RICE LAKE PHASE 1 INVESTIGATION REPORT

Emmons County, North Dakota

SWC Project #2147
August 2020

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September 25, 2020

Mr. Glenn Geffre, Chairman
Emmons County Water Resource Board
PO Box 643
Linton, ND 58552-0643

RE: Rice Lake Phase 1 Investigation Report Erratum

Dear Chairman Geffre:

An error was found in the Rice Lake Phase 1 Investigation Report dated August 2020. On page 2, within the second paragraph from the bottom, the highest lake level on record should state “1802.9 feet” rather than “1402.9 feet”. The corrected page is attached.

This elevation was simply mistyped and does not change the data pertaining to the Phase 1 investigation. Please feel free to contact me with any questions.

Sincerely,

Alexis Faber

Alexis Faber, E.I.T.
Water Resource Engineer

AF:pp/2147

RICE LAKE PHASE 1 INVESTIGATION REPORT

Emmons County, North Dakota

SWC Project #2147

North Dakota State Water Commission

900 East Boulevard Ave.

Bismarck, ND 58505-0850

PREPARED FOR:

Emmons County Water Resource District

August 2020

Prepared by:

Alexis Faber, E.I.T.

Water Resource Engineer

Under the direct supervision of:

REGISTERED PROFESSIONAL ENGINEER
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PE-7851
DATE 8/4/20
NORTH DAKOTA

Laura Ackerman, P.E.

Investigations Section Chief

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1. INTRODUCTION

Rice Lake is located in southeastern Emmons County, approximately 3.5 miles west of Hague, ND. Rice Lake's water level has been gradually rising since the 1930's but has significantly increased over the past few years, resulting in its connection with downstream waterbodies in early 2020. The rising water level is a concern for inundating homes, critical roads, and agricultural land.

The North Dakota State Water Commission (Commission) was contacted by the Emmons County Water Resource Board (Board) to investigate the flooding concerns at Rice Lake. The Commission entered into an agreement (Appendix A) with the Board in April 2020. It was agreed that this investigation would be completed in two phases. Phase 1 focused on collection of field data, analyzing existing conditions at the lake, evaluating the topography of the downstream flow path, and providing this information to the Board as soon as reasonably possible. Phase 2 focuses on understanding the hydrology of the lake and modeling downstream impacts and proposed mitigation alternatives.

This report details the findings of the Phase 1 investigation. A separate report will be prepared with the completion of Phase 2.

2. PROBLEM BACKGROUND

Southeastern Emmons County is part of the glaciated prairie pothole region. Emmons County is on the eastern edge of the Missouri River Trench, with the southeastern part of the county on the Missouri Couteau (Bluemle, 1984a). The Missouri Couteau is an area of relatively fresh glacial topography consisting of lake basins with interior drainage, i.e. intermittent streams drain into numerous depressions (Bluemle, 1984a).

Rice Lake is a glacial depression that fills up and overflows into other depressions downstream, eventually draining into a tributary that leads to Lake Oahe.

The soil in Emmons County is generally sandy to loamy, but heavier clay soils have developed over areas of glacial till in the eastern part of the county. Till consists of unsorted glacial sediment that results in poor drainage. The southeastern quarter of the county is the only part of the county where the surface till unit "Emmons Till" is present. The Emmons Till averages 17 percent sand, 36 percent silt, and 47 percent clay (Bluemle, 1984a). Rice Lake lies within an area of the flat fluvial plains, a zone of flat-bedded sediment, that is covered by water-lain material (Bluemle, 1984b). The land surrounding Rice Lake is primarily cultivated crops and grasslands (Multi-Resolution Land Characteristics Consortium, 2016).

According to the Government Land Office (GLO) maps and historic aerial photos, Rice Lake was once a dry lakebed (North Dakota State Water Commission, 2020a). Rice Lake's water level has gradually increased since the 1930's and has significantly increased over the past few years. In 2019, rapidly rising water levels resulted in emergency road raises on Highway 83 and 96th Street SE shortly before the lake iced over. There has been some debate regarding the overflow elevation of Rice Lake and what the corresponding effects would be when the lake is at its overflow elevation.

The highest lake level on record, 1802.9 feet North American Vertical Datum of 1988 (NAVD88), occurred during April 2020. At this elevation, the lake naturally connected with downstream depressions, flowing over various control points and high spots.

There are multiple depressions downstream of Rice Lake, making it a complex system with more than one overflow control point. Figure 1 shows Rice Lake and the surrounding area. The downstream waterbodies have been labelled for reference

throughout this report. There are multiple "Nieuwsma" dams in the vicinity of Rice Lake. The label "Nieuwsma Stock Dam" in Figure 1 is not a legal name and is for reference purposes only. Please note that this waterbody is in the northeast quarter of Section 22 in Township 129 North, Range 75 West and is separate from the well-known Nieuwsma Lake, which is approximately 0.8 miles to the southeast of the labelled waterbody.

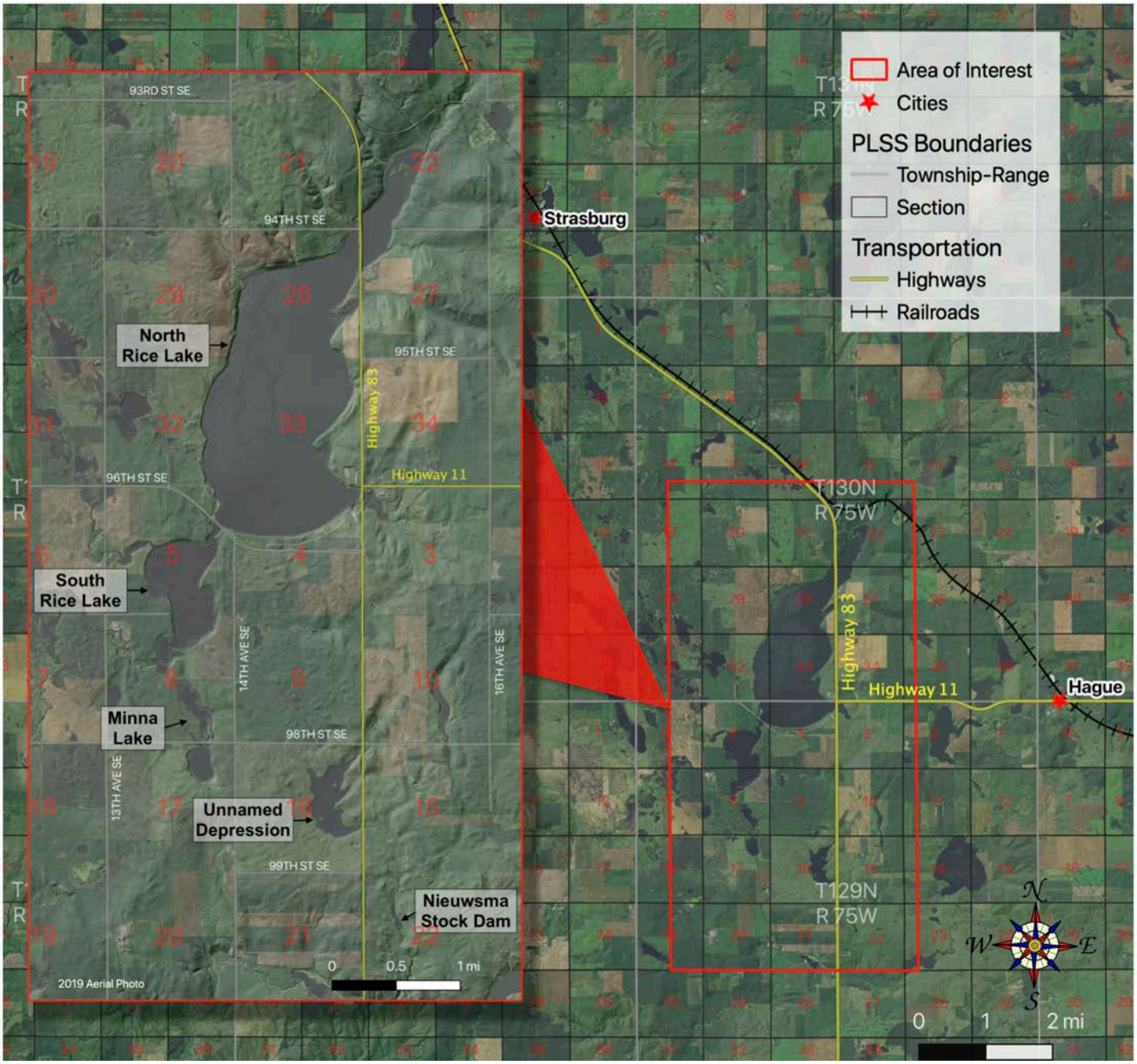

Figure 1 – Rice Lake Overview

3. EXISTING DATA

The GLO maps and historic aerial photos of Rice Lake and the surrounding area were gathered from the Commission's MapService as GeoTIFFs and are contained in Appendix D, along with the GIS project file that was created for the Phase 1 analysis (North Dakota State Water Commission, 2020a). Snapshots of the GLOs and historic aerial photos, as well as other photos gathered during the 2020 site visits, can be found in Appendix C.

