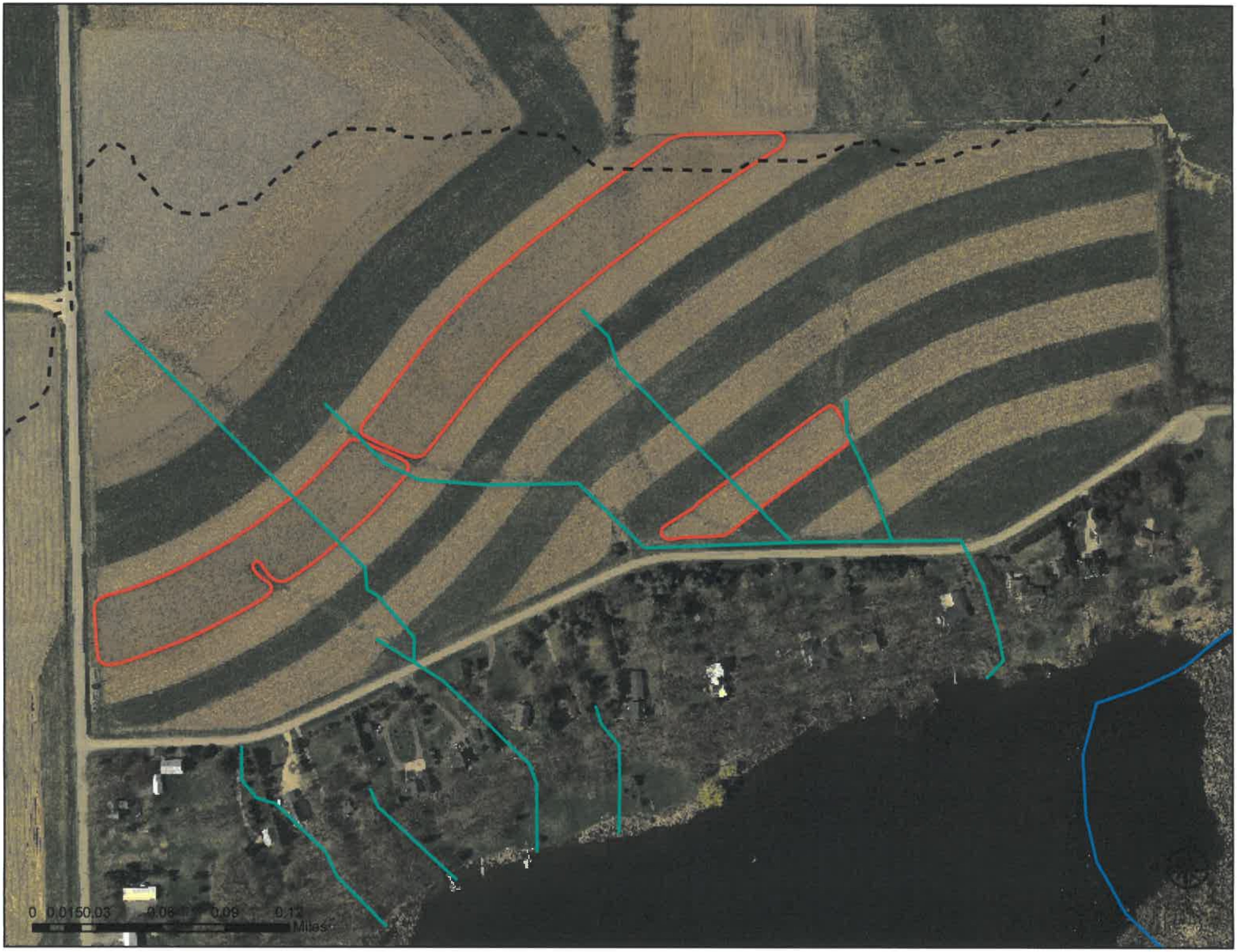
Miles


0 0.0150.03 0.06 0.09 0.12
Miles

APPENDIX B
FISHERIES DATA

Wisconsin Department of Natural Resources
Fish Stocking Summary
DNR Hatcheries, Ponds, and Coop Ponds

Please Note: The stocking records for the current stocking year will be posted annually after verification by our fisheries biologists. Please contact your local fisheries biologist if you have questions about our current stocking practices.

