Northwest Angle Watershed Management Plan

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Acronyms

BMP	Best Management Practice
BOD_5	5-day biochemical oxygen demand
Chl-*a*	Chlorophyll-*a*
Deg C	Degrees Celsius
DO	Dissolved Oxygen
E. coli	*Escherichia coli*
GIS	Geographic Information Systems
HUC	Hydrologic Unit Code
IBI	Index of Biological Integrity
ISTS	Individual Sewage Treatment System
km^2	square kilometer
Lb	pound
lb/day	pounds per day
lb/yr	pounds per year
m	meter
mg/L	milligrams per liter
mL	milliliter
MPCA	Minnesota Pollution Control Agency
NLCD	National Land Cover Dataset
P	Phosphorus
RNR	River Nutrient Region
SSTS	Subsurface Sewage Treatment Systems
TP	Total phosphorus
µg/L	microgram per liter
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency

Executive Summary

The Northwest Angle (NWA), often referred to as "the Angle", is a very unique area. It is part of the state of Minnesota but is separated from it by Lake of the Woods (LOW). The land borders Manitoba in Canada. It is also the northernmost point in the contiguous United States. There are two ways to access the NWA: crossing the lake or by crossing the international border, traveling through Manitoba, and then accessing a remote border crossing at Angle Inlet. The population of the NWA is very small: only 119 individuals at the 2010 census. However, there are several resorts at the Angle, and the area sees many visitors in the summer and winter for fishing.

The majority of the NWA is forest and water, including wetlands. Land use includes approximately 77% forest/shrub wetland, 3% emergent wetland, 4.5% mixed forest, 11% open water, and 2.25% developed (Minnesota Land Cover Classification and Impervious Surface Area by Landsat and Lidar: 2013 update - Version 2). Seventy percent of the land is held in trust by the Red Lake Band of Chippewa Indians (Red Lake Band). The Red Lake Band has land holding of more than 835,000 acres in Minnesota, of which approximately 53,000 is at the NWA. There are also numerous islands in the Northwest Angle area; however, because tribal lands are not inhabited on the islands, this plan focuses on the mainland area of the NWA.

The LOW is an international body of water located on the US/Canadian border in the state of Minnesota and provinces of Ontario and Manitoba. It's listed by the state of Minnesota as impaired for nutrients based on their ecoregion based criteria and recognized by Canadian governments as impaired without any official designation as such. The Canadian government recognizes the water quality concerns and has designated funding to ECCC to study the issue and if appropriate make recommendations for necessary load reductions. Managing an international water presents a unique set of challenges. Coordination of efforts to study the lake, manage land use in the watershed, and disseminate information to the public is imperative if efforts are to be successful.

Water quality in the lake is influenced by inflow from Manitoba, Ontario, Minnesota, and the lands held by The Red Lake Band on the NWA. The NWA is dominated by undeveloped wetlands. The Band uses the area for hunting, fishing, and wild rice harvesting. An international Multi-Agency (IMA) Working Arrangement was created to address water quality issues related to nutrient impairment on the lake. There are nine signatories including Environment Canada, US EPA, Red Lake Band, and other governmental entities in the US and Canada. This was the first international agreement of its kind to include tribal representation.

Historically, the Red Lake Band had monitored three stream sites flowing into LOW for general water quality parameters. In 2010, the International Office of EPA supported Red Lake's monitoring efforts by recommending the Commission for Environmental Cooperation (CEC) fund the Band for increased monitoring at LOW streams. Red Lake was awarded a $125,000 grant by the CEC to allow for equipment acquisition and increased monitoring on tribal waters. Dedicated sampling equipment was purchased as LOW is infested by *Bythotrephes longimanus* (spiny water flea), and the Band did not want to contaminate other Reservation waterbodies.

A total of seven stream sites and two lake sites were sampled monthly during the open water season beginning in August of 2010. Efforts were made to continue sampling from May-October as funding allowed. Some years only three sample events occurred whereas other years, five events were completed. Along with typical physical and chemical analyses, the Band collected flow data with an M9 RiverSurveyor at four of the stream sites. HOBO depth level loggers were deployed at the same sites so nutrient loading could be calculated.

Data analyses indicate little nutrient contribution of NWA streams to LOW. However, continued monitoring will be conducted now that additional sites have been established and equipment acquired to ensure water quality remains high for the northwest Angle region. Continued coordination with participating watershed agencies will help to maintain this goal.

The goal of this nine-element plan is to protect the high quality waters of the Red Lake Band at the NWA and preserve them in their current state. An effort is made to include the goals laid forth by the IMA, state of Minnesota, and the Red Lake Band collectively. While efforts were made to reach out to Canadian counterparts in this region, little additional feedback was gained.

1 Project Overview

Nine-element watershed plans generally identify and prioritize management activities to restore waters that are listed with 303(d) impairments but can also be developed for watershed protection. The NWA was not included during Minnesota's HUC 8 Lake of the Woods Watershed Total Maximum Daily Load (TMDL) study that was undertaken to address the nutrient issues in LOW. This plan is being developed to address concerns not identified by the Minnesota TMDL for the NWA and includes protection of high quality waters. In addition, efforts are being made to coordinate with the local One Watershed, One Plan that is currently being developed by local partners on the US side.

The Red Lake Band has a strong traditional connection to water including Lake of the Woods. Two food staples, walleye and wild rice, are found in abundance there and are very important to the Tribe. In an effort to cooperatively manage the water resources of the Lake of the Woods, the Band has dedicated staff and resources to collect water quality data and assist in decision making processes.

The goal for this plan is to have comparable data and management approaches between the Tribe and Minnesota and Canada in work that is already underway to the extent possible. The Red Lake Band does not currently have water quality standards but is in the process of developing them. The Band's water quality goals for the NWA are to maintain water quality at historic levels through monitoring and protection and to partner with stakeholders in the region to implement BMP's to improve current conditions where possible. As standards are developed, the plan will be updated to reflect any relevant changes. This plan addresses only streams of the Northwest Angle and not islands or open water/lake areas. While the plan assesses land uses across the entirety of the NW Angle, the Red Lake Band only has authority to implement projects on reservation acreage and will lean heavily on state and local partners to implement BMPs off reservation. Any discussion of responsibilities by those partners is to be interpreted as a request or recommendation and not an assertion of jurisdiction.

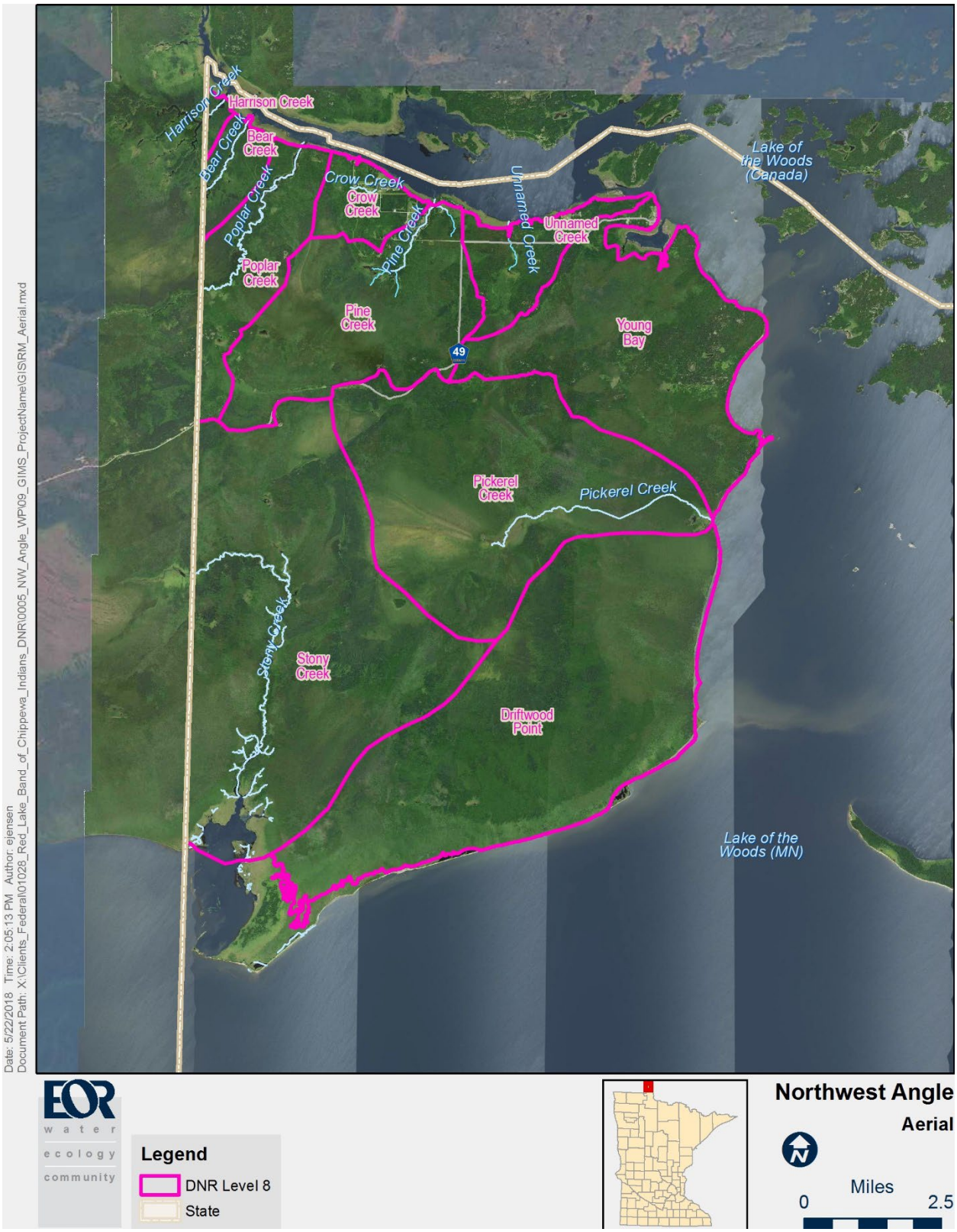


Figure 1-1. Map of watershed

2 Applicable Water Quality Standards and Numeric Water Quality Targets

Minnesota water quality standards for Class 2 waters, protected for aquatic life and aquatic recreation, are summarized below as a reference for the current water quality of streams in the Northwest Angle Watershed. The Red Lake Band feels that the state nutrient standard is appropriately protective of tribal resources, and the Band does not currently have water quality standards for their waters. The Band's water quality goals of maintaining and improving water quality at the NW Angle will be met if these standards are implemented. These criteria have been adopted into the tribal draft standards which may be submitted to EPA for approval as early as fall of 2018. Therefore they will be used for this report as well as for tribal management decisions. When standards are developed for the Band, those will be utilized for analyses of tribal waters. In the event that the tribe adopts more stringent criteria or additional designated uses, further analysis will need to be completed. As previously stated, this plan only addresses streams of the NWA, not the lake.