The James River Basin Phase 5 LiDAR collect from 2014 was utilized as the topographic data for the Phase 1 analysis (North Dakota State Water Commission, 2020b). High spots along the downstream flow path were field verified via an elevation survey. The site survey is further discussed in the following section.

An elevation-volume curve and an elevation-area curve were developed for the waterbodies upstream of the highest control point, 1801.6 feet (NAVD88). The LiDAR and North Dakota Game and Fish (NDGF) bathymetric contours were utilized to develop the elevation-area-volume relationship of North Rice Lake. These contours were delineated in 2004 (North Dakota Game and Fish Department, 2020). The LiDAR and USGS National Elevation Dataset (NED) were utilized to develop the elevation-area-volume relationship of South Rice Lake. The USGS NED was gathered in the 1990's but is the most current available bathymetric data for South Rice Lake (U.S. Geological Survey, National Geospatial Program, 2020). The elevation-area-volume relationship for Minna Lake was developed using LiDAR, as this waterbody was mostly dry in 2014 (North Dakota State Water Commission, 2020b). The elevation-area and elevation-volume curves are shown in Figures 2 and 3, respectively, and can also be found in Appendix D.

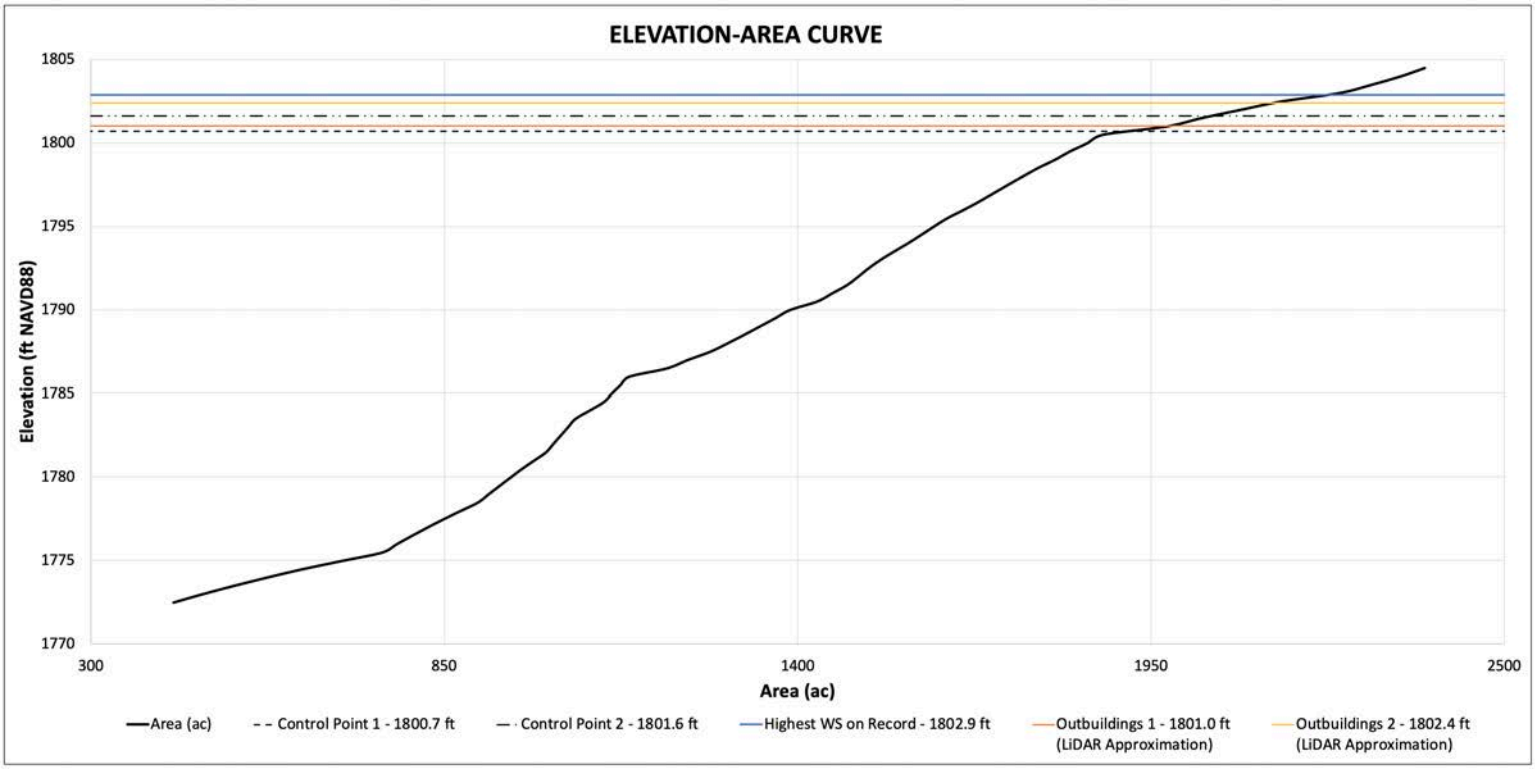

Figure 2 – Elevation-Area Curve

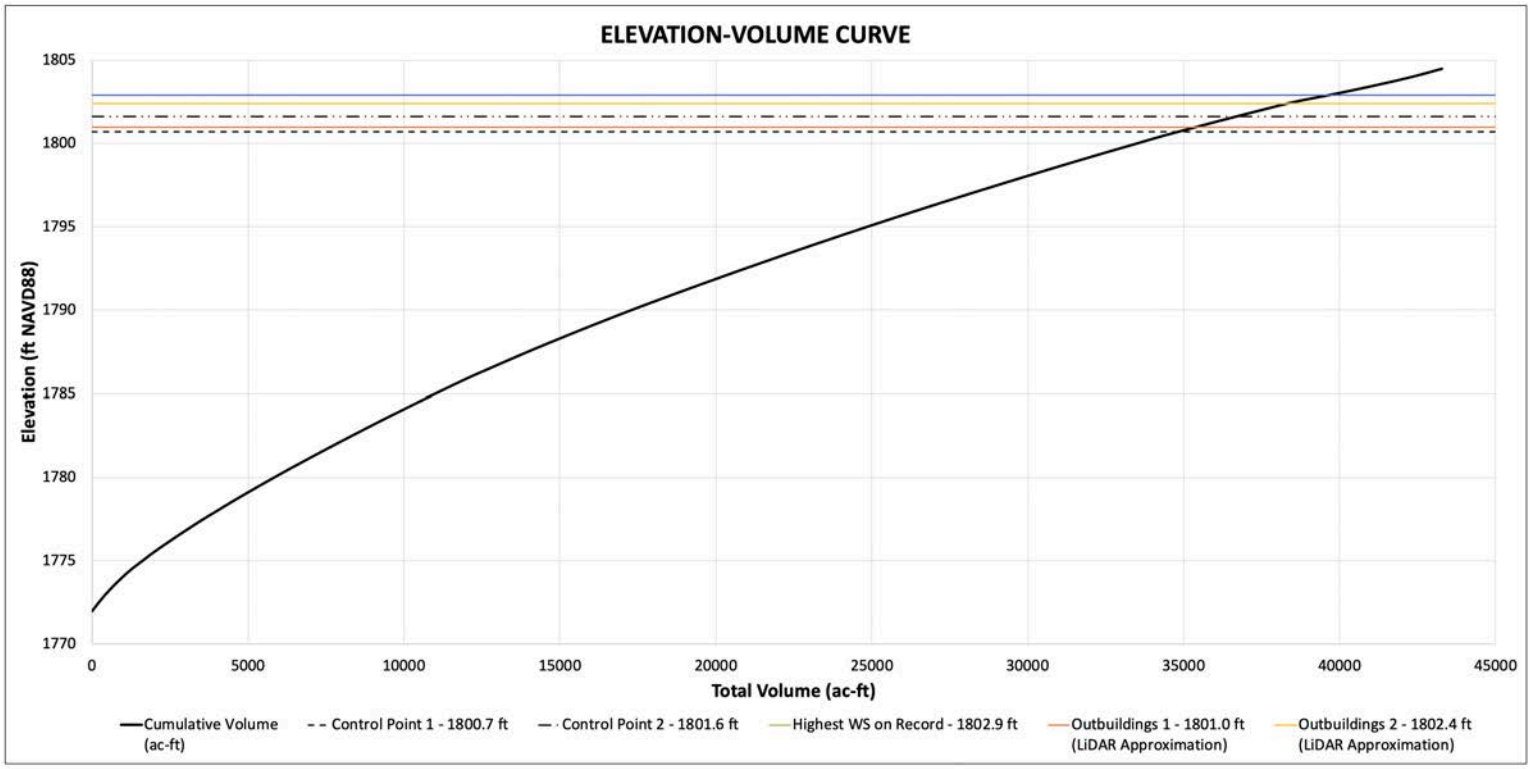

Figure 3 – Elevation-Volume Curve

SITE VISIT AND SURVEY

