

**Nest Lake
Aquatic Plant
Management Project
Engineer's Report
CIP #10-01**

Prepared for:

**Middle Fork Crow River
Watershed District**



Wenck

March 2011



**Middle Fork Crow
River Watershed
District**

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Wenck File #1979-04

Prepared for:

**MIDDLE FORK CROW RIVER
WATERSHED DISTRICT**

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Nest Lake Curly-leaf Pondweed Management Alternatives Project Engineer's Report

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I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I, a duly Licensed Professional Engineer under the laws of Minnesota.

Print Name Christopher J. Meehan

Signature 

Date 3-1-2011 License No. 43066

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1.0 Introduction

This report has been prepared in response to a petition (Capital Improvement Project (CIP) #10-01, Attachment 1) by the Nest Lake Improvement Association (NLIA) to the Middle Fork Crow River Watershed District (MFCRWD). This petition is for support of a new invasive aquatic plant management project, and equitably assessing the costs for management on Nest Lake. The NLIA has successfully operated an aquatic plant harvesting program since 1986. However, NLIA believes there is a need to establish a aquatic plant management project through the MFCRWD for the purpose of improving water quality, improving use of the lake for navigation, maintaining the economic benefit of the lake; and for distributing the project cost to all benefited parties, expanding the area of management, and increasing the aesthetics of Nest Lake. Therefore, the purpose of this Engineers Report is to state the project need, discuss alternatives and to make a recommendation for aquatic plant management activities on Nest Lake.

A lake management plan, developed as a cooperative effort between the NLIA, MFCRWD, and the MN Department of Natural Resources (DNR) was completed in 2009 (Jacobson, et. al. 2009 (Attachment 2)). Included in the plan are strategies for the following:

1. *Restoration of water quality in the lake.* The plan sets long-term water quality goals for phosphorus, chlorophyll a, and water clarity that exceed the state standards for deep lakes in the North Central Hardwood Forest (NCHF) ecoregion adopted by the State of Minnesota in 2008.
2. *Control of curly leaf pondweed.* The plan lays out actions to monitor and pursue methods to control curly leaf pondweed to reduce its occurrence to non-nuisance levels.
3. *Native aquatic plant protection and restoration.* The plan identifies actions to track, protect, and where necessary restore native aquatic vegetation in the lake.

The NLIA currently operates two harvesting machines with funds from donations and

fundraising conducted by NLIA. The existing program was augmented in 2010 with 60-acres of herbicide treatment, which was funded through a combination of DNR grant and NLIA contributions. The funding source for the current program is variable from year to year and is not effective in reaching all of the benefitted properties on Nest Lake. There is a desire for a fairer distribution of costs, as well as expanding management activities. Figure 1 shows the areas where Curly-leaf pondweed (*Potamogeton crispus*) presence as mapped by the DNR in 2009.



Figure 1. Abundance of Curly Leaf Pondweed On Nest Lake (June 2009) from Eisterhold, J and K. Uhler 2009

The Nest Lake Watershed covers parts of three counties (Kandiyohi, Pope, and Stearns). The Nest Lake watershed is approximately 120.3 square miles (Figure 2). The watershed is dominated by agricultural land use.