2.1 Streams

2.1.1 Bacteria

The State of Minnesota has developed numeric water quality standards for bacteria (Minn. R. 7050.0222), in this case *Escherichia coli* (*E. coli*), which are protective concentrations for short- and long-term exposure to pathogens in water. The current *E. coli* water quality standards for Class 2 waters are shown in Table 2-1. *E. coli* is fecal bacteria used as indicators for waterborne pathogens that have the potential to cause human illness. Although most are harmless themselves, fecal indicator bacteria are used as an easy-to-measure surrogate to evaluate the suitability of recreational and drinking waters, specifically, the presence of pathogens and probability of illness. Pathogenic bacteria, viruses, and protozoa pose a health risk to humans, potentially causing illnesses with gastrointestinal symptoms (nausea, vomiting, fever, headache, and diarrhea), skin irritations, or other symptoms. Pathogen types and quantities vary among fecal sources; therefore, human health risk varies based on the source of fecal contamination.

As of March 17, 2008, Minn. R. 7050 water quality standards for *E. coli* are: *Escherichia (E.) coli* - Not to exceed 126 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31.

Geometric mean is used in place of arithmetic mean in order to measure the central tendency of the data, dampening the effect that very high or very low values have on arithmetic means.

Table 2-1. *E. coli* water quality standards of bacteria for the beneficial use of aquatic recreation (primary and secondary body contact)

Current Standard	Units	Notes
Long-term	126 orgs *E. coli* per 100 ml	Geometric mean of ≥5 samples per month (April - October)
Short-term	1,260 orgs *E. coli* per 100 ml	<10% of all samples per month (April - October) that individually exceed

2.1.2 Dissolved Oxygen

Dissolved oxygen (DO) is essential to life for all aquatic organisms. When dissolved oxygen drops below acceptable levels, desirable aquatic organisms, such as fish, can be killed or harmed. A stream is considered impaired if there are at least three total violations and more than 10 percent of the "suitable" (taken before 9:00 am) May through September measurements, more than 10 percent of the total May through September measurements, or more than 10 percent of the October through April measurements violate the standard. A total of 20 independent observations per stream are recommended.

Table 2-2. Stream dissolved oxygen standards (Minnesota Rule 7050.0220)

Stream Dissolved Oxygen Standards	
Stream Class	**Daily Minimum Dissolved Oxygen (mg/L)**
2A – Coldwater	7
2B – Coolwater or warmwater	5

2.1.3 Turbidity and Total Suspended Solids

Turbidity is a measure of reduced transparency that can increase due to suspended particles such as sediment, algae, and organic matter. The former Minnesota turbidity standard was 10 Nephelometric Turbidity Units (NTU) for class 2A waters and 25 NTU for class 2B waters. The state of Minnesota has amended state water quality standards and replaced stream water quality standards for turbidity with standards for total suspended solids (TSS). One component of the rationale for this change is that the turbidity unit (NTUs) is not concentration-based and therefore not well-suited to load-based studies (Markus, 2011, Aquatic Life Water Quality Standards Draft Technical Support Document for Total Suspended Solids (Turbidity) report)

The new TSS criteria are stratified by geographic region and stream class due to differences in natural background conditions resulting from the varied geology of the state and biological sensitivity. The assessment window for these samples is April-September, so any TSS data collected outside of this period will not be considered for assessment purposes. The TSS standard for streams in the North River Nutrient Region is 15 milligrams per liter (mg/L). For assessment, this concentration is not to be exceeded in more than 10 percent of samples within a 10-year data window.

Table 2-3. Total suspended solids standard by stream class

River Nutrient Region	Total Suspended Solids (mg/L)
North	15

For more information, refer to:

- Markus (MPCA) 2011 Aquatic Life Water Quality Standards Draft Technical Support Document for Total Suspended Solids (Turbidity) report https://www.pca.state.mn.us/sites/default/files/wq-s6-11.pdf
- Heiskary, Bouchard, and Markus (MPCA) 2013 Minnesota Nutrient Criteria Development for Rivers report https://www.pca.state.mn.us/sites/default/files/wq-s6-08.pdf

2.1.4 Stream Eutrophication

Stream eutrophication standards, and in particular phosphorus standards, were developed based on data evaluated from a large cross-section of rivers from across the state (Heiskary, Bouchard, and Markus, 2013, Minnesota Nutrient Criteria Development for Rivers report). Clear relationships were established between total phosphorus as the causal factor and the biological response variables (stressors): sestonic chlorophyll-a, dissolved oxygen (DO) flux, and the 5-day biochemical oxygen demand (BOD_5). Based on these relationships, it is expected that by meeting the phosphorus target, the chlorophyll-a, DO flux, and BOD_5 standards will likewise be met. DO flux is the magnitude of change in DO over the course of one day (daily maximum DO minus the daily minimum DO), and measures the amount of algal production in a stream, with large DO fluxes indicative of excess algal production and due to excess phosphorus. BOD_5 is the 5-day biochemical oxygen demand and is another measure of excess algal production in a stream. Consistent with USEPA guidance, stream eutrophication criteria were developed for three "River Nutrient Regions (RNR)".

The river eutrophication phosphorus standard for Northern Nutrient Region streams is 50 micrograms per liter (µg/L) as a growing season (June-September) average (Table 2-4).

Table 2-4. Stream Eutrophication Standards

River Nutrient Region	Nutrient	Stressor		
	TP (µg/L)	Chl-a (µg/L)	DO flux (mg/L)	BOD5 (mg/L)
North	≤ 50	≤ 7	≤ 3.0	≤ 1.5

For more information, refer to:

- Heiskary, Bouchard, and Markus (MPCA) 2013 Minnesota Nutrient Criteria Development for Rivers report https://www.pca.state.mn.us/sites/default/files/wq-s6-08.pdf

2.1.5 Nitrate

The nitrogen forms of primary concern for human health are nitrite and nitrate. Nitrite is the most toxic form of nitrogen to humans, especially infants. Nitrate is of most significance, not because of direct toxicity, but when ingested is converted to nitrite. Exposure to nitrate and in some cases nitrite contaminated water has notably contributed to methemoglobinemia or "blue baby syndrome" in infants. In addition, high levels of nitrate can be toxic to other forms of aquatic life in streams, including fish and macroinvertebrates.

The Minnesota water quality standard for nitrate in drinking water is a maximum concentration of 10 mg/L. When assessing drinking water-protected surface waters Class 1B and 1C, the MPCA compares 24-hour average nitrate concentrations to the 10 mg/L standard. Two 24-hour averages exceeding 10 mg/L within a three-year period indicates impairment.

3 Watershed and Water body Characterization

3.1 Precipitation

Table 3-1. 1981-2010 Monthly Precipitation Data for Angle Inlet, MN

Month	1981-2010 Normal Precipitation* (in.)
January	0.71
February	0.60
March	0.84
April	1.36
May	3.06
June	4.45
July	3.98
August	2.96
September	2.59
October	1.99
November	1.20
December	0.85

* From the MN Climatology Working Group Gridded Precipitation Data: Angle Inlet (167N, 34W 5) (http://climateapps.dnr.state.mn.us/gridded_data/precip/monthly/monthly_gridded_precip.asp)

Table 3-2. NOAA Atlas 14* precipitation frequency estimates for Warroad, MN

Duration	2-year rainfall (in.)	10-year rainfall (in.)	50-year rainfall (in.)	100-year rainfall (in.)
1 hour	1.11	1.67	2.35	2.61
2 hour	1.34	2.01	2.78	3.13
6 hour	1.74	2.58	3.60	4.07
12 hour	2.00	2.91	4.17	4.81
24 hour	2.28	3.36	4.96	5.78