Site surveys were conducted on April 8, 2020 and June 10, 2020. Points-of-interest included water surfaces, high ground within the flow path, and culverts adjacent to the lake and along the downstream flow path. Figures 4 and 5 display the inundated areas resulting from the observed water surfaces during the site visits on April 8, 2020 and June 10, 2020. These maps were generated from the 2014 LiDAR; thus, the boundaries are approximate. The raw survey data can be found in Appendix B.

NDGF provided survey and photos of the newly constructed drop structure located at the Nieuwsma Stock Dam. This structure was installed to maintain an elevation drop that prevents undesirable fish, like common carp, from jumping or swimming upstream into Rice Lake. There are carp present in Lake Pocasse, which is now connected to Rice Lake via tributaries. Construction of the drop structure was completed on April 20, 2020. The provided survey data and photos can be found in Appendices B and C, respectively.

WATER LEVEL GAGE

The water level gage was installed on May 11, 2020. This gage collects water pressure and barometric pressure every 15 minutes. These pressures are then translated into water levels via the Commission's database. The water level data is useful for analyzing how the lake responds to storm events and will be used to calibrate future models. The water level data can be viewed on the Commission's MapService webpage at http://mapservice.swc.nd.gov/php/groundsurfacewatersites/waterlevels.php?id=130996.

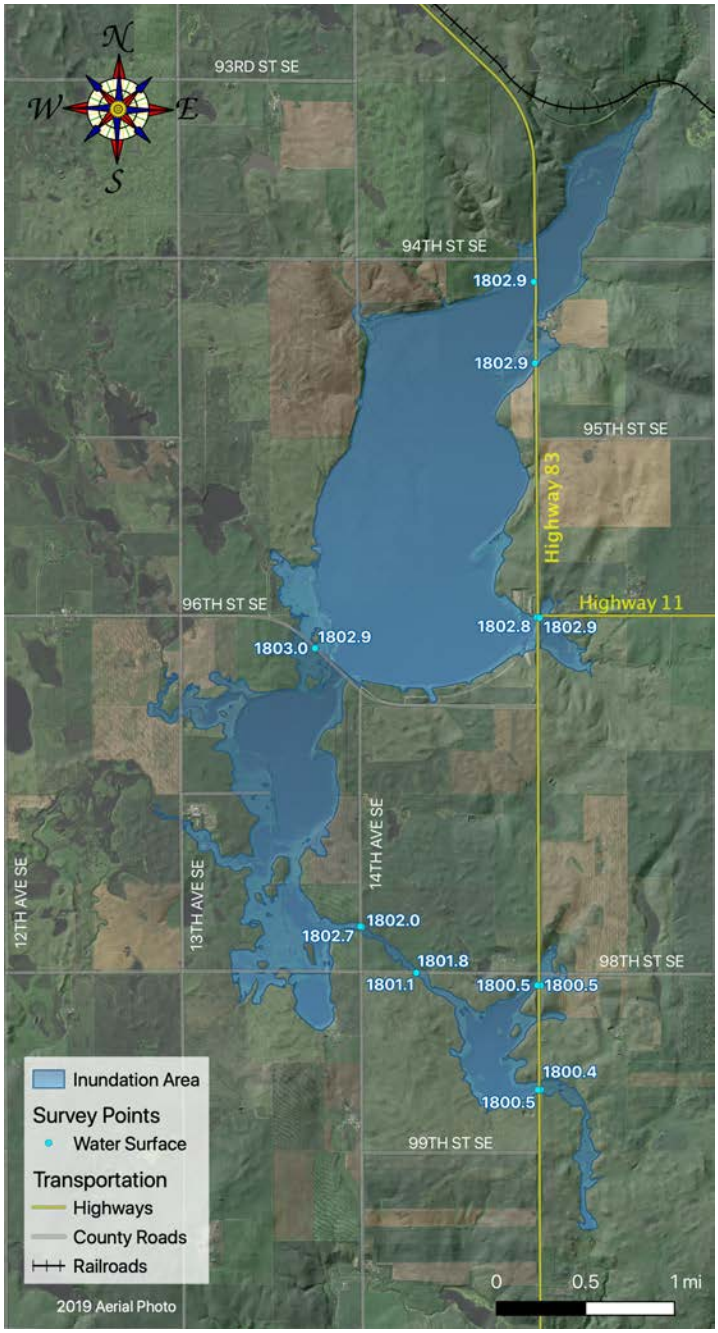

Figure 4 - Observed Water Surface (April 8, 2020)

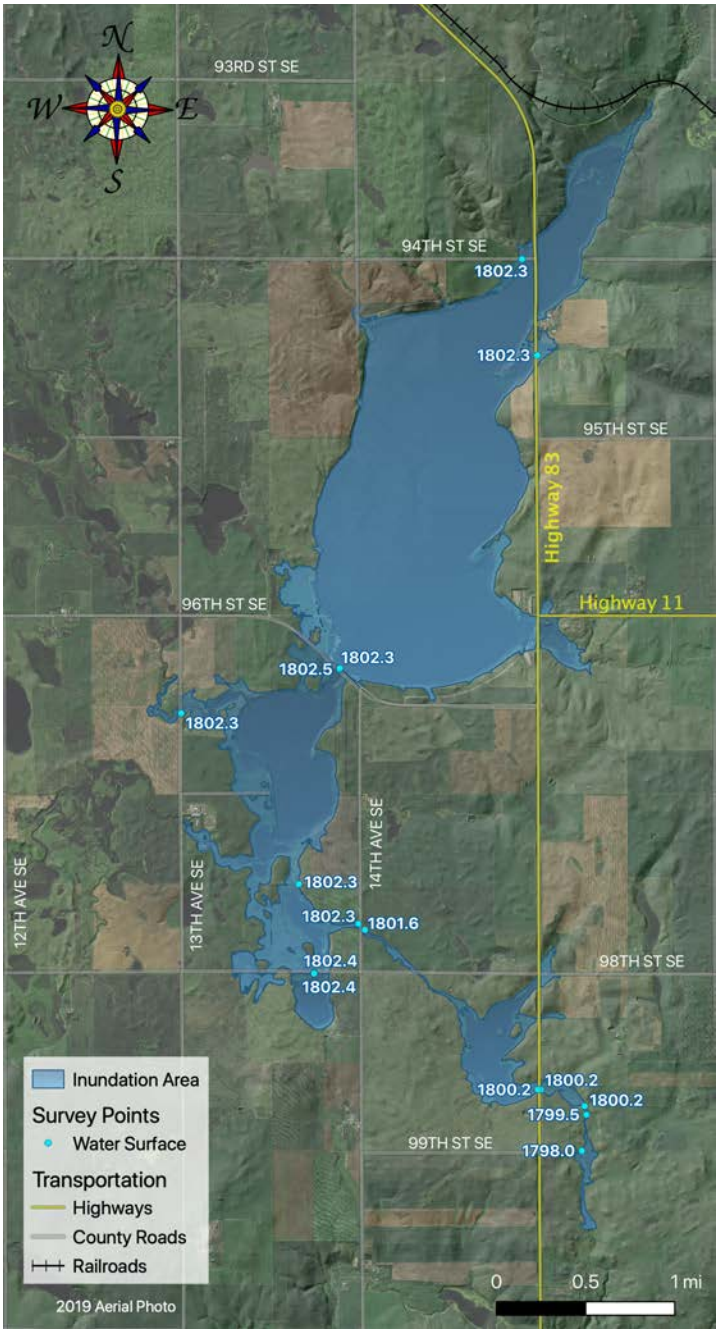

Figure 5 - Observed Water Surface (June 10, 2020)