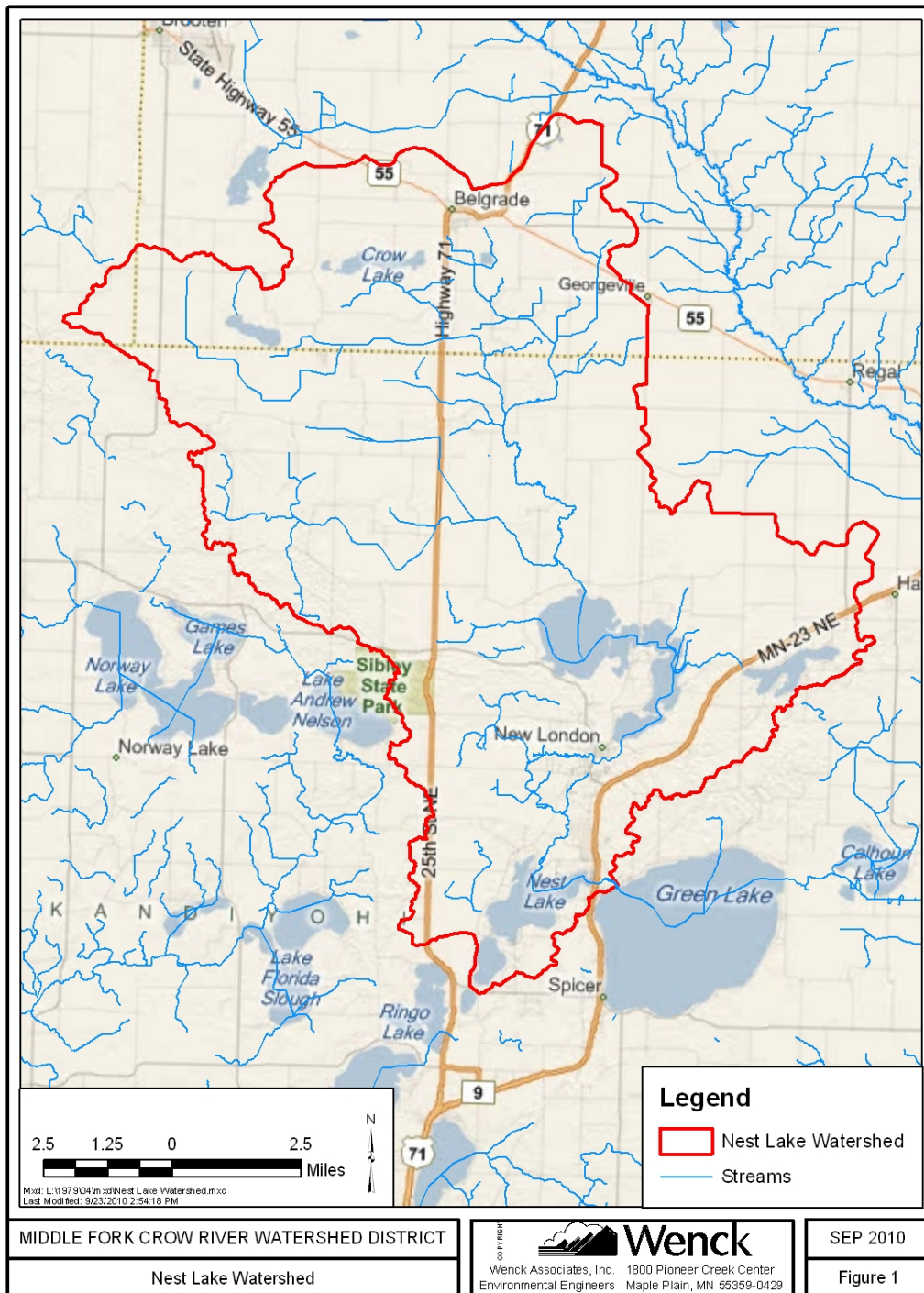


Figure 2: Nest Lake Watershed

2.0 Objective

The objective of this report is to respond to the petition, and satisfy the requirements for an Engineer's Report under Minnesota Statutes 103D.711. According to the statute an Engineer's report must include findings and recommendations about the proposed project; and if the engineer finds the project feasible, the engineer must provide a plan of the proposed project as part of the report.

The objectives of the proposed project are to:

- Determine a feasible solution to management of invasive aquatic species on the lake, and reestablish native vegetation in managed areas
- Develop an annual budget for program implementation.
- Develop a sustainable funding source, which creates an equitable distribution of costs among benefitted properties.
- To expand the amount of managed area as allowed by appropriate plans and permits for the purpose of improving water quality and recreation.

The intent of this project is to allow management of any nuisance aquatic plant growth within the constraints of the Nest Lake Management Plan and applicable permit requirements.

3.0 Benefited Properties

Benefited properties for this project have not been defined by MFCRWD. Approval of this report by the MFCRWD will lead into appraisers being retained to determine the extent of benefitted properties from this project. Appraisers will use varying approaches for determining the benefits of a project, but an outline of typical criteria is provided below.

Determination of benefits: Benefited properties are typically defined as all lands, including lands owned by the State of Minnesota or any subdivision thereof receiving direct benefits. Direct benefits include but are not limited to recreation, improved navigation, improved lake access, increase in property value, and improved fishing.

Nest Lake Curly-Leaf Management Project CIP #10-01: Will provide a number of benefits to lakeshore property owners and surrounding area of Nest Lake. Typical benefits include but are not limited to:

1. Improve lake access for lakeshore property owners or other property owners sharing a private lake access.
2. Increase property values on the lake, and property surrounding the lake.
3. Plant growth incorporates nutrients from lake bottom sediments. By removing plants you remove nutrients in plants and lower plant growth.
4. Provide a low cost service of removing invasive aquatic plants, add to the navigatability of the lake and help in slowing down the spread of weeds in the lake.
5. Increase recreational use of Nest Lake to enhance tourism and to improve the financial stability of the community.

4.0 Findings

This study finds that a new aquatic plant management project (hereafter called the Aquatic Plant Management Project) is feasible since the NLIA has been doing some level of management since 1986. The report also finds that it is feasible to expand management operations, but how much is a cost decision by the MFCRWD Board of Managers. To identify the optimum amount of expansion the following assessment was completed.