* https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

3.2 Soils

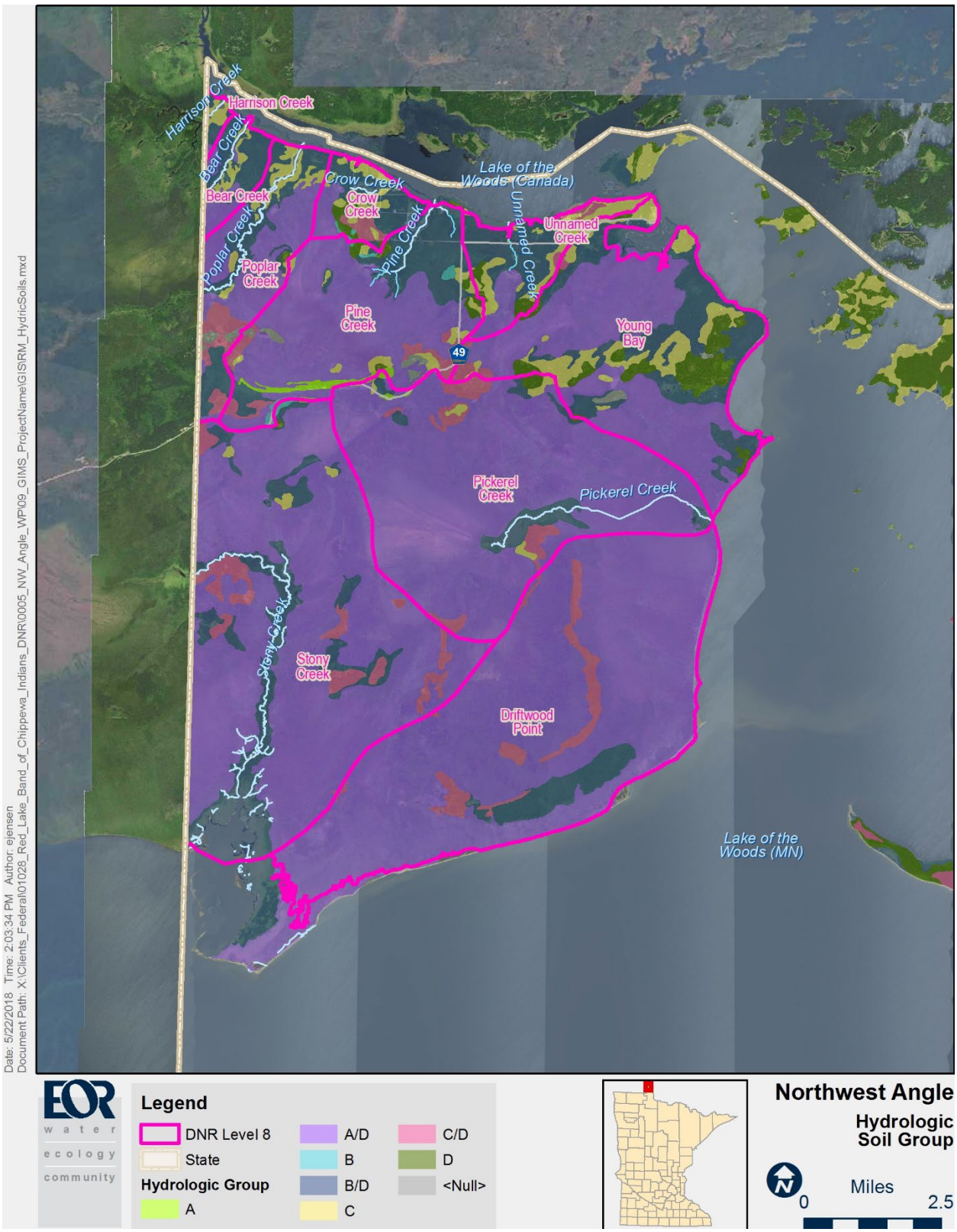


Figure 3-1. Northwest Angle Hydrologic Soil Groups

3.3 Historic and Current Land Use

Logging was a historical land use practice at the NWA but hasn't been regularly occurring since about 50 years ago. This could have some implications on NWA streams but isn't a current issue and isn't likely in the near future. There are very few land use practices occurring. The majority of the area is wetlands.

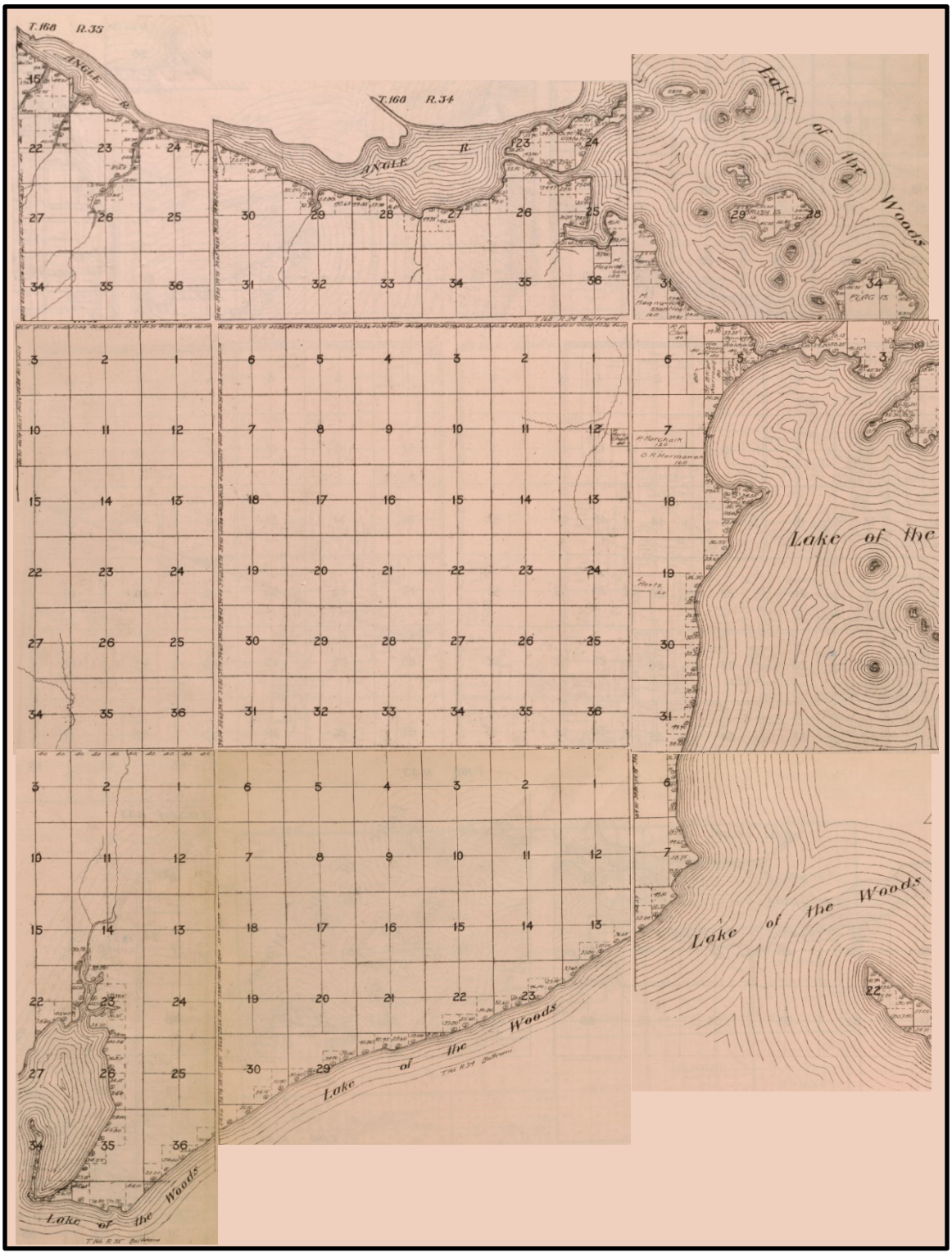


Figure 3-1. Historic Plat of Northwest Angle (1916). Source: John R. Borchert Map Library, UMN.

Table 3-1. Northwest Angle Watershed land cover (2016 Minnesota Land Cover Classification and Impervious Surface Area by Landsat and Lidar: 2013 Update, https://conservancy.umn.edu/handle/11299/181555)

Northwest Angle Watershed Land Cover Summary (% total acres)							
Subwatershed	Total Acres	Impervious	Wetlands	Forest	Open Water	Grassland	Hay /Pasture and Cropland
Bear Creek	1,099	1%	30%	67%	1%	1%	0%
Crow Creek	1,458	5%	60%	22%	0%	7%	5%
Driftwood Point	16,990	0%	98%	1%	0%	0%	0%
Harrison Creek	241	4%	34%	54%	8%	0%	0%
Pickerel Creek	12,698	2%	98%	1%	0%	0%	0%
Pine Creek	7,341	3%	94%	2%	0%	1%	0%
Poplar Creek	3,591	3%	81%	14%	1%	1%	0%
Stony Creek	17,941	2%	92%	4%	2%	0%	0%
Unnamed Creek	2,114	3%	69%	25%	0%	3%	0%
Young Bay	9,481	1%	95%	2%	0%	1%	1%
Total Northwest Angle Watershed	**72,954**	**1.6%**	**92%**	**5%**	**0.5%**	**0.7%**	**0.3%**

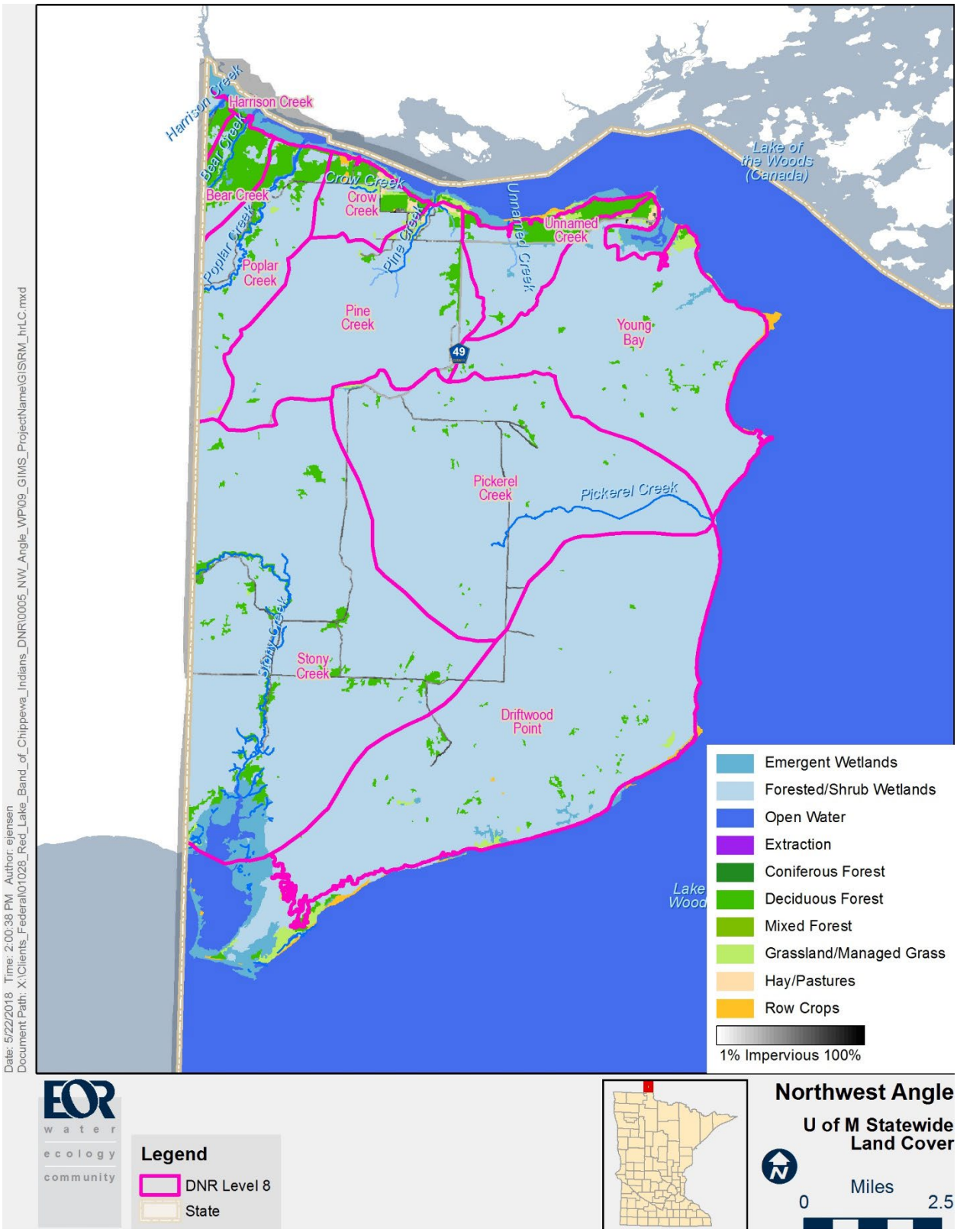


Figure 3-2. Northwest Angle Watershed Land Cover (2016 Minnesota Land Cover Classification and Impervious Surface Area by Landsat and Lidar: 2013 Update, https://conservancy.umn.edu/handle/11299/181555)

3.4 Streams

The focus of this plan is addressing trust lands and impacts to tribal resources; however, the watershed is being assessed wholly including non-tribal lands. Partnerships with other local agencies will be imperative to addressing concerns throughout the entire watershed.

