Date: August 28, 2012

To: Lake Alexander Property Owners Association
Dr. Bill Faber
7427 Cottonwood Road
Cushing, MN 56443

Subject: 2012 Trophic Status Index Mapping Flight Report

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Introduction to TSI Lake Mapping

TSI Lake Mapping provides mapped TSI values that would historically be determined by measuring the Secchi depth, total phosphorus concentration, chlorophyll *a* concentration, and placing the resulting values into the Carlson Trophic Status Index algorithms. The Carlson Trophic Status Index (TSI) is a tool used to summarize measurements of water quality into one index value. This value can be used to compare lakes in the same region or as a historical comparison of improvement/degradation over time. In many ways, the index can be viewed as a measure of the potential for algal productivity. Since most people value lakes with high clarity and low algal productivity, the lower the TSI value the healthier the lake is considered to be.

TSI Value	Trophic Status	General Lake Characteristics
0 – 30	Oligotrophic	*Very clean lake; water is clear.*
31 – 40	Oligotrophic	*Clean Lake with clear water and normal algae levels.*
41 – 50	Mesotrophic	*Reduced water clarity; temporary algae/aquatic plant problems.*
51 - 60	Eutrophic	*Reduced water clarity; persistent algae/aquatic plant problems.*
61 - 70	Eutrophic	*Greatly Reduced water clarity; persistent algae/aquatic plant problems.*
71 - 80	Hypereutrophic	*Water clarity is poor; extreme algae/aquatic plant problems.*
81 - 100	Hypereutrophic	*Water clarity is poor; extreme algae/aquatic plant problems.*

A.W. Research Laboratories, Inc. has developed a multispectral camera that measures the TSI values for the entire lake. The camera's capabilities are similar to combining approximately 870 manually collected samples per acre and mapping the results to one image. The resulting image provides a clear depiction of problem areas that is easily understood by lake managers and property owners alike. By pinpointing problem areas immediately, you can put your efforts and budget toward remediation of the problems.

Flight Data

On August 2, 2012 AWRL conducted a TSI Mapping Flight of Lake Alexander (MN ID# 49-0079 in Morrison County, Minnesota.

The following conditions were recorded on the day of the flight:

Date: August 2, 2012

Time: 11:50 am

Conditions: Clear

Air Temp: 78.8 ^{o}F

Dew Point: 59.0 ^{o}F

Humidity: 51%

Visibility: 10.0 miles

Wind: Calm

Lake Stats

MN ID#: 49-0079

Nearest Town: Randall

Primary County: Morrison

Lake Area (acres): 2709

Littoral Area (acres): 842

Max Depth (feet): 764

Water Clarity (feet): 12.78*

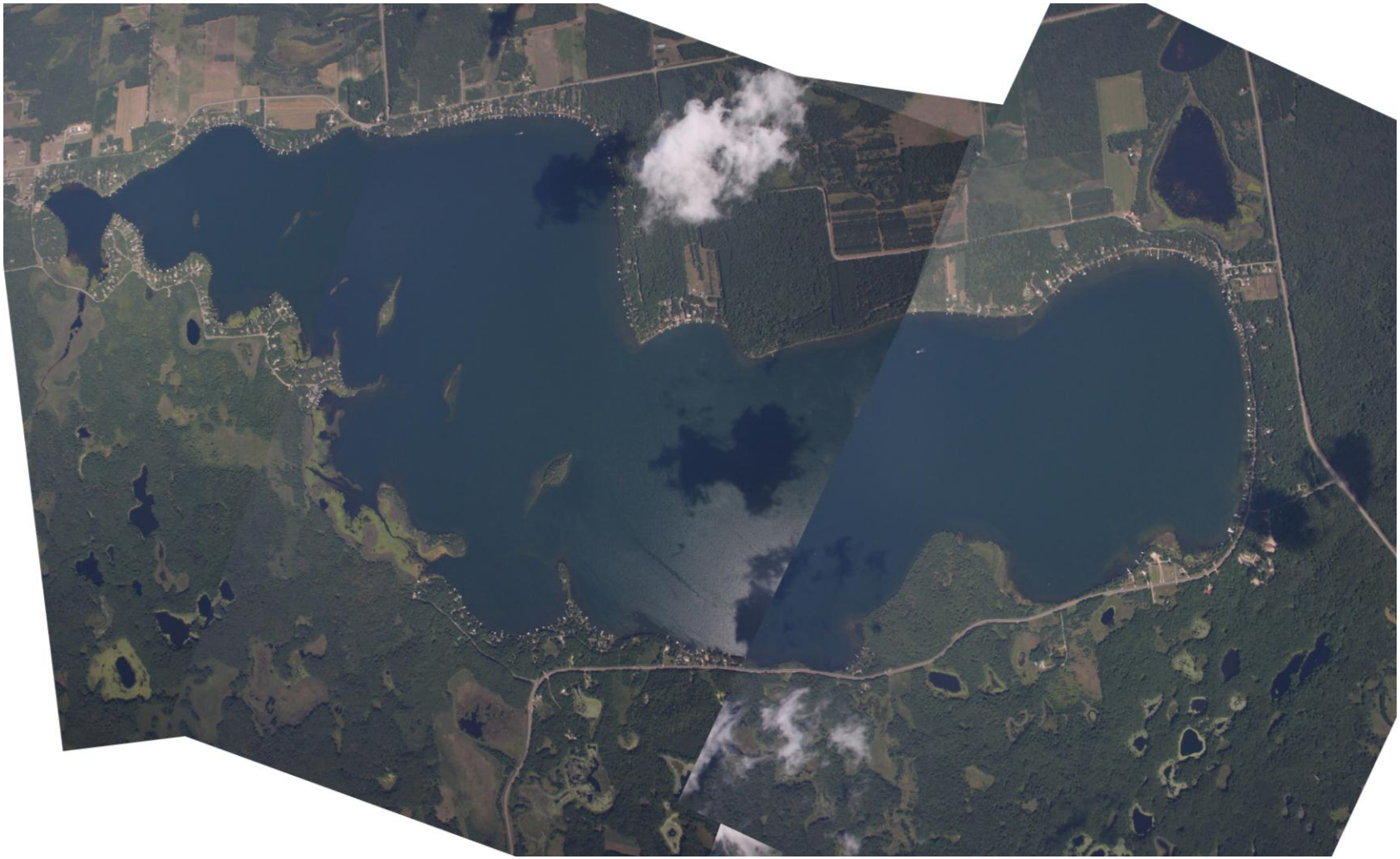
Physical Condition: 2 – Not quite crystal clear, little algae present/visible^

Recreational Suitability: 2 – Very minor aesthetic problems, excellent for swimming^