This assessment includes:

- An assessment of management impacts to fisheries, fish habitat, and water quality
- Descriptions and assessments of alternative scenarios for management
- A description of other considerations

4.1 Assessment of Impacts

A brief description of impacts of aquatic plant management (both positive and negative) was completed to address environment impacts on fisheries, fish habitat, and water quality and is presented below.

4.1.1 Environmental Impacts on Fisheries and Fish Habitat

Aquatic plants are an important part of lake ecosystems, and the value of maintaining aquatic plants in fostering diverse aquatic ecosystems has been well documented. Aquatic plants are an important component of fish and wildlife habitat. The Aquatic Ecosystem Restoration Foundation (2003) states that aquatic and littoral vegetation provides fish, waterfowl and some mammals with:

- Oxygen
- Habitat
- Food sources
- Breeding areas
- Refuge for predators and prey
- Stabilized bottom sediments and nutrients.

These resources are not only important for good sport fisheries, but also for other recreational activities, aesthetic enjoyment of water resources, and maintenance of healthy aquatic and littoral ecosystems.

Nest Lake has extensive coverage of aquatic plants. However, much of this coverage contains curly-leaf pondweed. The 2009 survey by the MnDNR represented in Figure 1 estimated the frequency of occurrence of curly-leaf pondweed at about 63% of the area of the lake between 0 and 20 feet deep (roughly 590 acres of the lake area).

The presence of curly-leaf pondweed is a concern for fish habitat for the following reasons:

1. Curly-leaf pondweed is an invasive exotic (i.e., non-native) plant. Curly-leaf pondweed starts growing in the fall and with the onset of spring has a competitive advantage over native plants. It can grow to have very dense canopy-forming mats that greatly reduce other aquatic plants species. This reduces aquatic ecosystem diversity and fisheries habitat complexity. Dense growths can also interfere with feeding by large predators.
2. Curly-leaf pondweed dies in early July. In areas where the curly-leaf pondweed growth is dominant and prevents native plants from growing, the die-off of curly-leaf in early July can leave areas devoid of aquatic plant growth, and associated habitat benefits, for much of the growing season.
3. The die-off of curly-leaf pondweed has water quality implications, which are discussed in more detail below. These implications include decomposition of the plant, which can consume oxygen leading to low oxygen conditions less conducive to fisheries. The die-off and decomposition can also contribute to internal phosphorus loads through release of phosphorus in the plant tissue and changes at water/sediment interface. This can

accelerate eutrophication, which can increase fisheries productivity in terms of fish biomass, but under hypereutrophic conditions that favor rough fish.

Management of invasive aquatic plants can moderate these affects. However, the current operation of harvesting equipment may impact lake fauna. Physical disturbance of bottom sediments can occur in shallow areas, turbulence caused by the motor can suspend sediments, and harvesting is not selective for specific plant species within the targeted area. In other words beneficial plants as well as nuisance plants may be harvested. These impacts can affect fish and fish habitat. However, the negative impacts of harvesting could be largely limited by doing the following:

- Limit harvesting in water depths less than 3-4 feet, where fish spawning typically occurs in shallow areas. This limitation would also limit the potential for resuspension of bottom sediments.
- Avoid harvesting in areas where the dominant macrophytes are native.
- Limit harvesting in areas within 150 feet of the shore to cutting pathways for access from docks and boat turn-around areas.

Along with harvesting, herbicide treatment of curly-leaf pondweed (current invasive species present in lake) with endothall was investigated for this project. The use of early-season low-dose applications of endothall compounds like Aquathol K to control curly-leaf pondweed is expected to have virtually no negative impact on fisheries and fish habitat. The compound is a selective contact herbicide that disrupts biological processes unique to plants, such as interfering with plant respiration and disrupting plant cell membranes (USEPA 2005). Further, the early season application proposed is designed to avoid impacts to native plants and maximize effectiveness in controlling curly-leaf pondweed, since curly-leaf is the first aquatic plant to grow in the spring. Finally, endothall compounds do not bioaccumulate in fish or hydrosol.

4.1.2 Impacts on Water Quality

Water quality impacts of invasive aquatic plants control methods may be both positive and negative. For harvesting, the biggest negative impacts are related to the potential for suspending sediments. The impacts associated with the harvesting project in Nest Lake should be minor because of the limited amount of cutting in shallow areas (i.e., areas less than 5 feet deep).