Bear Creek

Bear Creek is a very low gradient stream which is heavily influenced by beaver activity, located on the north western portion of the NWA. Several beaver dams spanning the entire creek and several feet high affect the hydrology and, in turn, chemistry of the stream. It has been come challenging to effectively monitor as the first beaver dam encountered is only 0.75 miles upstream from Angle Inlet. In such a low gradient system, it is hard to measure flow at this site without influences from the lake/Inlet. The surrounding land is primarily forested wetland with no known human impacts.

Crow Creek

Crow Creek was historically monitored by the Red Lake Band. However, upon further investigation, it appeared a majority of the stream had likely been dredged for navigational purposes for recreational boating. At a point a half mile from the lake, the stream, which varies from 30-130 feet wide, becomes a tiny trickle, oftentimes no flow by July, from a small culvert protruding from the hillside. Since there was such a short length between a feasible sampling point and the lake, it was deemed an ineffective sample location, and the site was no longer monitored after 2009. The majority of this stream is heavily influenced by human development with a large number of homes and seasonal cabins. There are numerous docks and many lawns are mowed to the stream edge.

Harrison Creek

Harrison Creek, ranging from approximately 230-770 feet wide, averaging 320 feet wide, is a low gradient stream located the further northwest at the NWA while still residing in Minnesota. The sample location is located only three-fourths of a mile upstream from the Inlet as that is where it enters the Canadian province of Manitoba. Ideally, this site would be monitored further upstream so as not to see lake effect. The stream travels roughly another 0.75 miles before becoming a relatively small stream flowing through forested wetlands. There is only one home located on the Minnesota portion of Harrison Creek (and none visible on the Manitoba portion).

Pickerel Creek

Pickerel Creek is a very small, low gradient stream located on the eastern edge of the Northwest Angle flowing through forested wetlands. It is heavily influenced by the lake and beaver activity. There have been several times when the stream is not flowing directly into the lake as a sand bar has formed at the mouth, cutting off connection. There are no cabins or homes located on this stream. As you travel upstream, the stream is very narrow with many downed trees and small beaver dams.

Pine Creek

Pine Creek is located in the north-central region of the NWA at the community of Angle Inlet. The portion directly flowing into the Inlet is heavily influenced by seasonal cabins and some permanent residents and also includes a resort. Many lawns are mowed to the stream edge, and numerous docks are present. Once the creek reaches the road crossing, it narrows significantly and follows a more natural path as you travel upstream.

Poplar Creek

Poplar Creek is located in the northwest portion of the NWA, flowing into the Inlet. There are approximately a dozen seasonal homes/cabins on this stream. The majority of the land use is forest and wetlands. This is a stream we are able to sample quite a ways upstream – approximately 2.5 miles – to reduce the influence of lake effect on samples.

Stony Creek

Stony Creek is located on the southern end of the NWA. There are a couple of seasonal cabins located at the mouth of the river and one located further upstream. The stream starts out fairly decent sized several hundred feet wide but quickly narrows to a small stream less than 30 feet wide. The surrounding area is dominated by forested wetlands.

3.5 Hydrology

Drainage area for the stream reaches are listed in Table 3-2. A summary of available flow monitoring data is listed in Table 3-3.

Table 3-2. Stream reach drainage areas in Minnesota

Stream Drainage Areas		
Station ID	**Stream Name**	**Direct Drainage Area (ac) in MN**
BEAR-I	Bear Creek	1,099
CROW-I	Crow Creek	1,458
HARR-I	Harrison Creek	2,114
PICK-I	Pickerel Creek	12,698
PINE-I	Pine Creek	7,341
POPL-I	Poplar Creek	3,591
STON-I	Stony Creek	17,941

Table 3-3. Northwest Angle streams flow data summary (Red Lake DNR)

Stream	No. of Samples	Minimum Flow (cfs)	Median Flow (cfs)	Maximum Flow (cfs)
Bear Creek	8	2.0	8.8	38.3
Crow Creek	0	-	-	-
Harrison Creek	2	1.0*	-	322.3
Pickerel Creek	11	0.3*	5.9	33.1
Pine Creek	9	0*	3.9	42.1
Poplar Creek	14	5.9	32.1	326.8
Stony Creek	11	0.9	27.2	209.5

Unnamed Creek	9	0.5	5	7

* Note that some lake effect backflow is observed under low flow conditions in these streams

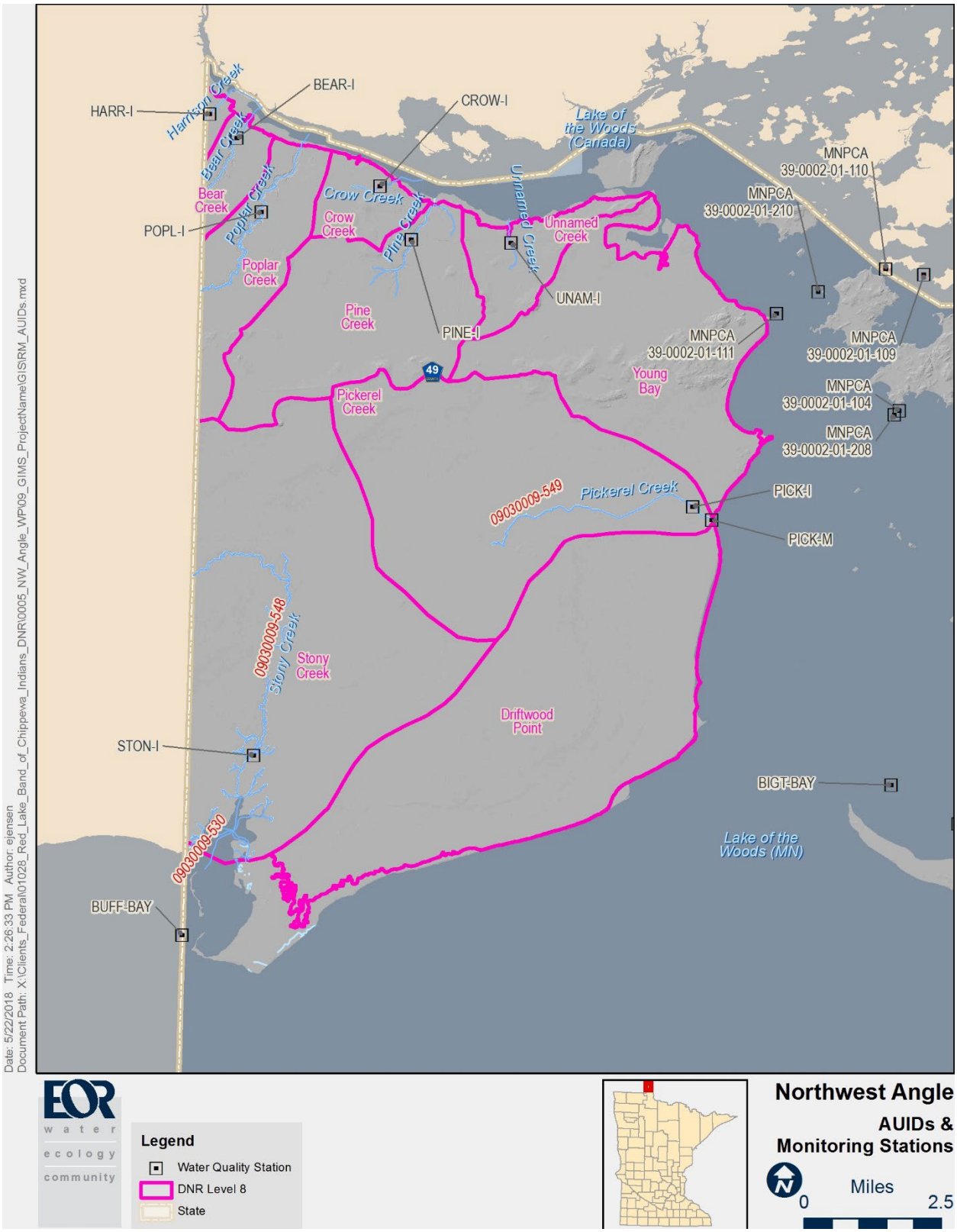


Figure 3-3. Stream drainage areas and monitoring stations

3.6 Current/Historical Water Quality

The existing in-stream water quality conditions were quantified using data collected by the Red Lake DNR between 2004 and 2016 (Table 3-4). The stream monitoring stations are illustrated in Figure 3-3. From the tribe's perspective, these are natural background conditions for the streams and considered a non-issue. However, currently there is not enough information to define background sufficiently. It will be challenging to incorporate water quality standards until more years of data are available. Exceedances at the lake sites are of concern; however, lake data is not addressed in this plan.

Table 3-4. Water quality period of record, by stream

Stream	Water Quality Period of Record
Bear Creek	2010-2016
Crow Creek	2004-2009
Harrison Creek	2010-2016
Pickerel Creek	2010-2016
Pine Creek	2004-2016
Poplar Creek	2010-2016
Stony Creek	2010-2016
Unnamed Creek	2004-2016

3.6.1 Stream *E. coli*

E. coli concentration data, measured as most probable number of organisms per 100 mL (MPN/100mL), was available for Crow Creek, Pine Creek, and Unnamed Creek in 2009 only. There is difficulty in sampling *E. coli* and having it analyzed within the 24-hour holding time. After 2009, the Red Lake DNR sampling efforts expanded to two-day trips making *E. coli* analyses impossible to complete within that time. The limited amount of data showed *E. coli* concentrations were below state standards (126 org/100mL).