County Name	Waterbody Name	Local Waterbody Name	Location (TRS)
GREEN LAKE	TWIN LAKES		

Year	Stocked Waterbody Name	Local Waterbody Name	Location	Species	Strain (Stock)	Age Class	Number Fish Stocked	Avg Fish Length (IN)
1997	TWIN LAKES		15N-13E-5	NORTHERN PIKE	UNSPECIFIED	LARGE FINGERLING	111	8.10
1996	TWIN LAKES		15N-13E-5	LARGEMOUTH BASS	UNSPECIFIED	FINGERLING	2,775	1.40
1996	TWIN LAKES		15N-13E-5	NORTHERN PIKE	UNSPECIFIED	FINGERLING	222	8.00
1995	TWIN LAKES		15N-13E-5	NORTHERN PIKE	UNSPECIFIED	FINGERLING	111	8.20
1994	TWIN LAKES		15N-13E-5	LARGEMOUTH BASS	UNSPECIFIED	FINGERLING	5,000	1.00
1994	TWIN LAKES		15N-13E-5	NORTHERN PIKE	UNSPECIFIED	FINGERLING	111	7.70
1989	TWIN LAKES		15N-13E-5	LARGEMOUTH BASS	UNSPECIFIED	FINGERLING	6,000	1.00
1988	TWIN LAKES		15N-13E-5	LARGEMOUTH BASS	UNSPECIFIED	FINGERLING	5,000	3.00
1984	TWIN LAKES		15N-13E-5	LARGEMOUTH BASS	UNSPECIFIED	FINGERLING	4,635	3.00
1983	TWIN LAKES		15N-13E-5	NORTHERN PIKE	UNSPECIFIED	FINGERLING	500	9.00
1974	TWIN LAKES		15N-13E-5	LARGEMOUTH BASS	UNSPECIFIED	FINGERLING	8,000	3.00
1972	TWIN LAKES		15N-13E-5	LARGEMOUTH BASS	UNSPECIFIED	FINGERLING	2,500	3.00

Fish and Wildlife Assessment

Twin Lakes and Spring Lake are well-known fishing destinations in Green Lake County. Some of the most commonly found species in these lakes include largemouth bass, northern pike and panfish (WNDR 2005).

In 2014, the WDNR conducted late-spring electrofishing surveys focused on bass/panfish on Twin Lakes and Spring Lake. The Twin Lakes survey took place on May 20, 2014 and covered approximately 1.5 miles of shoreline. The Spring Lake survey took place on June 3, 2014 and covered approximately 1.2 miles of shoreline. Results of these surveys are found in **Appendix B**. **Tables 14 and 15** show the types on numbers of fish caught during the surveys of Twin Lakes and Spring Lake, respectively. During both surveys, bluegills and largemouth bass were the most abundant species found.

Table 14. Abundance of fish species found by the WDNR on May 20, 2014 in Twin Lakes, Green Lake County, Wisconsin

Fish Species	Total Catch
Bluegill	130
Largemouth Bass	69
Pumpkinseed	17
Northern Pike	12
Black Crappie	4
Yellow Perch	3

Table 15. Abundance of fish species found by the WDNR on June 3, 2014 in Spring Lake, Green Lake County, Wisconsin

Fish Species	Total Catch
Bluegill	164
Largemouth Bass	76
Yellow Perch	11
Pumpkinseed	7
Green Sunfish	2
Walleye	1

In Twin Lakes, there were a fair number of bluegills, 20 of which were "quality-sized". Largemouth bass exhibited a strong upcoming year class with some large fish present. The average size was a little small, but not bad. The northern pike were very small/stunted with moderate numbers. Few yellow perch and black crappies were caught. It is possible the survey took place after the crappies' spawn which resulted in low numbers. In Spring Lake, there were strong numbers of bluegills, 35 of which were "quality-sized". Largemouth bass exhibited small average size with some trophy-sized fish. Yellow perch numbers were low, but good sized. The WDNR lists Twin Lakes as having walleyes, however, none were identified during the 2014 survey.

Table 16 includes habitat requirements and improvements information regarding fish species commonly found in these waters. This information was gathered from George C. Becker's *Fishes of Wisconsin*.

Table 16. Description of fish habitat requirements and improvements for fish species found in the Twin Lakes and Spring Lakes, Green Lake County, Wisconsin.