Positive water quality impacts of harvesting occur because nutrients in the plant tissue are removed along with the harvested plant materials. The targeted species for harvesting in Nest Lake is curly-leaf pondweed. James, et al. (2001) found lake-wide curly-leaf pondweed dry weight biomass of 31.1 g/m² and 25.4 g/m², uncorrected and corrected for harvesting, respectively. They also found an average dry weight phosphorus content of 0.43%. Using these values curly-leaf pondweed tissue contains an average of 0.95 to 1.2 lbs/ac of phosphorus at medium to heavy densities. Not all of this is removed with harvesting since plants may be cut off at some distance above the sediment and there are some materials that are not captured. Based on estimates for tissue phosphorus content, there is perhaps 0.95-1.2 lbs. of phosphorus /ac for heavy growths of curly-leaf pondweed (Sauk River Watershed District 2004). If all the tissue-bound phosphorus were removed in the harvested area (a liberal assumption, since only part of the plant is generally removed by harvesting), up to 240 pounds of phosphorus may have been removed from the system as a result of the harvesting operation. This compares with an external load of 4,200 pounds of phosphorus and a total load (internal and external) of over 6,600 pounds estimated by MPCA staff for 2004 (Wilson, B. et. al. 2004). Thus, phosphorus removal associated with curly-leaf pondweed harvesting and removal is likely no more than 3-4% of the total annual phosphorus load affecting the lake. To the extent that repeated, aggressive management of curly-leaf pondweed leads to a decrease in the long-term abundance of the plant, prevention of negative impacts can also occur with this control method.

Controlling the distribution and abundance of curly-leaf pondweed by minimizing turion germination and/or plant growth soon after germination can also prevent negative water quality impacts associated with the life cycle of curly-leaf pondweed. According to James, et al. (2001),

the plants can directly recycle phosphorus from the sediments through root uptake, incorporation into plant tissue, and subsequent senescence (i.e. decomposition). They can also indirectly recycle phosphorus from the sediments by increasing pH in the water column through photosynthetic activities. Phosphorus release from sediments can be enhanced at high pH as a result of ligand exchange on iron oxide contained in the sediment. In addition, senescence/decomposition of the plant material can contribute to low dissolved oxygen conditions at the sediment water interface. Low oxygen conditions contribute to weakening of the iron-phosphate bond leading to phosphorus release from sediments. Phosphorus loads from plant senescence and sediment effects cannot be estimated without detailed study. However, it can be significant, particularly when curly-leaf pondweed grows at densities that block out other plants. In these cases, when curly-leaf pondweed dies in early July, it can leave areas devoid of aquatic plants. The subsequent release of phosphorus from senescence can then be used by algae leading to nuisance algae blooms and decreased water clarity. In the Oxbow Lake study by James, et al. (2001), they estimated that curly-leaf pondweed decomposition provided about 26 percent of the measured internal phosphorus load during the summer. More importantly this load was released in a 2-week period at the height of the growing season and is largely dissolved phosphorus available for algae uptake. Thus, effective control options – whether based on mechanical harvesting, early-season low-dose Aquathol K treatments, or a combination of these – should have an overall positive effect on water quality (improved water clarity and lower phosphorus loading) and the native plant and animal community in Nest Lake.

4.2 Description of Scenarios

As mentioned previously, the NLIA has conducted an invasive aquatic plant harvesting program since 1986, when it purchased a used harvester that was manufactured in 1973. The invasive species target at that time was coontail. Since 2000, the effort has been focused on using harvesting to cut and remove curly-leaf pondweed from high-priority areas of Nest Lake. In 2009, with only one harvester, 1,500 cubic yards of curly-leaf pondweed were harvested from approximately 150 acres of the lake, (personal communication from Joel Peterson, Nest Lake

Association, to Chris Meehan). In 2010 NLIA purchased a used harvester to supplement its existing harvester, and started a pilot herbicide treatment funded by the DNR. The total area managed was 260 acres (200 acres harvested and 60 acres herbicide) (Figure 3), but the densest areas of curly-leaf were targeted for herbicide treatment (personal communication from Joel Peterson, Nest Lake Association, to Chris Meehan). The volume of curly-leaf harvested with the additional harvester (2,200 cubic yards) was not proportional to the additional acreage treated due to the densest areas being treated with herbicide.



Figure 3: 2010 Pilot Herbicide Treatment Area (Eisterhold, 2010).

Four different management scenarios were assessed including the existing program:

- **Alternative #1 - Harvesting Only (200 acres).** This scenario consists of using the existing harvesting equipment to the maximum extent possible. This area was assumed to be harvested one time over a period from the second week of May to the first week of July, roughly 7-8 weeks. This is consistent with NLIA staff current operation.
- **Alternative #2 - Harvesting with Herbicide Treatment (260 acres).** Like Alternative #1, both harvesters would be used, but management would be supplemented with 60 acres of herbicide treatment. The area treated with herbicide would reflect the area treated in 2010 by the DNR (Figure 3).
- **Alternative #3 – Harvesting with Herbicide Treatment (280 acres).** This would be an expansion of Alternative #3 which would include an additional 20 acres of herbicide treatment at targeted locations around the lake.
- **Alternative #4 – Whole-Lake Herbicide Treatment (412 acres).** A whole lake herbicide treatment would be completed for the littoral area. This alternative would look to sell the existing harvesters for additional capital towards the project.