Table 3-5. Geometric mean *E. coli* concentrations (MPN/100ml) by month, 2009.

Stream	Month	Number of Samples	Geometric Mean (MPN/100ml)
Crow Creek	**June**	1	12.0
	July	1	16.1
	August	1	2.0
	September	1	5.2
Pine Creek	**June**	1	6.3
	July	1	42.6
	August	1	42.8
	September	1	3.1
Unnamed Creek	**June**	1	7.2
	July	1	66.3
	August	1	50.4
	September	1	108.1

3.6.2 Stream Dissolved Oxygen

The number of dissolved oxygen samples less than the water quality standard of 5 mg/L available for each stream between 2004-2016 are summarized in Table 3-6.

Table 3-6. Number of samples less than the dissolved oxygen standard of 5 mg/L by stream, 2004-2016.

Stream	No. of Samples	No. of Samples < 5 mg/L
Bear Creek	25	5
Crow Creek	8	2
Harrison Creek	26	0
Pickerel Creek	23	6
Pine Creek	40	14
Poplar Creek	25	2
Stony Creek	23	3
Unnamed Creek	37	1

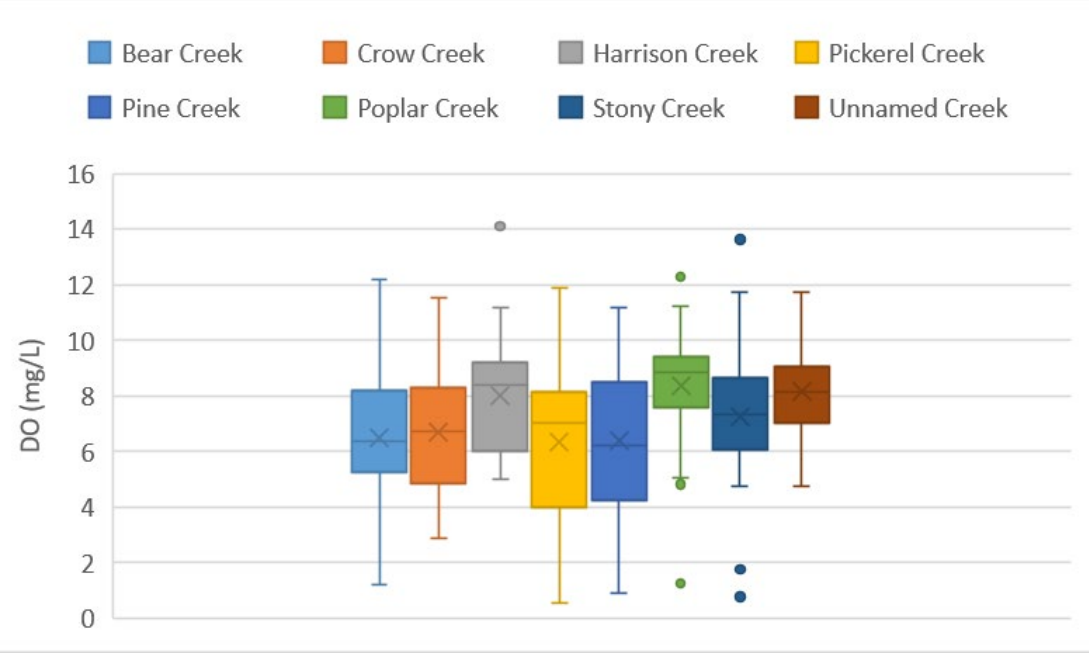


Figure 3-4. Box and whisker plots of dissolved oxygen (mg/L) measurements by stream in the Northwest Angle Watershed, 2004-2016. The dashed line represents the DO standard for coolwater and warmwater streams (5mg/L). The box represents the 25th, 50th (median), and 75th percentile value. The whiskers represent the range of values.

3.6.3 Stream Total Suspended Solids

The number of total suspended solids (TSS) samples exceeding the North River Nutrient Region standard of 15 mg/L, from May through October, available for each stream between 2004-2016 are summarized in Table 3-7.

Table 3-7. Number of samples exceeding the TSS water quality standard of 15 mg/L by stream, 2004-2016 (April – September).

Stream	Average TSS Concentration (mg/L)	No. of Samples	No. of Samples > 15 mg/L
Bear Creek	4.54	24	1
Crow Creek	3.57	7	0
Harrison Creek	3.91	23	1
Pickerel Creek	3.63	19	0
Pine Creek	3.19	25	0
Poplar Creek	9.54	26	4
Stony Creek	3.33	21	0
Unnamed Creek	8.04	27	4

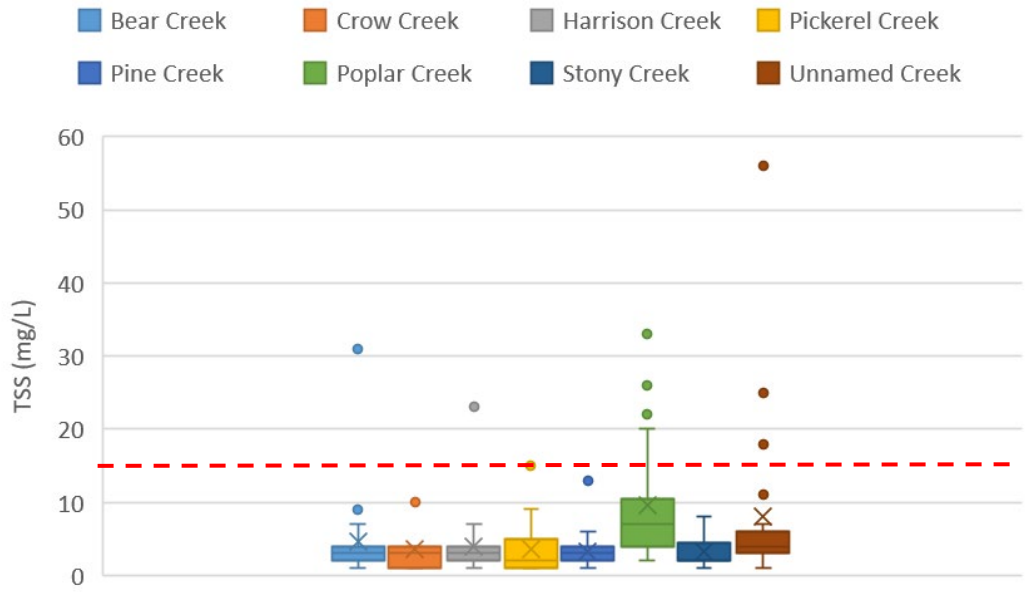


Figure 3-5. Box and whisker plots of total suspended sediment (mg/L) measurements by stream in the Northwest Angle Watershed, 2004-2016. The dashed line represents the TSS standard (15 mg/L) for Northern Streams. The box represents the 25th, 50th (median), and 75th percentile value. The whiskers represent the range of values.

3.6.4 Phosphorus (Eutrophication)

Growing season average (June – September) total phosphorus concentrations available for each stream between 2004-2016 are summarized by stream in Table 3-8.

Table 3-8. Growing season (June – September) average total phosphorus concentration (mg/l) by stream, 2004-2016. The North River Nutrient region water quality standard for phosphorus is a growing season average of less than 0.05 mg/L.

Stream	June-September average TP (mg/L)	No. of samples
Bear Creek	0.038	26
Crow Creek	0.042	17
Harrison Creek	0.027	25
Pickerel Creek	0.043	24
Pine Creek	0.036	22
Poplar Creek	0.041	26
Stony Creek	0.031	23
Unnamed Creek	0.070	27

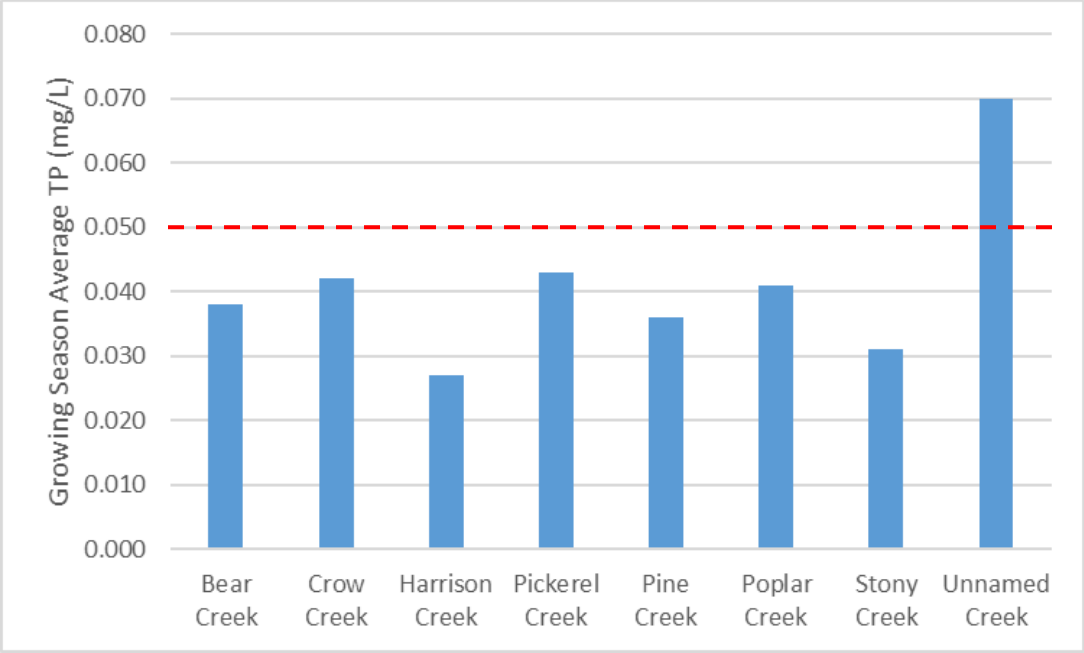


Figure 3-6. Growing season average total phosphorus (mg/l) by stream, 2004-2016. The dashed red line represents the TP eutrophication standard for Northern Region Streams (0.05 mg/L).