Species	Habitat Requirements: Spawning	Rearing	Foraging	Habitat Improvements	Important Water Quality Parameters
Large-Mouth Bass (*Micropterus salmoides*)	* Shallow protected areas containing emergent vegetation with sandy to gravely substrate * Soft bottoms with woody debris present	* Shallow edges	* Waters less than 18 ft. deep containing aquatic macrophytes * Shallow open areas	* Leave woody debris in lake including small limbs *Control dense stands of nuisance vegetation to improve foraging efforts	* Water temperature is a very important factor * L-M Bass prefer warm water (27-30°C)
Northern Pike (*Esox lucius*)	* Shallow flooded marshes associated with a lake or any flooded area containing emergent vegetation	* Shallow spawning areas with vegetation	* Site feeders, prefer vegetation for camouflage which allows them to ambush their prey	* Control dense stands of nuisance vegetation * Plant native macrophytes	* Do best in cool to moderately warm water temperatures. (21-27°C)
Walleye (*Sander vitreus*)	* Rocky Shorelines with wave washed shallows * Areas where inlet streams enter lake and contain a gravel substrate	* After hatching migrate out to open waters of lake * After 1-2 months return to inshore habitats	* Utilize hard bottom areas including bars, shoals, and emergent vegetation	* Construction of artificial spawning areas (rocks, gravel) * Addition of woody debris (logs) for habitat/foraging	* Do well in both clear and turbid waters
Black Crappie (*Pomoxis nigromaculatus*)	* Shallows containing sand or fine gravel substrate * Spawn near chara and other submerged vegetation	* Young live in shallow protected areas	* Midwater feeders associated to abundant stands of aquatic vegetation and open areas * School around large submerged trees	* Plant chara which is associated with spawning sites * Submerge woody structures	* Prefer clear, warm waters

Table 16 (continued). Description of fish habitat requirements and improvements for fish species found in the Twin Lakes and Spring Lakes, Green Lake County, Wisconsin.

Species	Habitat Requirements: Spawning	Rearing	Foraging	Habitat Improvements	Important Water Quality Parameters
Bluegill *(Lepomis macrochirus)*	* Shallows consisting of sand or gravel substrate	* Young stick to shallow cover (emergent and submerged vegetation)	* Tend to remain in or near cover during the day and at night enter the shallows * Utilize all sources of vegetation	* Control dense stands of exotic vegetation *Add woody cover if habitat is limited	* Found more frequently in clear water verses turbid * Very susceptible to winter kill due to low oxygen levels
Pumpkinseed *(Lepomis gibbosus)*	* Spawn in shallow warm bays with sand or gravel substrates	* Young tend to live on or near shallow water spawning areas in emergent vegetation	* Feed in deeper waters with rocky or plant covered substrates	* Control dense stands of exotic macrophytes * Restore native emergents	* Most frequently found in cool to moderately warm waters * Prefer clear to moderately turbid water
Green Sunfish *(Lepomis cyanellus.)*	* Spawn in shallow water, Nests built in shelter of rocks, logs and clumps of grass	* Young seek warm, shallow waters in the vicinity of weed beds.	* Feed in quiet pools in warm, shallow waters	* Control dense stands of exotic macrophytes * Restore native emergents	* Can survive in clear to turbid waters in temperatures over 90°F
Yellow Perch *(Perca flavescens)*	* Spawn in slow-moving or static waters where emergent and submerged vegetation is present * Also spawn on submerged brush	* Shallows among vegetation	* Feed mainly near the bottom in offshore open water habitats lacking dense vegetation	* Control dense stands of nuisance vegetation * Protect native macrophytes	* Do well in turbid, nutrient rich waters

Results of the fish and wildlife habitat survey are found in **Figures 30-42**. These maps identified areas of woody debris and tree falls as well as emergent and floating-leaf plant locations within Big and Little Twin Lakes and Spring Lake. Collectively, a large portion of these lakes is littoral and exhibit abundant plant growth. A majority of the emergent plant growth on Big and Little twin Lakes is from cattails (*Typha* spp.), but to a far lesser extent bulrushes (*Schoenoplectus* spp.) and burreed (*Sparganium* spp.). Bulrushes and cattails are both abundant on Spring Lake. Floating-leaf plants such as the waterlilies are moderately abundant along the south and west shores of Big Twin Lake and the south shore of Spring Lake. Little Twin Lake does not have a community of floating-leaf plants. Very little woody debris exists in these lakes. Two areas of woody debris were identified on Big Twin Lake. None were found on Little Twin or Spring Lakes.

APPENDIX C
STAKEHOLDER SURVEY

Property Owner Survey: We need your input about the management of Twin Lakes. Your honest opinion is important to us. Please take a few minutes to fill out this survey and send it back. Thank you!