4. OUTLET DETAILS

There are four control points associated with the waterbodies displayed in Figure 1. These control points are the elevations at which the waterbodies must rise to before flowing downstream into the next waterbody. There are also high spots that were not considered control points. These high spots do not result in a significant increase in inundated area, but they impede flow. Figure 6 displays the control points and the high spots. These locations were initially determined using LiDAR and were verified via site surveys. Table 1 outlines details regarding the control points, and Table 2 outlines details regarding the high spots.

Table 1 – Control Point Elevations

UPSTREAM WATERBODY	DOWNSTREAM WATERBODY	LIDAR ELEVATION *feet (NAVD 88)*	SURVEY ELEVATION *feet (NAVD 88)*	CONNECTION TYPE	LOCATION
North Rice Lake	South Rice Lake	-	Unknown	Culvert	129-075-05 NE ¼
South Rice Lake	Minna Lake	1800.6	1800.7	Natural Ground	129-075-08 NE ¼
Minna Lake	Unnamed Depression	1801.8	1801.6	Natural Ground	129-075-08 SE ¼
Unnamed Depression	Nieuwsma Stock Dam	1800.0	1799.4	Natural Ground	129-075-15 SW ¼
Nieuwsma Stock Dam	Downstream Flow Path	-	1795.8	Culvert	129-075-22 SW ¼

Table 2 – High Spot Elevations

UPSTREAM WATERBODY	DOWNSTREAM WATERBODY	LIDAR ELEVATION *feet (NAVD 88)*	SURVEY ELEVATION *feet (NAVD 88)*	CONNECTION TYPE	LOCATION
South Rice Lake	Minna Lake	1800.2	1800.5	Natural Ground	129-075-08 SE ¼
Minna Lake	Unnamed Depression	1801.1	1801.1	Natural Ground	129-075-09 SW ¼
Minna Lake	Unnamed Depression	-	1799.2	Culvert	129-075-16 SW ¼
Unnamed Depression	Nieuwsma Stock Dam	-	1796.1	Culvert	129-075-15 SE ¼
Unnamed Depression	Nieuwsma Stock Dam	1798.2	-	Natural Ground	129-075-15 SW ¼
Unnamed Depression	Nieuwsma Stock Dam	1797.7	1797.6	Natural Ground	129-075-15 SW ¼

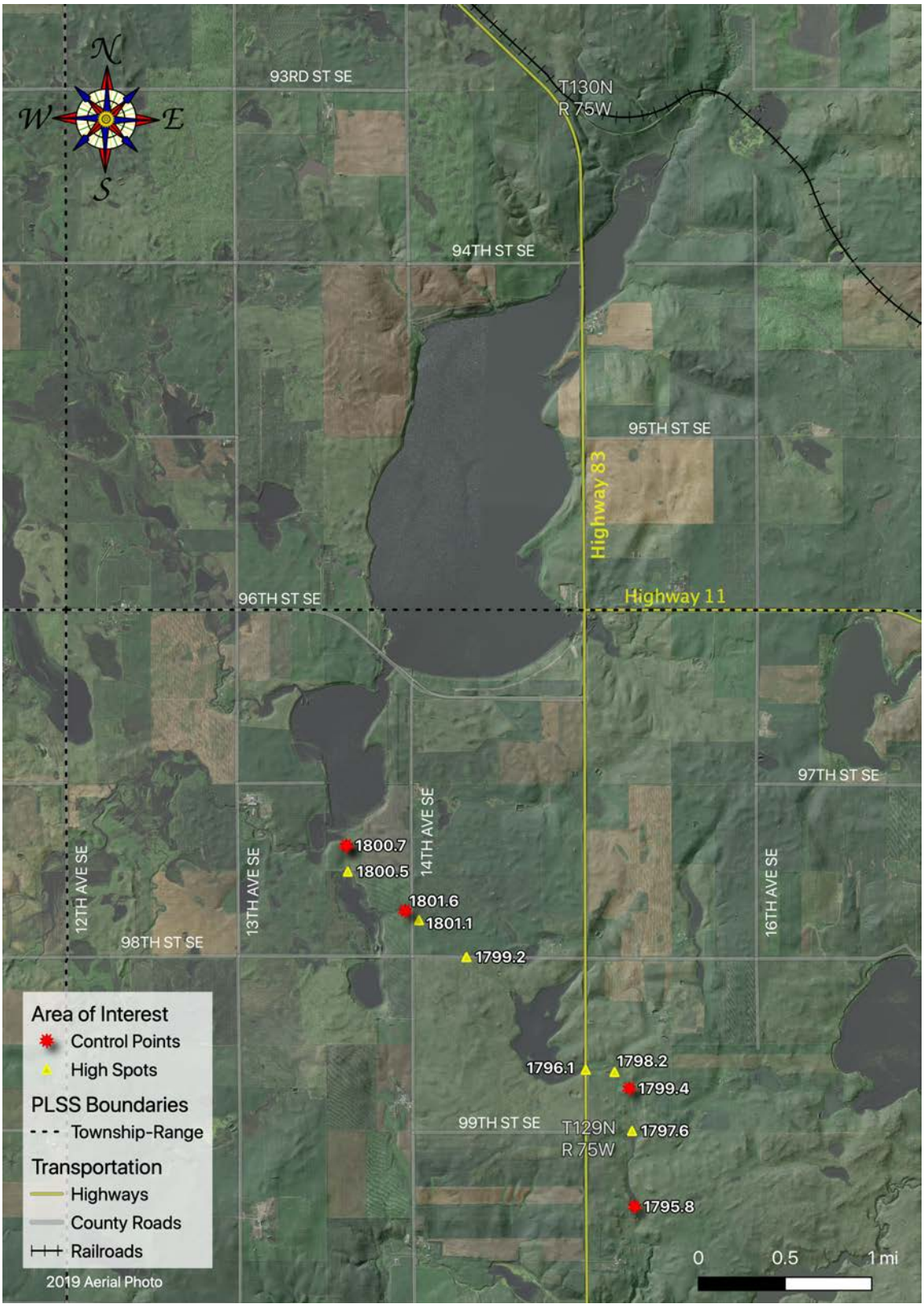

Figure 6 – Rice Lake Control Points and High Spots

According to the Emmons County Road Department (Department), North Rice Lake and South Rice Lake equalize via a culvert beneath 96th Street SE. Unfortunately, the county road department does not have elevation data on this culvert, and it was too far underwater to locate and survey. Since this is a high-water study, it was assumed North Rice Lake and South Rice Lake are continuously equalized.

The first control point is located between South Rice Lake and Minna Lake. This location is an area of high ground in a cultivated field. The high point just downstream of the first control point is a silted-in fence line.

The next control point is located between Minna Lake and an unnamed depression. This control point is also an area of high ground located in a cultivated field, 200 feet upstream of the 14th Avenue SE culverts. At this elevation, North Rice Lake, South Rice Lake, and Minna Lake are connected as one waterbody.

Once this control point is overtopped, water will flow through the 14th Avenue culverts. The old 14th Avenue culvert is a 24-inch RCP that was installed in a manner that directs runoff into Minna Lake, South Rice Lake, and North Rice Lake. The new 14th Avenue culvert is a 36-inch CMP that was installed in 2019 in an attempt to improve outflow from the lake. The Emmons County Commission was under the impression that the size of this culvert was controlled by the Highway 83 culvert downstream, so a larger culvert was not installed.