3.6.5 Inorganic Nitrogen: Nitrate+Nitrite

Nitrogen is assessed in the form of nitrate plus nitrite. There is no standard for nitrogen in Minnesota; however, there are ecoregion values for inorganic nitrogen. The Northern Minnesota Wetlands Ecoregion range for inorganic nitrogen is 0.01-0.08 mg/L. This range is for typical measurements found in this ecoregion. Values are summarized in Table 3-9.

Though these streams were not assessed for drinking water (as they are not Class 1 waters), no sites exceeded the drinking water standard of 10 mg/L for nitrates.

Table 3-9. Nitrate+Nitrite exceedances by stream in Northwest Angle, 2004-2016.

Stream	No. of samples	No. of samples above ecoregion range	Minimum [mg/L]	Maximum [mg/L]
Bear Creek	28	1	*	0.391
Crow Creek	11	0	*	0.050
Harrison Creek	28	1	*	0.147
Pickerel Creek	26	0	*	0.071
Pine Creek	36	0	*	0.050
Poplar Creek	28	1	*	0.095
Stony Creek	24	0	*	*
Unnamed Creek	34	0	*	0.077

* Nitrate+Nitrite level was below detection limit

4 Pollutant Sources

4.1.1 Point Sources

There are currently no point sources located at the Northwest Angle. If any new sources arise, this plan will be modified to include that information.

4.1.2 Watershed Runoff

Total phosphorus export coefficients (TPECs) based on land cover were used to calculate the watershed runoff TP loads by subwatershed (Table 4-1) at the DNR HUC8 watershed scale. The TPECs are the phosphorus runoff yield (i.e., loading rate) for a given land use, applicable in a given region having common surface features and a comparable climate record. The Lake St. Croix Total Phosphorus Loading Study summarized TPECs from published reports of runoff studies conducted by natural scientists and water resource managers in Minnesota, Wisconsin, and/or Upper Midwest landscapes (Table 4-2). TPECs are higher for developed land uses primarily because of the volume of flow generated from impervious surfaces.

Crow Creek had the highest TP yield compared to the rest of the subwatersheds due to a higher proportion of hay/pasture & cropland.

Table 4-1. Subwatershed drainage areas and TP loads based on Lake St. Croix TPECs

Subwatershed	Drainage Area (ac)	TP Load (lb/yr)	TP Yield (lb/ac/yr)
Bear Creek	1,099	103	0.094
Crow Creek	1,458	234	0.161
Driftwood Point	16,990	1,589	0.094
Harrison Creek	241	26	0.110
Pickerel Creek	12,698	1,247	0.098
Pine Creek	7,341	787	0.107
Poplar Creek	3,591	387	0.105
Stony Creek	17,941	1,822	0.102
Unnamed Creek	2,114	230	0.109
Young Bay	9,481	934	0.099
Total	**72,954**	**7,354**	**0.101**

Table 4-2. TPECs by Land Cover Type

Land Cover Type	TPEC (lb/ac/yr)
Water	0.045
Forest & Wetlands	0.089

Grass (Grasslands & Hay/Pasture)	0.223
Agriculture (Row Crops)	0.668
Urban (Impervious)	0.668

4.1.3 Septic Systems

Phosphorus loads from SSTS were estimated based on assumptions described in the *Detailed Assessment of Phosphorus Sources to Minnesota Watershed* (MPCA 2004). The TP load from septic systems was calculated by sub-watershed using estimates of the number of septic systems, failure rate, residents per household, and TP load per person per year. The number of septic systems in the North West Angle watershed was estimated by the Red Lake DNR. Given the shallow depth to bedrock in the watershed, it was assumed that 50% of septic systems were failing (i.e., non-conforming). Typical occupancy in Lake of the Woods County (comparable to Northwest Angle) is 2.40 persons/household according to population estimates made by the U.S. Census Bureau in July, 2016. Phosphorus load was assumed to be 2.0 lb per person per year (MPCA 2004). It was also assumed that 19% of residences are permanent and 81% are seasonal (Red Lake DNR estimate).

Table 4-3. Estimated septic system load by subwatershed

Subwatershed	Residences	TP Load (lb/yr)
Angle Inlet	55	32
Northwest Angle (including Angle Inlet)	345	196

5 Protection Strategies

Elements of the 9 point watershed plan addressed in this section:

9 Elements	EOR Approach
Describe management measures that will achieve load reductions and targeted critical areas	Protection Strategy table
Estimate amounts of technical and financial assistance and the relevant authorities needed to implement the plan	A component of the Strategy table
Develop a project schedule	A component of the Strategy table
Describe the interim, measureable milestones	A component of the Strategy table
Identify indicators to measure progress	A component of the Strategy table

5.1 Targeting of Geographic Areas

The following section describes the specific tools that were used to identify, locate and prioritize watershed restoration and protection actions. Follow-up field reconnaissance will be the next part of the process to validate the identified areas potentially needing work.

5.1.1 Critical Area Identification

- **Ecological Ranking Tool (ERT)**: This tool helps prioritize tracts of land to be targeted for conservation easements or other conservation practices. The tool consists of three spatial data layers: erosion potential of soils, terrain analysis and surface water proximity to determine critical overland flow areas, and habitat quality. These databases can be combined into an Environmental Benefits Index (EBI) to help prioritize local conservation activities. The tools do not suggest which particular conservation practices are appropriate, only which lands could be targeted for maximum benefit. More detailed information is available on the NRRI website: https://beaver.nrri.umn.edu/EcolRank/.
    - **Soil Erosion Risk**: The Soil Erosion Risk layer illustrates the areas of the watershed potentially at risk for soil erosion based on bare soil conditions (disregards land use). Soil risk was calculated from the R, K, L, and S factors of universal soil loss equation. The greatest conservation needs in the watershed are the dark green areas adjacent to surface water resources.
    - **Water Quality Risk**: The Water Quality layer is based on proximity to surface water and terrain attributes (stream power index) that measure flow accumulation and direction. High Stream Power Index (SPI) values indicate areas on the landscape that have a potential for overland erosion during runoff events. The greatest conservation needs are the dark green areas that have the highest SPI scores and are in close proximity to water resources.

- **Wildlife Habitat Benefit Index**: The Wildlife Habitat Benefit Index layer illustrates a weighted wildlife habitat benefit index; areas of significant wildlife value are shown in dark green. The index is based on a combination of several layers used to produce a weighted evaluation of wildlife habitat. Highly valuable areas provide recognized ecological functions such as nesting habitat, contain native plant communities, and support species of greatest concern.
- **Environmental Benefit Index**: The Environmental Benefit Index layer illustrates areas within the watershed where implementation of best management practices will achieve maximum ecological benefit by combining the previous three layers (soil erosion risk, water quality risk, and wildlife benefit) to form an overall environmental benefit index. Darker areas are more valuable from a conservation perspective than lighter areas.