Administrative, equipment and repair, labor, and fuel expenses used for defining existing conditions and assessing scenarios were obtained from NLIA for the period of 2009 through 2010. Equipment costs were obtained from vendors.

4.3 Assessment of Scenarios

The following assumptions were made for assessing the scenarios. These assumptions developed through conversation with vendors, NLIA, DNR, and MFCRWD are believed to be reasonable.

Assumptions

- Each scenario assumes the project begins in 2012
- Each scenario was evaluated to determine equipment (capital) costs and operations cost based on a 15-year operations period to give a total present worth cost for each scenario.
- A 4% discount rate was used in the present worth calculations.
- All scenarios were considered feasible.
- Harvesting scenarios were evaluated on a 40-hour workweek.
- Harvesting scenarios assumed the purchase of a new conveyor in 2010.
- Harvesting scenarios assumed replacement of the older harvester in 2020 since it was originally manufactured in 1973, but was significantly refurbished in 2008. The typical life span of harvester is 15 years.
- Harvesting scenarios assume that current operators who work for NLIA would continue to operate the current harvesters.
- Assumed harvesting rate of 0.5 acres per hour per harvester, which accounts for 20% downtime.
- All scenarios assume a 7-8 week period (mid-May to early July) of aggressive harvesting for curly-leaf pondweed.
- Capital costs (2010 dollars) for alternatives with harvesting assumed an initial cost of \$57,750 for a conveyor and used harvester in 2020. This cost came from the vendors.
- Herbicide scenarios assumed the project would continue to receive a \$10,000 pilot program grant from the DNR through 2012.
- Herbicide treatments were assumed to be carried out for five consecutive years, with spot treatments to occur every other year thereafter.
- It was assumed the pilot herbicide area of 60 acres would be treated in 2011 and would serve as the second year of treatment for this area.
- Herbicide scenarios assume there will be monitoring and reporting completed by the MFCRWD and DNR after each year of treatment.

4.3.1 Alternative #1 – Harvesting Only (200 acres)

Harvesting would be conducted by both harvesters during the 7-8 week period and would cover a significant amount of the lake (Figure 4). The area shaded is greater than 200 acres, but gives the area which is most likely to be harvested based on surveyed density of curly-leaf pondweed in the lake and past operations. The specific area harvested any year will change based on its abundance due to growing conditions. Harvesting operations will follow priority areas described in Section 6.