After further discussion with the ND Department of Transportation (NDDOT), although the Highway 83 culvert is 36-inch, it does not inhibit installation of a larger culvert. According to NDDOT, an update to the Highway 83 culvert would be required if the Board decided to increase the size of this crossing. It is recommended that the Board work directly with NDDOT on any plans to increase the size of the 14th Avenue culvert.

There are two high spots downstream of the 14th Avenue culverts. The first is an area of high ground located in a cultivated field. The next is a culvert beneath 98th Street SE. This crossing is small, a 12-inch CMP culvert, and easily overwhelmed, resulting in inundation of a portion of the road.

The Highway 83 culvert upstream of the Nieuwsma Stock Dam is noted as a high point since it was installed to direct runoff towards Rice Lake. The control point between the unnamed depression and the Nieuwsma Stock Dam is also an area of high ground. The Department has been working with the Board to restore the channel leading up to the Nieuwsma Stock Dam. Channel restoration is being conducted by excavating silted-in areas along the flow path between the unnamed depression and the reservoir, specifically along the fence line at the marked high point.

The Nieuwsma Stock Dam is the final control point before water enters the unnamed tributary that leads into Lake Pocasse. As previously mentioned, NDGF recently installed a drop structure on the Nieuwsma Stock Dam. This drop structure consists of three 24-inch CMP culverts.

5. INUNDATION AREAS

GIS tools were used to map the inundation area of the lake and identify inundated structures, roads, and agricultural land. Figures 7 through 10 display the minimum inundated areas that correspond to the four control points. These maps were generated from the 2015 LiDAR; thus, the boundaries are approximate.

Although the highest control point is at an elevation of 1801.6 feet (NAVD88), that is not necessarily the maximum elevation that Rice Lake can rise to, as demonstrated this spring when the main lake was at nearly elevation 1803.0 feet (NAVD88) (Figures 4 and

5). The maximum water surface of the lake is dependent on hydrologic factors. These affects will be analyzed in Phase 2 of the Rice Lake investigation.

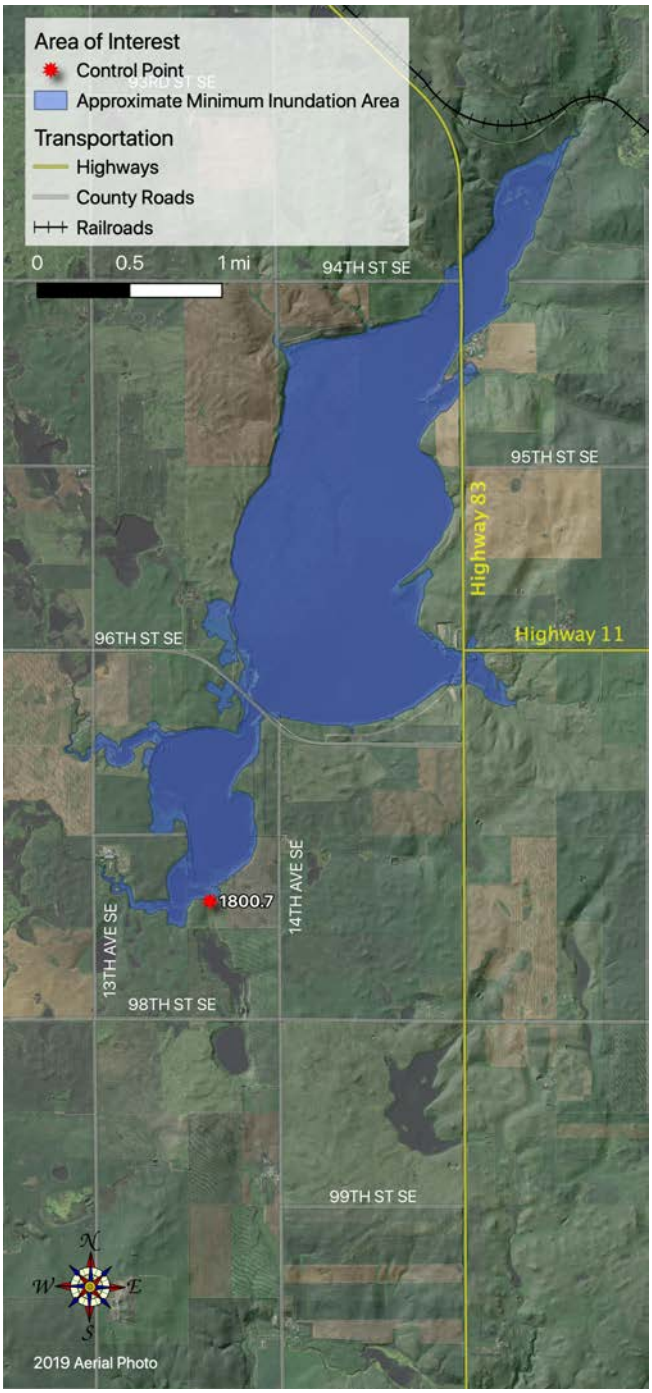

Figure 7 – Minimum Inundation Area Corresponding to Control Point 1

Figure 8 – Minimum Inundation Area Corresponding to Control Point 2

Figure 9 - Minimum Inundation Area Corresponding to Control Point 3

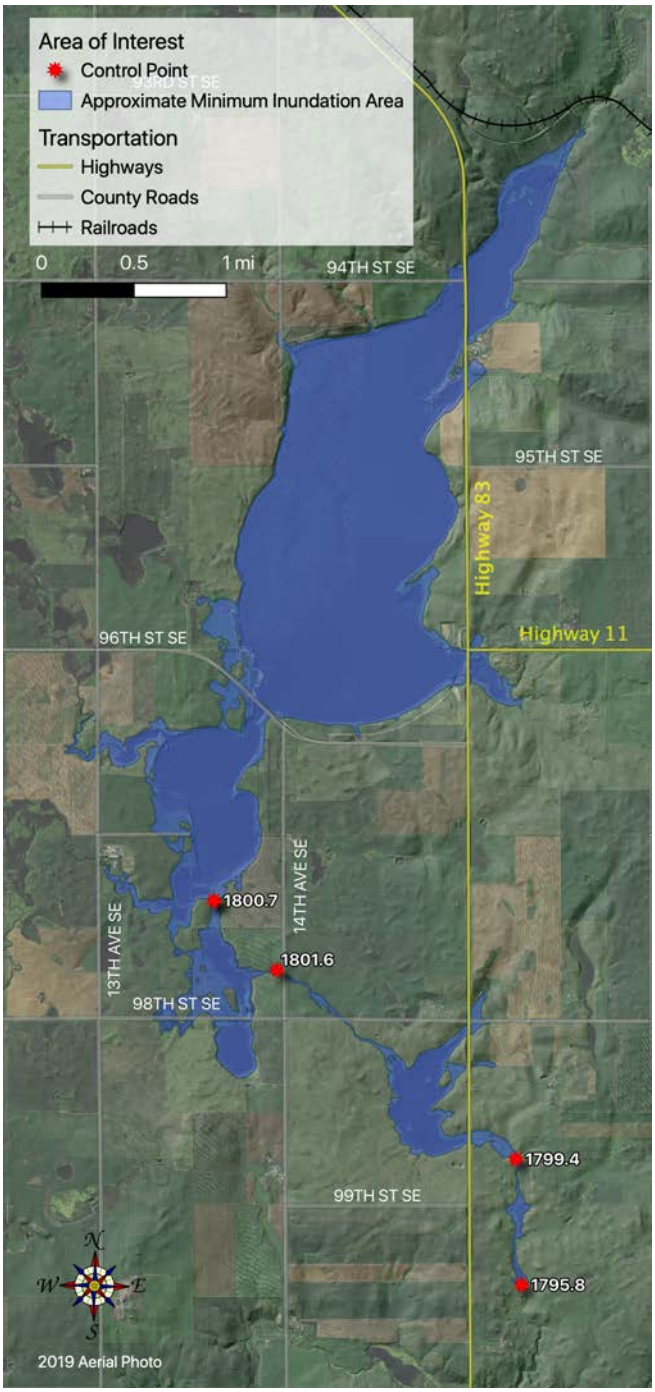

Figure 10 - Minimum Inundation Area Corresponding to Control Point 4

POTENTIAL IMPACTS

There have been various high-water complaints regarding the area surrounding Rice Lake, but not all necessarily pertain to the Rice Lake system. Many depressions in the area are also full, and high groundwater is expected due to the above-normal precipitation Emmons County has experienced from 2013 to 2019, excluding 2017 (U.S. Department of Commerce, et al., 2020). Rice Lake also lies above the Strasburg Aquifer, whose water-level gradient indicates percolation into Rice Lake (C. A. Armstrong, 1978).