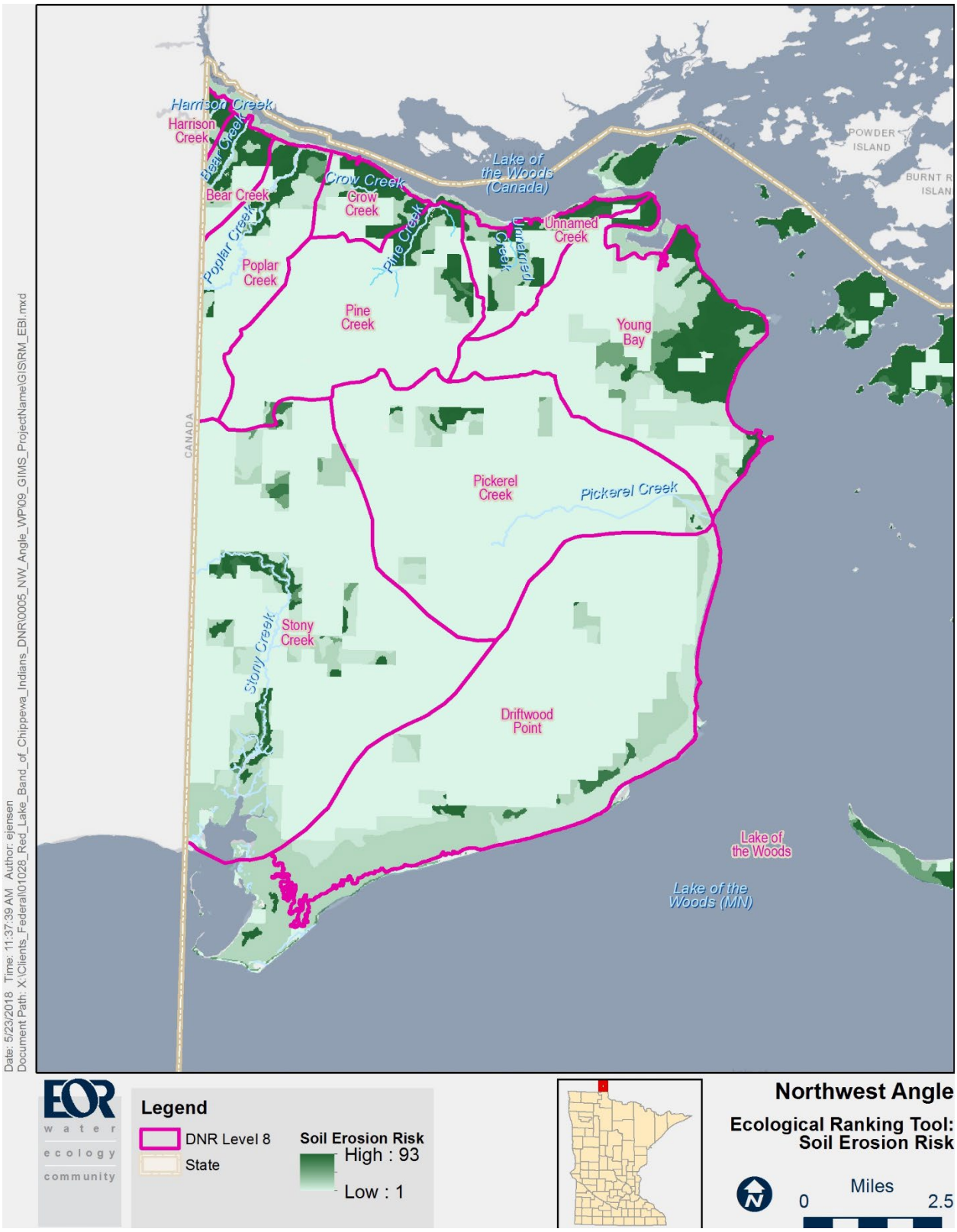


Figure 5-1. Northwest Angle Soil Erosion Risk

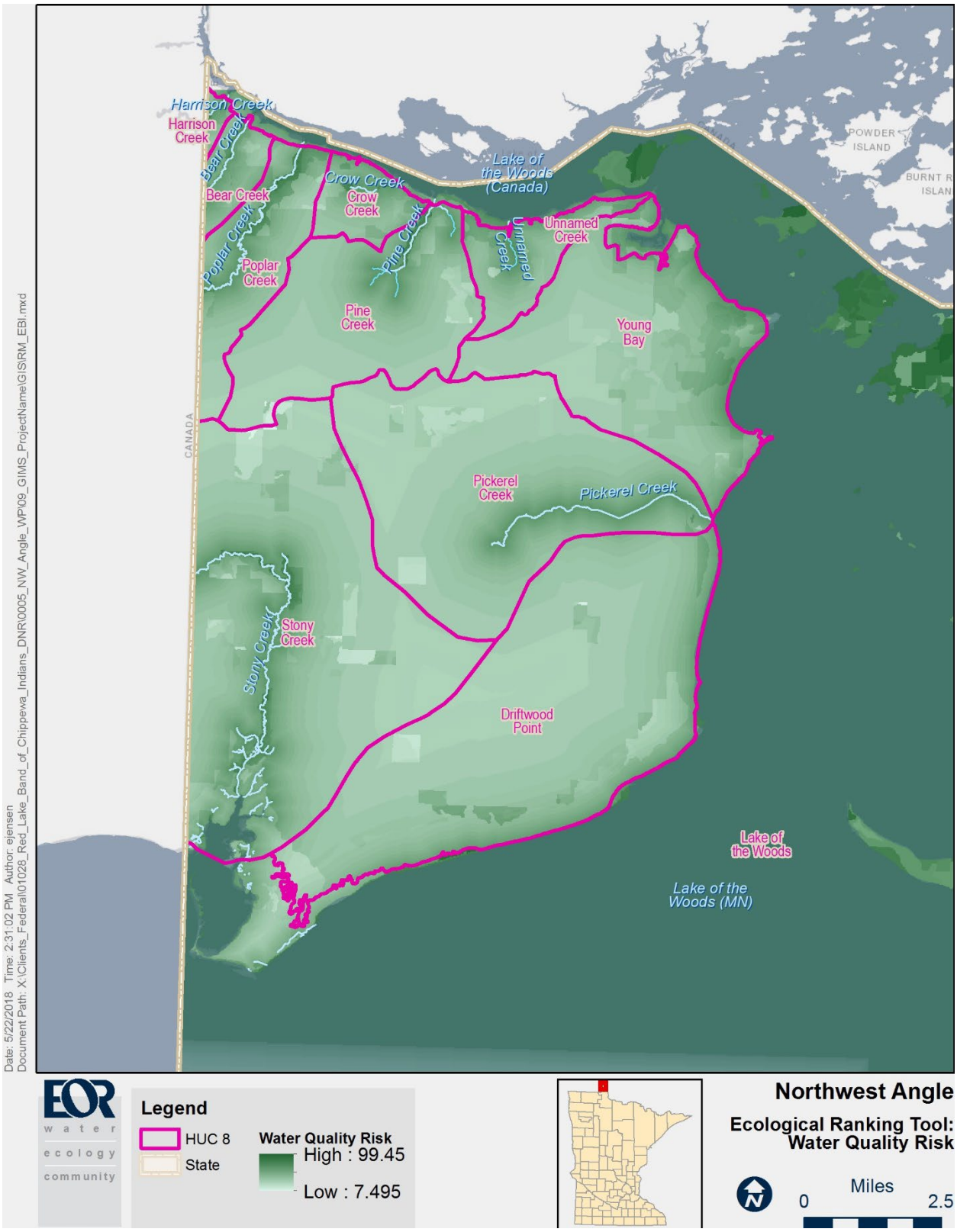


Figure 5-2. Northwest Angle Water Quality Risk

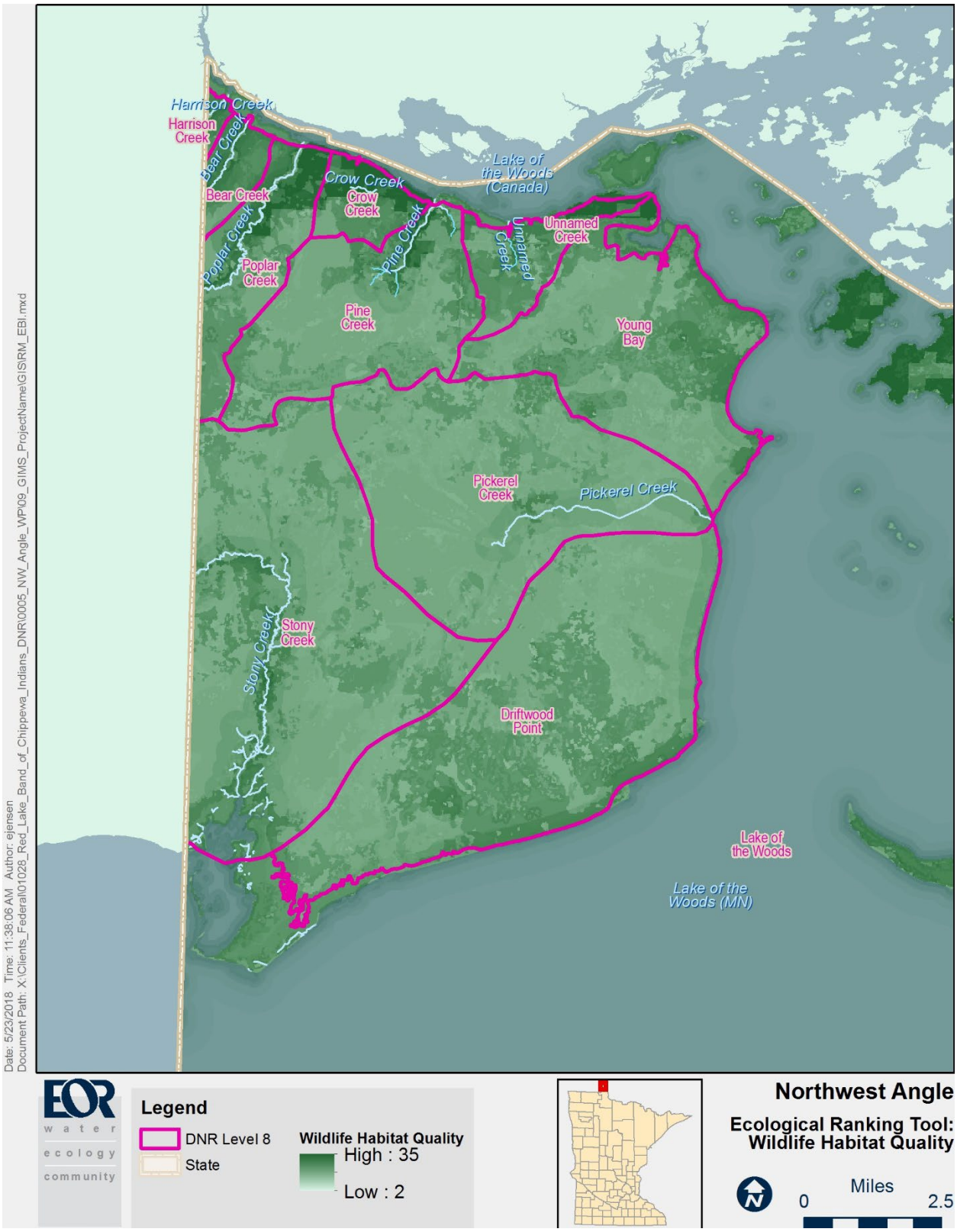


Figure 5-3. Northwest Angle Wildlife Habitat Quality

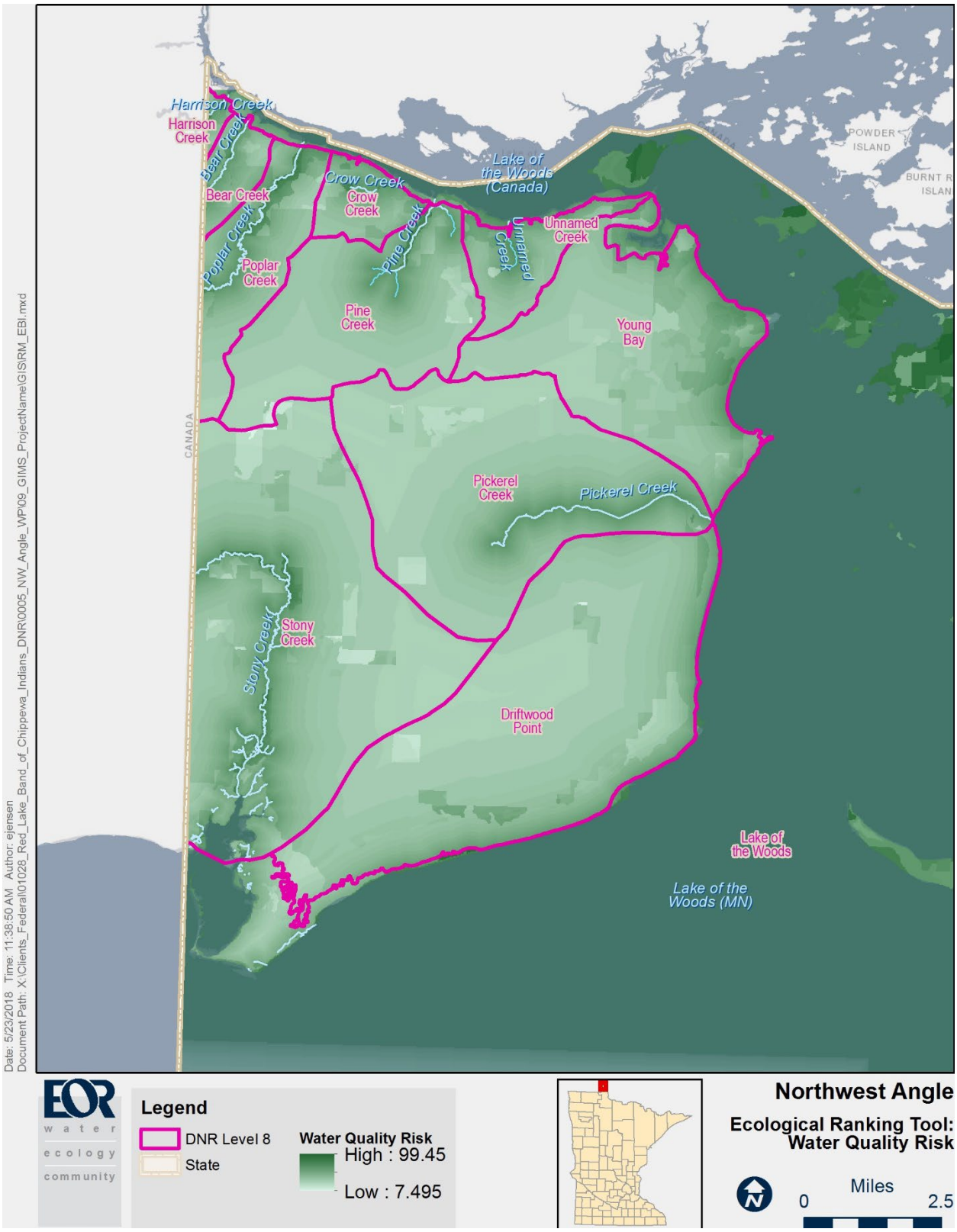


Figure 5-4. Northwest Angle Environmental Benefits Index

5.2 Protection Strategies

This section includes a detailed table (Table 5-1) identifying restoration and protection strategies for individual stream direct drainage areas that restore or protect water quality. Due to the uniform nature of the watershed, many strategies were identified on a watershed-wide basis. These projects include the following information:

- Water quality conditions and goals
- BMPs and other management activities
- Estimated scale of adoption needed for each strategy to achieve the water quality goal
- Governmental units with primary responsibility
- Estimated timeline for full implementation of strategy
- Interim 10-year milestones for implementation of strategy

5.2.1 Strategy Prioritization & Identification

The streams in the Northwest Angle Watershed are mostly unimpacted with no load reductions needed to support the LOW TMDL. The most important water quality issue identified to date is developed shoreline with potentially failing septic systems and application of yard fertilizer. Since both of these issues occur primarily outside reservation boundaries, the vast majority of implementation will have to occur through partners and use state funds through the One Watershed, One Plan (1W1P) process. The top protection strategies are for the tribe to establish water quality standards and to include the NW Angle in any shoreline development ordinance moving forward. Due to the unimpacted, uniform nature of the watershed, there is very little potential for "on the ground" projects on the Reservation. Tribal efforts will concentrate on cooperating with partners in development of protective ordinances, education, and monitoring. As opportunities arise, the Red Lake Reservation could work with partners to protect existing wetlands and riparian areas, and maintain stream connectivity at road crossings.

5.2.2 Funding Sources

The Minnesota Clean Water, Land, and Legacy Fund have several grant and loan programs that could potentially be used for implementation of the BMPs and education and outreach activities. The various programs and sponsoring agencies related to clean water funding and other sources of funding are listed below in hyperlinks. These grant funds can be used by partners of the Red Lake DNR to implement BMPs on non-tribal land to improve water quality in the Northwest Angle Watershed.

Tribal Funding Sources

- Clean Water Act Section 319 Grants (US EPA)
- Clean Water Act Section 106 Grants (US EPA)

- General Assistance Program (GAP) (USEPA)

- United States Fish and Wildlife Service
- Bureau of Indian Affairs (BIA)
- Environmental Quality Incentives Program (Natural Resources Conservation Service)

Partner Funding Sources

- Red River Basin Commission
- Agriculture BMP Loan Program (MDA)
- Clean Water Fund Grants (BWSR)
- Clean Water Partnership (MPCA)
- Environment and Natural Resources Trust Fund (Legislative-Citizen Commission on Minnesota Resources)
- Environmental Assistance Grants Program (MPCA)
- Phosphorus Reduction Grant Program (Minnesota Public Facilities Authority)
- Section 319 Grant Program (MPCA)
- Small Community Wastewater Treatment Construction Loans & Grants (Minnesota Public Facilities Authority)
- Source Water Protection Grant Program (Minnesota Department of Health)
- Surface Water Assessment Grants (MPCA)
- Wastewater and storm water financial assistance (MPCA)
- Conservation Partners Legacy Grant Program (DNR)
- Environmental Quality Incentives Program (Natural Resources Conservation Service)
- Conservation Reserve Program (USDA)
- Clean Water State Revolving Fund (US EPA)
- Clean Water Act Section 319 Grants (US EPA)

Table 5-1. Strategies and actions proposed for the Northwest Angle Watershed.

Stream Subwatershed	Parameter (incl. non-pollutant stressors)	Water Quality Conditions and Goals			Strategies	Actions	
		Current Conditions	Goals / Targets and Estimated % Reduction	Estimated Year to Achieve Final Goal			
All Streams	*E. coli*, TSS, TP, Inorganic Nitrogen	Meets water quality standards	Maintain existing water quality	Ongoing	Water quality standards	Set water quality standards for surface waters in the Red Lake reservation.	TSS and est lak Res