SECTION 1: FAMILIARITY WITH TWIN LAKES

1) **Are you a renter, or property owner?** Check ONE statement which **best** describes your situation.
    ____ Property Renter
    ____ Property Owner

2) **Which waterbody do you rent or live on** ________________
    ____ Big Twin Lake
    ____ Little Twin Lake
    ____ Spring Lake
    ____ None of the above

3) **How many years ago did you first visit Twin Lakes** ______ year(s)
    If less than one year, enter 1
    If you are a visitor/guest please answer this question, then advance to Section 2

4) **How long have you owned or rented your property?** ________ year(s) *If less than one year, enter 1*

5) **Is your property used as a primary or seasonal residence?** Circle One
    Primary   Seasonal*
    **If seasonal, approximately how many days each year is your lake property used by you or others?*______ day(s)

SECTION 2: RECREATION

6) **Circle all activities that are important to you on Twin Lakes.**
    a. Solitude / Relaxation
    b. View nature/wildlife
    c. Boating / Pontoon
    d. Hunting
    e. Ice fishing
    f. Entertaining
    g. Swimming
    h. Jet skiing
    i. Snowmobiling/ATV
    j. Hiking
    k. Fishing
    l. Water skiing/tubing
    m. Canoeing/kayaking
    n. Sailing
    o. Other_______________

    None of these activities are important to me (*advance to Section 3*)

7) **How many days each year do you recreate on Twin Lakes?** ______day(s)
    Provide you're best estimate by entering one number and not a range of days

8) **From the list in question 6, rank your top three important activities.**

    1st______   2nd______   3rd______

21) Are you aware of any aquatic invasive species in Twin Lakes? Circle One

1 – Yes
2 – I think so, but not positive
3 – No (*If no, advance to Section 6*)

22) If you answered yes or unsure in 21, which AIS are you aware of in Twin Lakes?

____Rusty crayfish
____Curly-leaf pondweed
____Flowering rush
____Purple loosestrife
____Zebra mussel
____Chinese mystery snail
____Eurasian water milfoil
____Carp
____Freshwater jellyfish
____Spiny waterflea
____Other__________
____ I'm unsure but believe AIS to be present

23) If you own a watercraft, do you use it on waters outside of Twin Lakes?

1 – Yes
2 – No (*If no, advance to Section 6*)

24) What decontamination routines do you use when entering or leaving a lake (check all that apply)?

____Physical removal of any visible mud, plants, fish or animals from watercraft and trailer
____Draining of water from watercraft (e.g. live wells, bait wells and bilge areas, etc.)
____Power washing of watercraft and trailer
____ Dry boats, trailers and all equipment
____ Disinfect anything that came into contact with water, if it cannot be dried before reuse.

SECTION 6: GENERAL

25) Refer to the list of common lake pressures below. To what level do you believe the following are having a *negative* effect on the waters within Twin Lakes? Place a 1, 2, 3 or 4 in front of <u>each</u> item below.

1 – Does not exist **2 – Exists, but no effect** **3 – Moderate Effect** **4 – Large Effect**

___Loss of fish habitat
___Faulty septic systems
___Water pollution
___Loss of shore vegetation
___Shoreline soil erosion
___Lakeshore development
___Watershed development
___Boating safety
___Loss of wildlife habitat
___Algae blooms
___Noise pollution
___Boat traffic
___Invasive species
___Fishing pressure
___Aquatic plants (not algae)

26) From the listing below, rank <u>your top three</u> concerns regarding Twin Lakes.
Place a letter into each rank with 1st being your highest concern

1st______ 2nd______ 3rd______

a. Lakeshore development
b. Lake bottom siltation
c. Water quality degradation
d. Noise pollution
e. Loss of fish habitat
f. Boating safety / Traffic
g. Light pollution
h. Agriculture runoff
i. Algae blooms
j. Fishing pressure
k. Aquatic plant growth
l. Loss of wildlife habitat
m. Loss of shoreline vegetation
n. Degradation of aquatic plants
o. Fish kills
p. Aquatic invasive species
q. Shoreline soil erosion
r. Other:

33) The Twin Lakes Association could better serve their membership by________. Please elaborate.

Thank you for participating in this survey. If you have additional concerns, ideas, or comments we want to hear from you. Please use the space below for your narrative.

APPENDIX D

SHORELINE ASSESSMENT