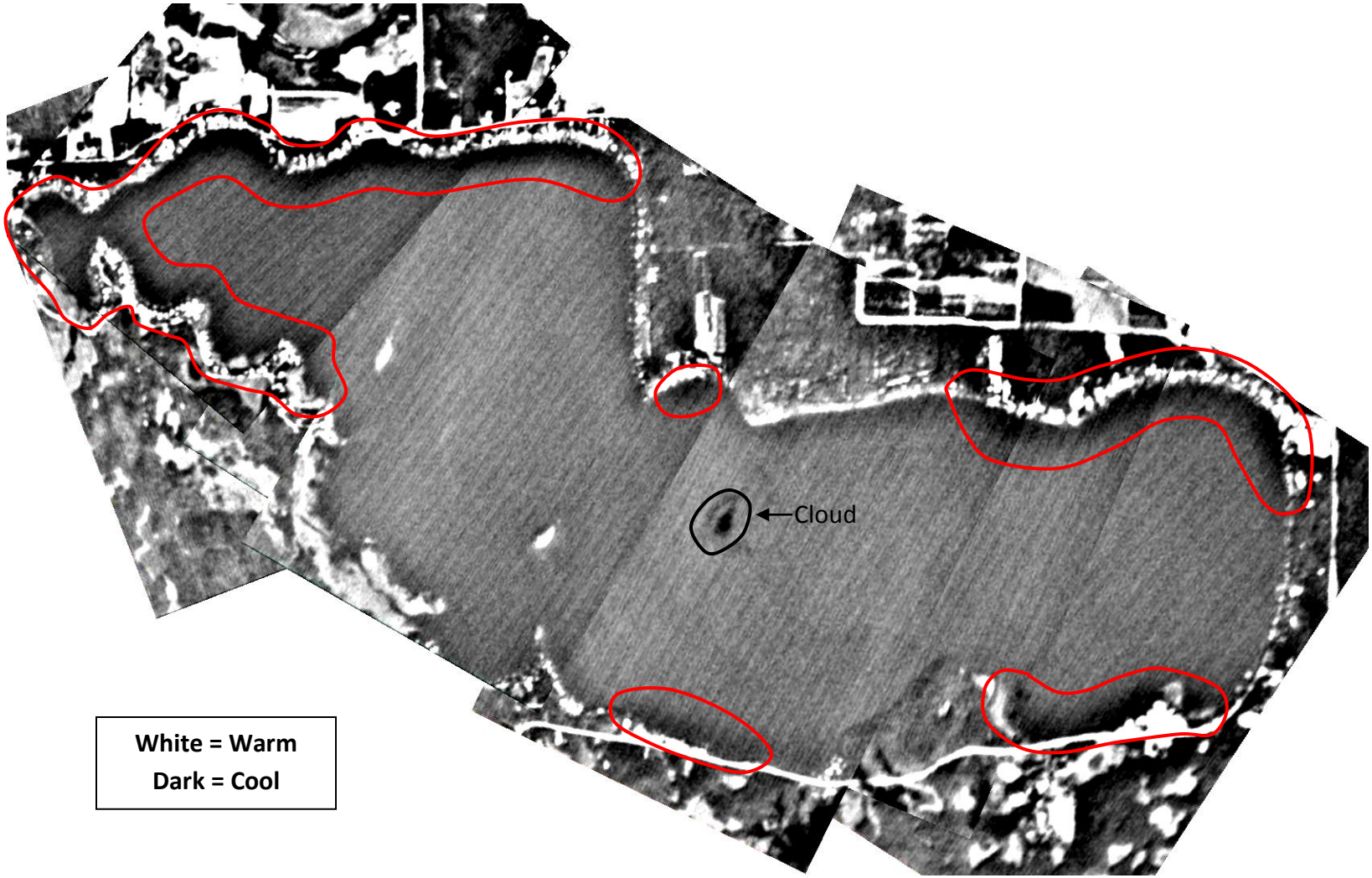
*Average of Secchi readings taken by Dale Ness, 8/6/2012