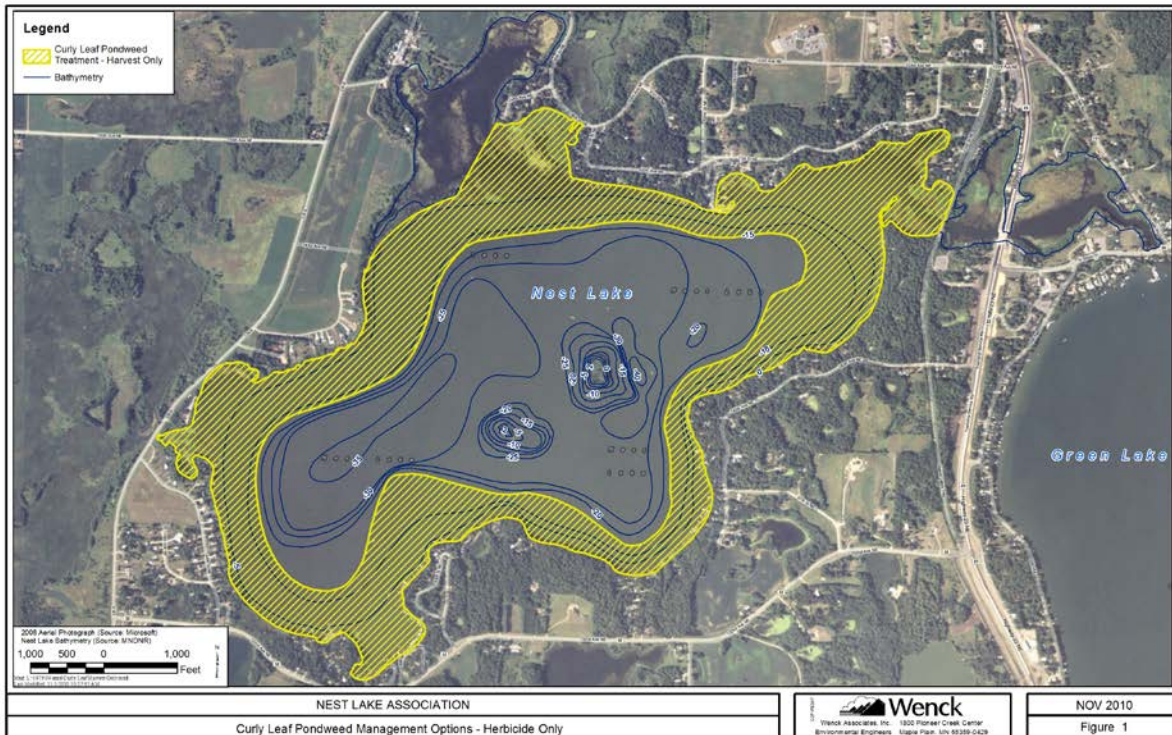


Figure 4: Harvest Only Alternative

There are a number of limitations characteristic of harvesting operations that need to be accounted for in assessing the cost-effectiveness of this control method. First, the permits required from the MnDNR that allow harvesting may limit harvesting activities to a portion of the littoral zone of the lake. This means that complete control of curly-leaf in the lake via harvesting will likely not be possible, since the turion-producing capability of the unharvested areas will be undiminished. Second, the cutting depth of the current machines is limited to about 7 feet, and cutting and removal of plants in water depths of less than 5 feet is difficult. Third, the window of time when the curly-leaf pondweed is robust enough for harvesting but is not yet in senescence is a fairly narrow period between early May and late June.

Following are the assumptions used to estimate a cost for this effort:

- Annual operations and maintenance costs of approximately \$26,000 per year were assumed for the expanded operation (two harvesters, conveyor, and disposal).

4.3.2 Alternative #2 – Harvest and 60-acre Herbicide (260 acres)

Harvesters currently used on the lake would be supplemented with herbicide treatment to manage the densest areas on the lake. The herbicide treatment would be conducted with an endothall product (e.g. Aquathol K), which has shown good promise in controlling curly-leaf pondweed (Crowell 2003).

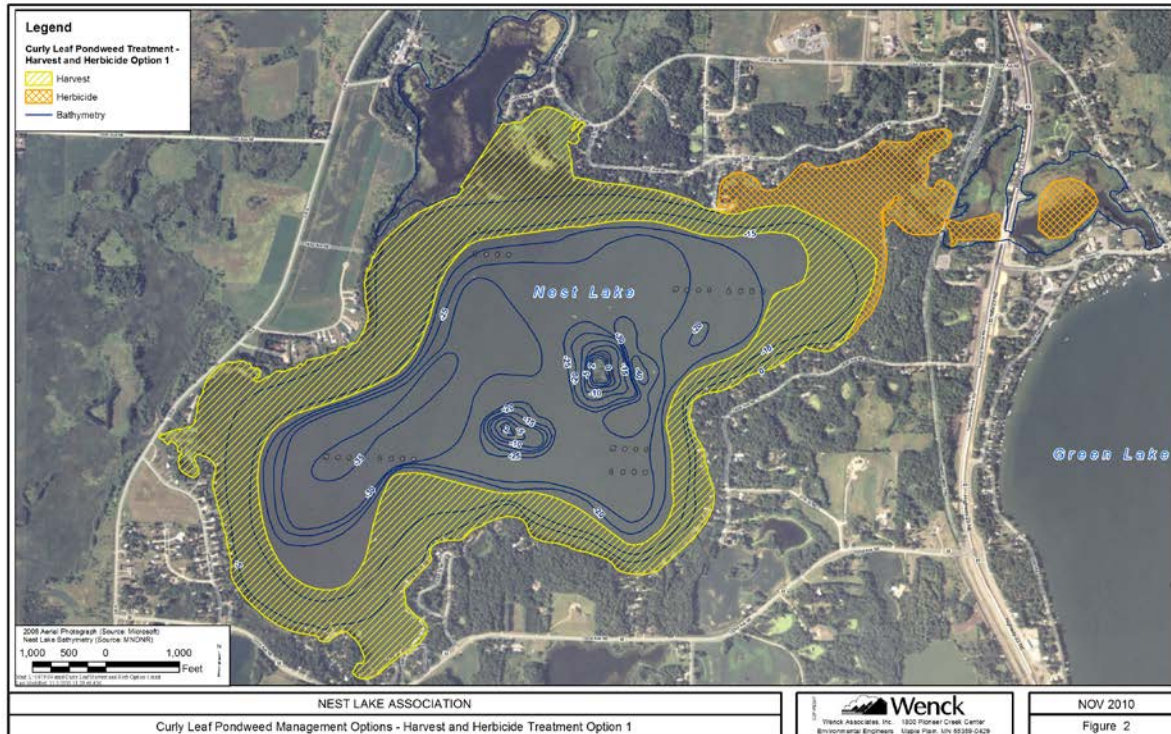


Figure 5: Harvest and Herbicide (60-acres) Alternative

Recent research indicates that early-season low- dose applications of Aquathol K have been effective at killing curly-leaf pondweed and reducing or eliminating turion production in the treated areas. This method of treatment also appears to have less-negative impacts on native aquatic plants than treatments done later in the summer. Guidelines from the MnDNR suggest that in order to deplete the bank of turions in the lake sediment and have a reasonable possibility of long-term control of curly-leaf pondweed, a lake should be treated for several years in succession (MN Department of Natural Resources 2008). As with all chemical treatments, these types of treatments require a permit from the DNR Division of Fisheries.