Figure 11 displays the homesteads within the Rice Lake area of interest that is delineated in Figure 1. There are 2 homesteads with inundated outbuildings as of June 10, but all marked residences are currently accessible. Homeowners in the area have also mentioned there is water in numerous basements. Future development of homes around the lake is imminent. It is recommended extra precautions are taken when determining placement of these homes and whether to include a basement.

Figure 12 displays the roads that are inundated by the maximum inundation on record, April 8, 2020. In the fall of 2019, emergency road raises mitigated inundation of critical roads, Highway 83 and 96th Street SE. The NDDOT is planning to further raise a portion of Highway 83 in the summer of 2020. Although it was also raised in the fall of 2019, 96th Street SE is very close to overtopping.

Since Rice Lake was historically dry, the entire lakebed could potentially be agricultural land. Thus, there are approximately 2030 acres of agricultural land that are inundated when North Rice Lake, South Rice Lake, and Minna Lake are connected at the highest control point elevation, 1801.6 feet (NAVD88) (see Figures 2 and 8).

Rice Lake is a popular fishing location, as it is stocked by NDGF. Unfortunately, the boat ramp is currently inaccessible. A new boat ramp is under construction.

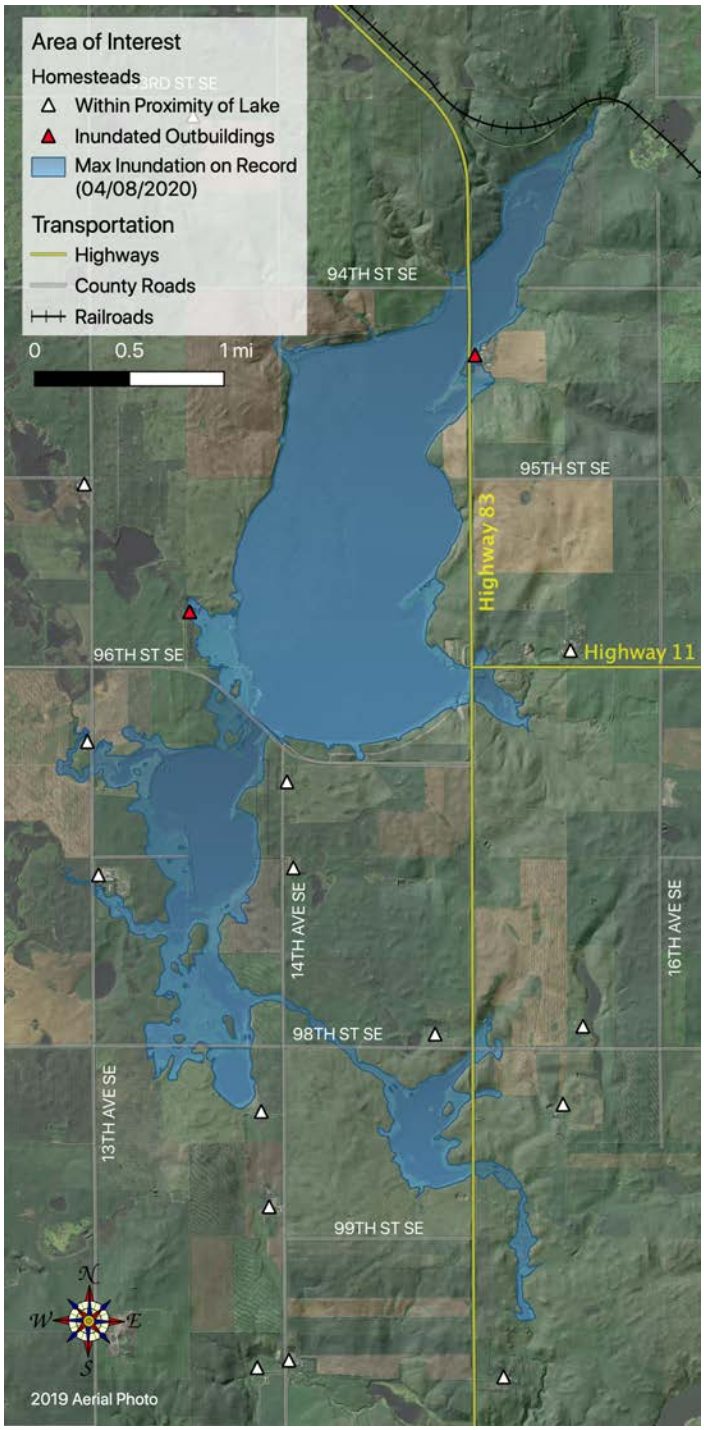

Figure 11 – Homesteads within the Rice Lake Area of Interest

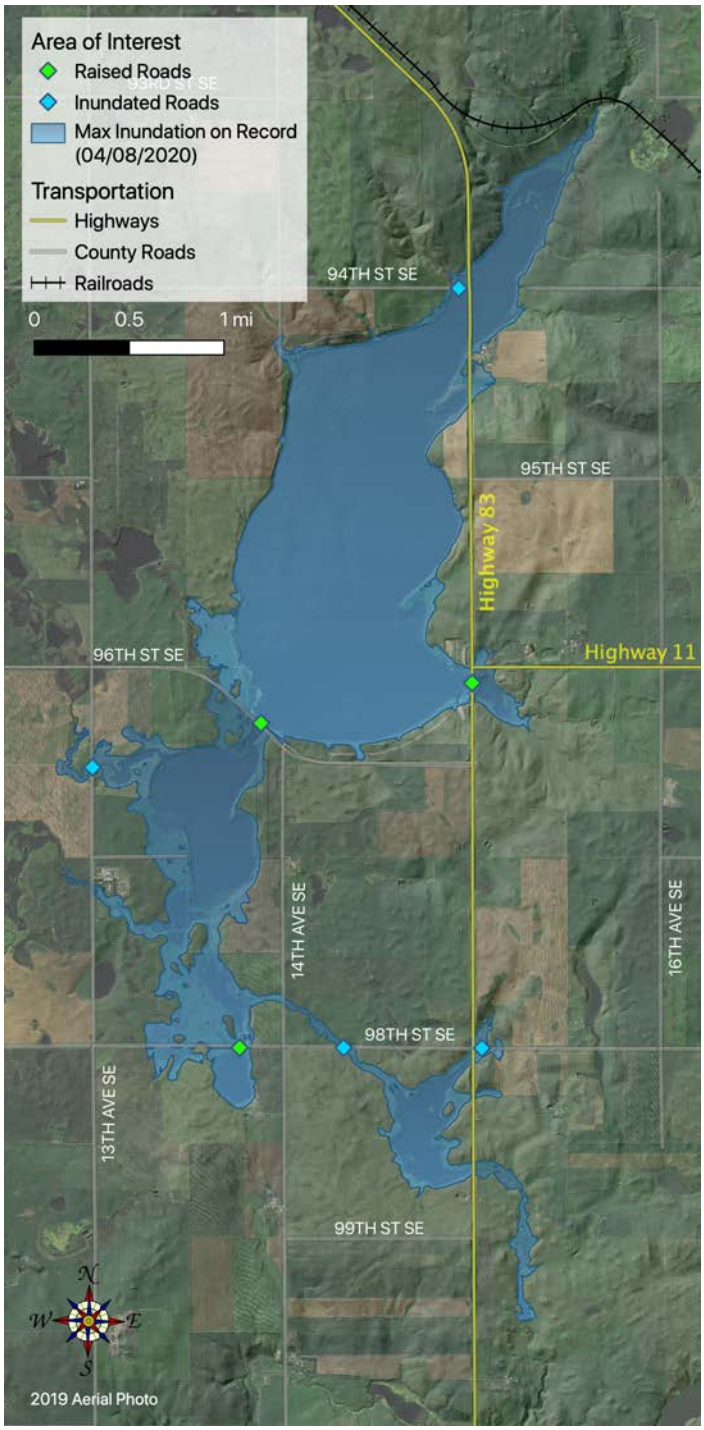

Figure 12 – Affected Roads

6. DOWNSTREAM FLOW PATH

Discharge from Rice Lake merges into Spring Creek approximately 1.5 miles downstream of Nieuwsma Dam. Water then flows into Lake Pocasse 28 miles downstream of the confluence, ultimately flowing into Lake Oahe. Figure 13 displays the downstream flow path of Rice Lake.