^Recorded by Dale Ness, 8/6/2012

Visible Image

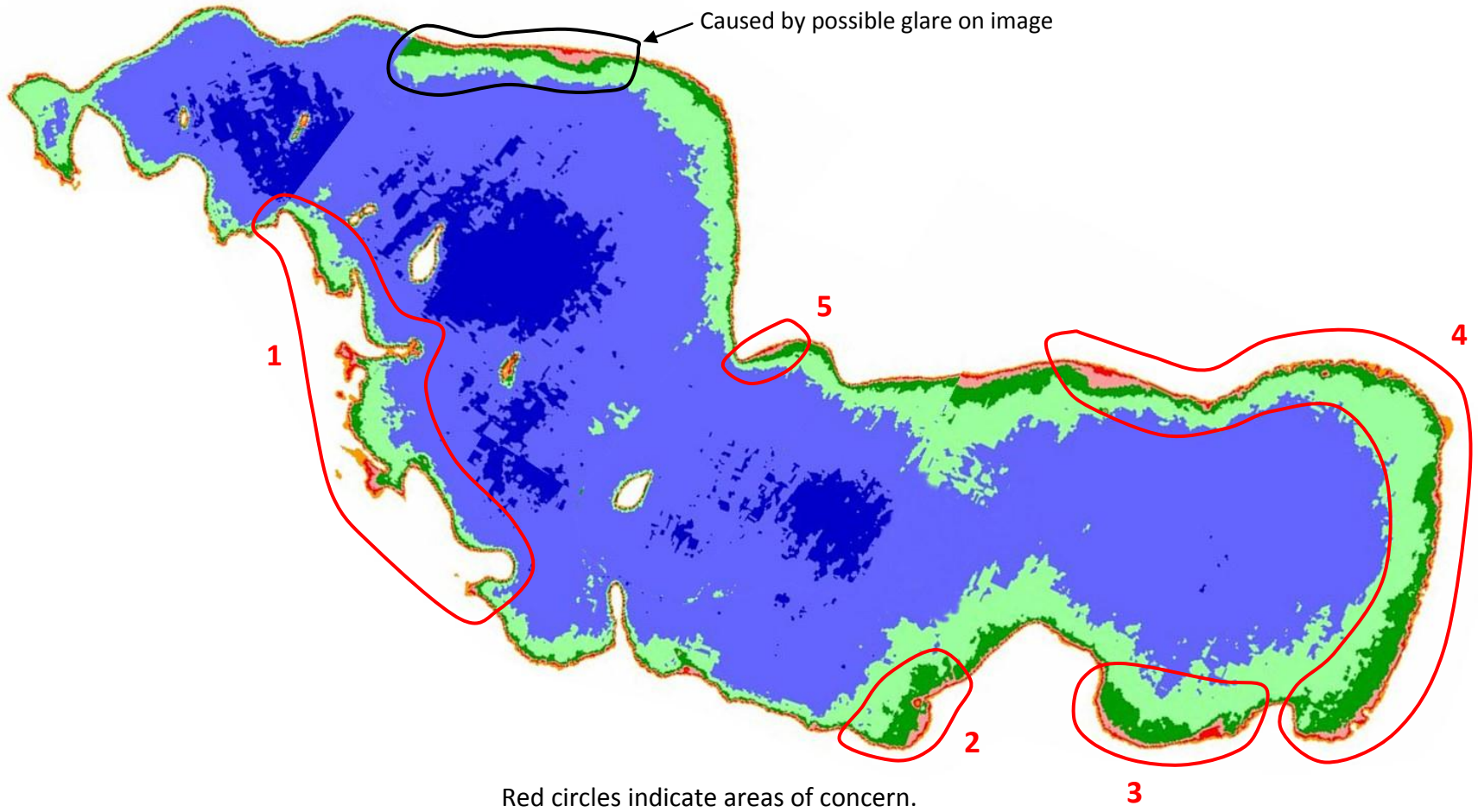


Thermal Image



Areas circled in red indicate cooler water entering the lake, potentially from groundwater springs or septic systems.

Trophic Status Index Map



Red circles indicate areas of concern.

TSI VALUES

0-30	31-40	41-50	51-60	61-70	71-80	81-100

Conclusions and Recommendations

The TSI Map for Lake Alexander shows TSI values ranging from 31-50 for the majority of the lake with higher TSI values (51-100) occurring near the shoreline areas. This is due to the fact that in general, the majority of nutrient loading occurs near the shoreline where runoff from roads, lawns and septic leaks from shoreline properties enter the lake.

There are a few areas where this loading is heavier that have been circled in red on the TSI Map above. These areas show a progression from Mesotrophic (light green), to Eutrophic (dark green and red), to Hypereutrophic (orange) as you move closer to the shoreline.

Area of concern #1 shows evidence of emergent vegetation and algae problems. The TSI Map indicates that there are a higher amount of nutrients in this location, which would support more vegetative growth. The sources of the higher nutrients in this location should be investigated further. Area #2 shows hypereutrophic conditions along the developed portion of the shoreline in this area. Since the thermal image shows no signs of springs in this location, we can assume that the most likely source of the increased TSI values is runoff from these shoreline properties.

Areas of concern #3, #4 and #5 are all likely caused by nutrient loading from leaking septic systems or springs. The thermal image indicates heavy spring activity at area #3 (Anderson Bay) which is likely providing excess nutrients from the input of groundwater at this location. Particular attention should be paid to the red plume entering the lake in this area. The shoreline along areas #4 and #5 is developed and therefore the influence of shoreline practices is of concern. The thermal image also shows the potential for groundwater springs in these areas.

To further identify and correct the impact of nutrient loading on Lake Alexander, AWRL recommends the following:

1. **Groundtruthing**

   A volunteer committee should be formed to conduct basic groundtruthing in the areas circled in red on the TSI Map to determine what potential sources (i.e. runoff, springs, or point discharge) could be contributing to the higher TSI values in these areas. Groundtruthing is a simple process that involves visiting the property of concern and working with the property owner to locate, identify and fix any found issues. Many problems, once discovered, may be a quick fix on the part of the property owner.

2. **Groundwater Intrusion Overflight (GWI)**

   Conduct a Groundwater Intrusion Overflight (GWI) of the areas of concern (approximately 5 miles of shoreline) in the winter of 2012-2013 to pinpoint problem septic systems and

springs that are influencing the lake. The information from the flight will then be used to mitigate these nutrient sources problems and stop the nutrient loading at the source. AWRL can provide a detailed proposal if you are interested in pursuing this project.