The following assumptions have been made to assess the cost of supplementing current harvesting operations in Nest Lake with Aquathol K for curly-leaf pondweed control

- The densest areas between shoreline and the 15-foot depth contour would be treated. The area treated would reflect the current DNR pilot treatment area.

- Three additional years of treatments (2012 – 2014) would be implemented. The targeted treatment area would have then been treated for five consecutive years.
- A Minnesota licensed herbicide applicator would be hired to provide the treatment service at a cost of \$260/ac. in 2011 dollars (assumes a 1 ppm concentration application).
- After intensive 5-year treatment, it was assumed that spot treatments every other year would be necessary to maintain long-term control for the remainder of the 15-year life cycle (assumed 25% of treated area).

4.3.3 Alternative #3 – Harvest and 80-acre Herbicide (260 acres)

Alternative #3 was assessed using the same criteria as Alternative #2 with the exception that the herbicide area would be increased from 60 acres to 80 acres. The additional treatment areas would be focused on expanding the current pilot treatment area, which is some of the densest in the lake. The focus on expanding the current area will ensure a more targeted treatment area, which will allow for monitoring results to be better quantified (Figure 6).

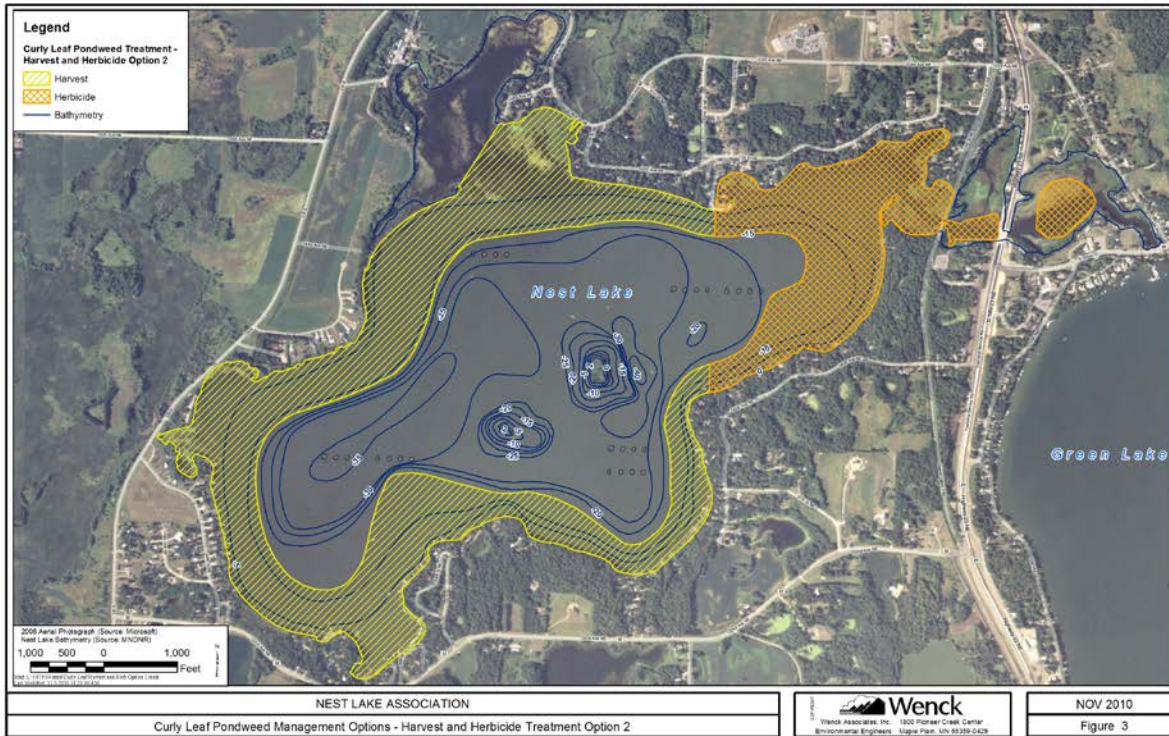


Figure 6: Harvest and Herbicide (80-acres) Alternative

The following assumptions have been made in addition to assumptions in Alternative #2:

- The additional 20 acres added to this alternative would be treated in 2014 and 2015. After 2015 spot treatments would occur every other year thereafter.

4.3.4 Alternative #4 – Whole-lake Herbicide Treatment (412 acres)

Alternative #4 would complete a whole lake herbicide treatment of the lake with an endothall product (Figure 7).