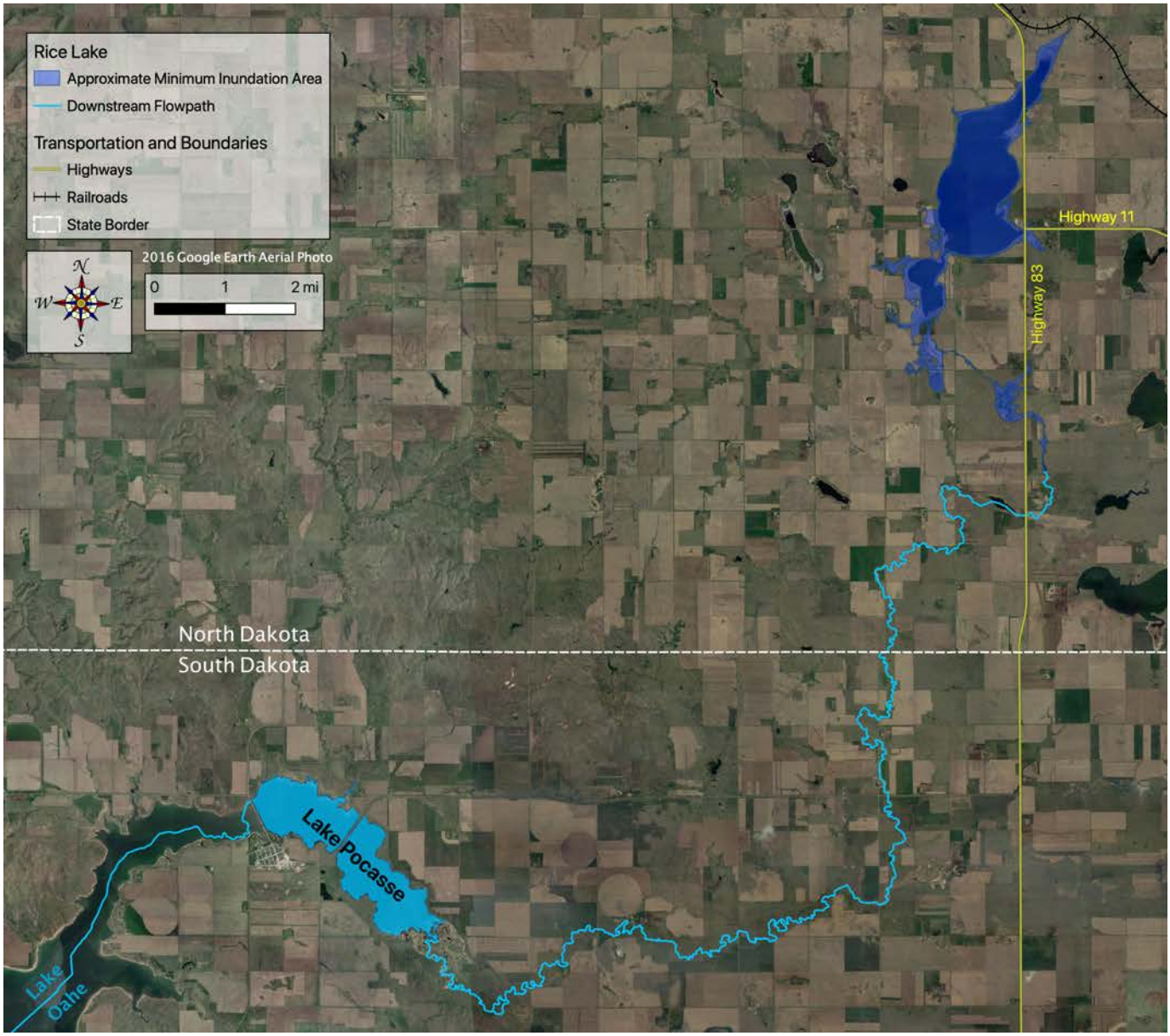

Figure 13 – Downstream Flow Path

7. NEXT STEPS

PHASE 2

Mitigative alternatives and associated downstream impacts will be evaluated in Phase 2. A meeting with the Board will be scheduled to discuss Phase 2 and the desired lake level.

Depending on the consensus of the Board, some alternatives that could potentially be analyzed during Phase 2 include restoring the flow path, construction of a permanent drain, raising roads, or resizing stream crossings. Some of these alternatives would require submitting a drain application with the ND Office of the State Engineer (OSE). The OSE's Regulatory requirements are outlined in the following section.

REGULATORY REQUIREMENTS

If the Board were to pursue drainage, a drainage permit would be required from the Regulatory Division of the OSE. It is important to note that the OSE's drainage permit may not be the only requirement needed for drainage. Other agencies that may require permits or concurrence include, but are not limited to, NDGF, NDDOT, North Dakota Department of Environmental Quality, United States Fish and Wildlife Service, United States Army Corps of Engineers, and Natural Resources Conservation Service.

The OSE's drainage policy was updated in 2020. It now clarifies that increasing the size of stream crossings does not require a drainage permit per Section 3.3.2.2. However, channelizing (i.e. deepening, widening) upstream and downstream of the crossing to accommodate a lower invert elevation or straightening a watercourse (i.e. stream, intermittent stream, river, etc.) to accommodate a new crossing location may rise to the level of drainage. As long as work remains within the road right-of-way, the OSE has never considered that drainage requiring a permit.

In addition, if a culvert doesn't meet North Dakota stream crossing standards, the upsized culvert would need to. It is the responsibility of the entity constructing the stream crossing to follow North Dakota stream crossing standards when applicable. North Dakota Administrative Code (NDAC) Chapter 89-14-01 provides further detail on the state's stream crossing standards. The OSE doesn't permit stream crossings, but the Regulatory Division can assist in determining the discharge a stream crossing must pass per NDAC § 24-03-08.

8. SUMMARY

Rice Lake has a complex drainage path with multiple control points. The approximate minimum inundation areas, Figures 7 through 10, were determined by establishing the control points of the Rice Lake system. The maximum lake level is dependent on hydrologic conditions, which will be analyzed in Phase 2 of the Commission's investigation.

The current control elevations result in inundation of homestead outbuildings, some surrounding roads, and agricultural land. Control points and high spots were presented in Figure 6. Altering these areas could potentially improve flow and maintain the lake at a lower, more desirable, elevation. Mitigative alternatives will be analyzed in Phase 2.

Since the two most critical roads, Highway 83 and 96th Street SE, are being raised, the main concern with Rice Lake continuing to rise is inundation of agricultural land, homestead outbuildings, and potentially residence access.

9. REFERENCES

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APPENDIX A

AGREEMENT

NORTH Dakota | Water Commission

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SWC Project #2147
Project Manager: A.Faber
April 2020

Investigation Agreement

1. **PARTIES.** This agreement is between the State of North Dakota (State), acting through the State Water Commission, 900 East Boulevard Avenue, Bismarck, ND 58505 (Commission) and the Emmons County Water Resource District, a North Dakota political subdivision, P.O. Box 643, Linton, ND 58552-0643 (District).

2. **PROJECT DESCRIPTION.** Commission will perform the tasks as outlined in the attached Rice Lake Investigation Scope of Work and incorporated into this Agreement.

3. **COMMISSION'S RESPONSIBILITIES.** Commission will:

   a. Conduct topographic surveys and field observations to collect necessary data.

   b. Examine the hydrology of Rice Lake.

   c. Evaluate alternatives to mitigate flood damages on Rice Lake.

   d. Evaluate downstream impacts of potential alternatives and of Rice Lake overflowing naturally.

   e. Complete a written report with findings, including cost estimates.