					Shoreland ordinances	Include the Northwest Angle in shoreland development ordinances	Wo dra
					Improve riparian vegetation/Shoreline stabilization	Establish and/or protect riparian corridors along all waterways, including ditches, using native vegetation whenever possible	12.
					Improve connectivity	Beaver dam removal and deterrence, review culvert sizing, and remove other obstructions in channel	Inc obs NW and dat
					Address failing septic systems	Replace all systems deemed Imminent Threat to Public Health (e.g., straight pipes, surface seepage), and promote education of proper SSTS maintenance	Wo SST acc pro
					Protect, restore, and enhance wetlands	Land conversion/ conservation easement	Ide pro
					Abandoned well sealing	Seal abandoned wells.	Loc nee 10
					Well testing clinics	Host clinics for testing well water.	Wo De to cli
					Ditch maintenance	Properly maintain ditches of the NWA	De iss
					Aquatic Invasive Species Education	Post AIS signage at public/resort accesses and provide AIS pamphlets to landowners; provide resources on websites and in newsletters..	De sig imp edu

Stream Subwatershed	Parameter (incl. non-pollutant stressors)	Water Quality Conditions and Goals			Strategies	Actions	
		Current Conditions	Goals / Targets and Estimated % Reduction	Estimated Year to Achieve Final Goal			
							we

6 Monitoring Plan

6.1 Stream Monitoring

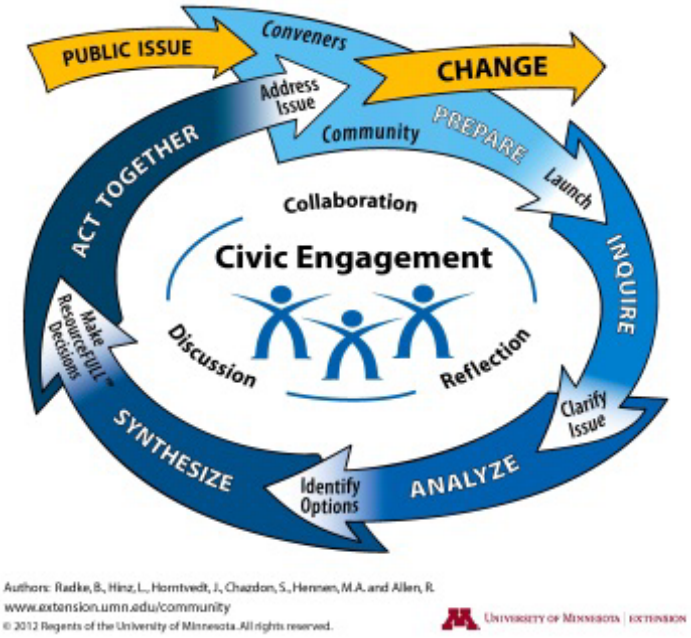
Current stream monitoring at the Northwest Angle includes approximately three sample events at the seven streams. Monitoring for physical as well as chemical constituents is included. Dissolved oxygen, pH, specific conductivity, and water temperature are measured with a multi-parameter sonde. Chemical constituents include total phosphorus, total Kjeldahl nitrogen, nitrate+nitrite, total nitrogen, orthophosphate, sulfate, total suspended solids, total suspended volatile solids, chloride, hardness and ammonia-nitrogen. These will continue to be monitored as funding allows. If new constituents of interest are discovered, those will be added to the monitoring plan.

6.2 BMP Monitoring

On-site monitoring of implementation practices should also take place in order to better assess BMP effectiveness. A variety of criteria such as land use, soil type, and other watershed characteristics, as well as monitoring feasibility, will be used to determine which BMPs to monitor. Under these criteria, monitoring of a specific type of implementation practice can be accomplished at one site but can be applied to similar practices under similar criteria and scenarios. Effectiveness of other BMPs can be extrapolated based on monitoring results. Areas where BMPs are likely to occur are not on reservation lands and will be 100% voluntary. Partnerships with the SWCD and County will be necessary to seek support and gain buy-in from local landowners to participate in BMPs. Once complete, the watershed management plan will be combined with the Lake of the Woods One Watershed One Plan (1W1P) effort and will provide a basis for implementation of BMPs in this watershed. Monitoring of BMP effectiveness under the 1W1P will depend upon the agency implementing the projects and whether effectiveness monitoring is allowable.

7 Education & Outreach

A key prerequisite for successful strategy development and on-the-ground implementation is meaningful civic engagement. This is distinguished from the broader term 'public participation' in that civic engagement encompasses a higher, more interactive level of involvement. Specifically, the University of Minnesota Extension's definition of civic engagement is "Making 'resourceFULL' decisions and taking collective action on public issues through processes that involve public discussion, reflection, and collaboration." A resourceFULL decision is one based on diverse sources of information and supported with buy-in, resources (including human), and competence. Further information on civic engagement is available at: http://www1.extension.umn.edu/community/civic-engagement/



Partnering agencies provide outreach through websites, community clinics (such as well water testing), and mailings/newsletters. The tribe provides outreach through their quarterly newsletters, website, Facebook page, and community meetings. These practices will be continued.

8 Literature Cited

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