4. **DISTRICT'S RESPONSIBILITIES.** District must:

   a. Use best efforts to acquire written permission from landowners to access property for data collection. The parties understand failure to obtain permission may impact Commission's ability to provide accurate survey data for that property. Commission agrees to use other available data and highlight any deficiencies in its report.

   b. Use best efforts to acquire written permission from landowners to install a water level gage on Rice Lake. The parties understand failure to obtain permission may impact accuracy of the Commission's work. Commission agrees to use other available data and highlight any deficiencies in its report.

   c. Pay $1,449 to Commission prior to commencement of field work. This amount constitutes one-half of the field survey costs anticipated for the work.

5. **TERM.** This agreement terminates on June 30, 2021, unless otherwise agreed to in writing by the parties.

6. **INSURANCE.** State and District each shall secure and keep in force during the term of this agreement, from an insurance company, government self-insurance pool, or government self-retention fund authorized to do business in North Dakota, commercial general liability with minimum limits of liability of $250,000 per person and $500,000 per occurrence.

7. **AGREEMENT BECOMES VOID.** This agreement is void if not signed and returned by District within 60 days of Commission's signature.

8. **TERMINATION.**

a. Commission may terminate this agreement effective upon delivery of written notice to District, or a later date as may be stated in the notice, under any of the following conditions:
   (1) If Commission determines an emergency exists.
   (2) If funding from federal, state, or other sources is not obtained and continued at levels sufficient to provide the funds necessary to comply with this agreement. The parties may modify this agreement to accommodate a reduction in funds.
   (3) If federal or state laws or rules are modified or interpreted in a way that the services are no longer allowable or appropriate for purchase under this agreement or are no longer eligible for the funding proposed for payments authorized by this agreement.
   (4) If any license, permit, or certificate required by law, rule, or this agreement is denied, revoked, suspended, or not renewed.
   (5) If Commission determines that continuing the agreement is no longer necessary or would not produce beneficial results commensurate with the further expenditure of public funds.

c. Any termination of this agreement shall be without prejudice to any obligations or liabilities of either party already accrued prior to termination.

d. In the event this agreement is terminated prior to Commission providing a report to District, District may request any draft or final materials prepared by Commission. Commission shall return any unused portion of funds paid by District. The parties may discuss and agree to other reasonable terms and conditions based on the level of completeness of the information/data at the time of termination.

e. The rights and remedies of any party provided in this agreement are not exclusive.

9. **APPLICABLE LAW AND VENUE.** This agreement is governed by and construed in accordance with the laws of the State of North Dakota. Any action to enforce this agreement must be brought in the District Court of Burleigh County, North Dakota.

10. **SEVERABILITY.** If any term of this agreement is declared by a court having jurisdiction to be illegal or unenforceable, the validity of the remaining terms must not be affected,

so long as the remaining rights and obligations of the parties are not substantially affected by the omitted term.

11. **SPOLIATION – NOTICE OF POTENTIAL CLAIMS.** The parties agree to promptly notify each other of all potential claims that arise or result from this agreement. The parties shall also take all reasonable steps to preserve all physical evidence and information that may be relevant to the circumstances surrounding a potential claim, while maintaining public safety, and grants to each other the opportunity to review and inspect the evidence, including the scene of an accident.

12. **MERGER.** This agreement constitutes the entire agreement between the parties. There are no understandings, agreements, or representations, oral or written, not specified within this agreement. This agreement may not be modified, supplemented, or amended in any manner except by written agreement signed by both parties.

NORTH DAKOTA STATE WATER COMMISSION

By: _____

John Paczkowski, P.E.
Interim Chief Engineer and Secretary

Date: 4-23-2020

EMMONS COUNTY WATER RESOURCE DISTRICT

By: _____

Glenn Geffre
Chairman

Date: 4-29-20

NORTH Dakota | Water Commission

Be Legendary.™

To: Emmons County Water Resource Board

From: Alexis Faber, E.I.T, Water Resources Engineer
Laura Ackerman, P.E., Investigations Section Chief

Subject: Scope of Work – Rice Lake Investigation

Date: April 13, 2020

Background:
The Emmons County Water Resource Board (Board) reached out to the North Dakota State Water Commission (Commission) about conducting an investigation of Rice Lake. The rising water level is a concern for inundating critical roads and potentially impacting agricultural land. Based on conversations with the Board during their March 9, 2020 meeting, there are three primary concerns related to Rice Lake that the Board wants investigated:

- Location and elevation of the natural outlet
- Inundation area of the lake if it was at its natural overflow elevation and associated effects (i.e. impacts to roads, agricultural land, structures, etc)
- Downstream effects of lake overflowing naturally or from proposed alternatives

Project Scope and Approach:
Below is a Scope of Work (SOW) for an investigation of Rice Lake to address the concerns described above. The SOW is separated into two phases. Phase 1 focuses on collection of field data, analyzing existing conditions at the lake, evaluating the topography of the downstream flowpath, and providing this information to the Board as soon as reasonably possible. Phase 2 focuses on understanding the hydrology of the lake, and modeling proposed alternatives and associated downstream impacts.

Phase 1

1. Gather existing information related to Rice Lake, such as aerial photos, topographic data, NDGF contour maps, etc
2. Site visit and survey
    i. Installation of a water level gage on Rice Lake
    ii. Field verification and elevation survey of points-of-interest surrounding the lake and along the downstream flowpath
3. Identify the location and elevation of the natural outlet of Rice Lake using LiDAR, supplemented with elevation survey
4. Identify the effects of the lake rising to its natural overflow elevation

i. Use elevation data (LiDAR, survey, NDGF contour maps) to create an elevation-volume relationship for the lake
ii. Use GIS tools to map the inundation area of the lake and identify inundated acres, structures, and roads

5. Deliver Phase 1 documentation and supporting data, including the following:
   i. Topography along downstream flowpath, with special emphasis on identifying high spots
   ii. Office of the State Engineer regulatory requirements for the Board's consideration if they were to pursue a drainage project

The approximate length of time for completion of Phase 1 is about two months. If further travel restrictions are placed on Commission staff due to COVID-19, this could delay the collection of field data and installation of the water level gage. After delivery of Phase 1 products, Commission staff will verify next steps with the Board for Phase 2.

The expected tasks for Phase 2 are outlined below. These tasks are described generally to allow for flexibility in the SOW.

Phase 2

1. Delineate the contributing drainage area for Rice Lake, document general characteristics, and evaluate runoff
2. Identify downstream impacts
   i. Create a 2-D hydraulic model to simulate the natural overflow of the lake or proposed alternatives
      1. Initial goal for the lake is to at least maintain at current elevation
      2. Anticipated downstream modeled area will extend from Rice Lake to ND-SD border, but could be subject to change based on modeling capabilities
   ii. Create maps showing the downstream inundation area
3. Coordinate completion of tasks and results with other state agencies
   i. NDDOT may be planning road raises for Highway 83
   ii. NDGF may be planning modifications to their boat ramp
4. Deliver report and supporting data

Due to the current lack of water level data for Rice Lake, the modeling of alternatives under Phase 2 could be handled a couple different ways. Option 1 would involve developing an uncalibrated runoff model for the lake to test alternatives. Because the model would be uncalibrated, there would be less confidence in the results. In other words, there would be less confidence that any particular alternative would be capable of maintaining the lake at a certain elevation. Option 2 would involve monitoring the lake for a few years, using that data to develop a calibrated runoff model, and performing an alternatives analysis. A calibrated runoff model would provide the Commission with more confidence in the behavior of the lake; and therefore, more confidence in the effectiveness of any alternative.

The Investigations Section of the Commission charges fifty percent of the total estimated field work costs to conduct an Investigation, which would make the Board's share of this study approximately $1,449. Field work is only expected for Phase 1. The Commission would cover all the costs associated with the lake gage.

In total the Rice Lake Investigation would cost, at a minimum, approximately $16,224. If the SOW expands to include additional work, the total value of the Investigation will increase.

Site Survey	$	2,899
Gather existing information	$	2,194
Natural Outlet Determination	$	439
Identify Overflow Elevation Impacts	$	2,194
Identify Downstream Impacts	$	4,389
Documentation	$	2,194
Update Meetings	$	1,317
Review	$	598
Study Total	**$**	**16,224**
Water Board Total	**$**	**1,449**