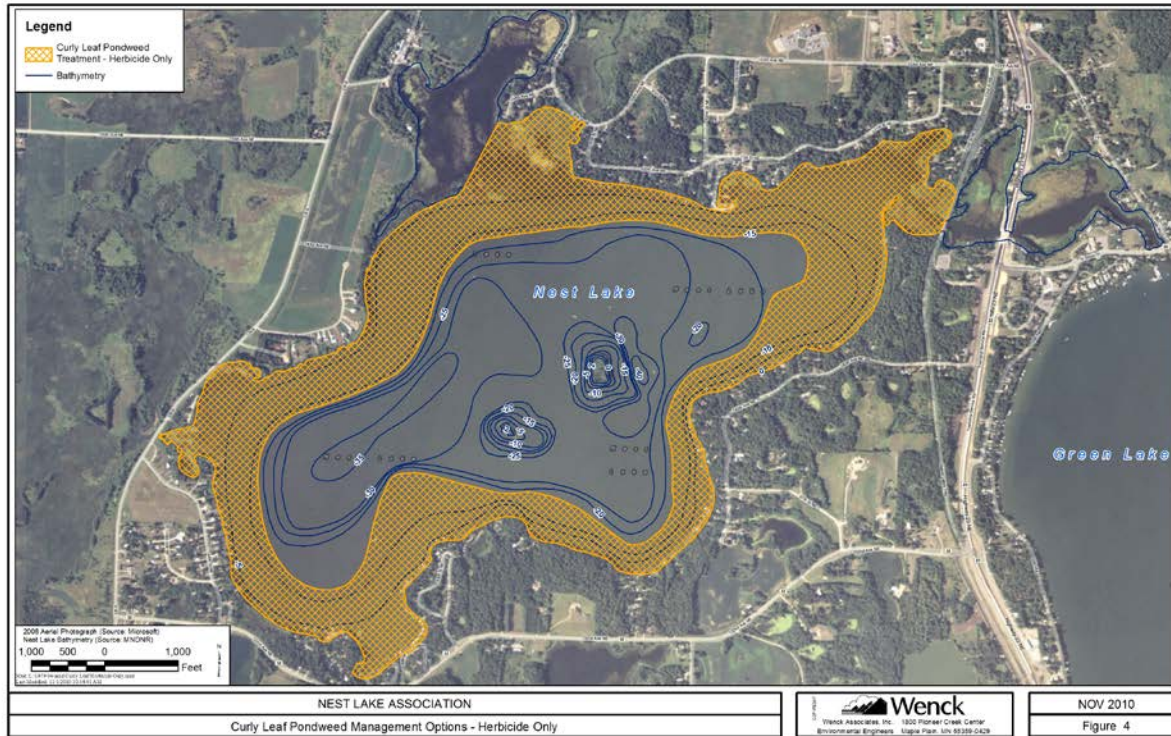


Figure 7: Whole-Lake Herbicide Treatment

Previously, herbicide applications have generally been limited to no more than 15% of the littoral area of a lake. Again, however, recent research has suggested that carried out properly, early-season low-dose applications of herbicides over most if not all the littoral area may be an acceptable management strategy that has minimal negative impact on the native plant community and provides more effective long-term control of the invasive. The treatments would be more aggressive the first three years and would be completed with spot treatments (10% of treated area) every other year there after. The lower percentage of spot treatment compared to Alternatives #2 & #3 is due to the fact the entire turion base would be treated, where as the other alternatives would only treat a portion requiring a more aggressive spot treatment. This alternative would then sell the existing harvesters and use the funds to supplement the project. It is estimated that the two harvesters could sell for \$29,000 combined. This estimate is based on market review and vendors quotes.

The following assumptions have been made in addition to assumptions in Alternative #2:

- The additional 352 acres above the pilot treatment area (60 acres) would be treated in 2014 and 2015. After 2015 spot treatments would occur every other year thereafter.

Table 1 shows a comparison of each of the scenario and areas treated.

**Table 1
Curley Leaf Pondweed Harvesting Alternatives Comparison**

Scenarios	#1	#2	#3	#4
Treated Area	200	260	280	412
Harvested Area	200	200	200	0
Herbicide Treated Area	0	60	80	412
Harvesting Personnel	2	2	2	0
Equipment Storage Sites	1	1	1	0

4.4 Other Considerations

Other considerations are discussed below with respect to equipment replacement schedules, selling and purchasing equipment new equipment, and staffing.

4.4.1 Equipment Replacement Schedules

The NLIA reported the existing harvesters have been rebuilt and are in good working condition. The older harvester is twenty-four years old and through regular maintenance has maintained a regular harvesting results. The newer harvester was purchased in 2009 and is a 2005 model. In all of the alternatives it was assumed one of the harvesters would be replaced in 2020. This assumption is based on NLIA having established an intensive maintenance program for their existing equipment. The life expectancy typically recommended by vendors is 15-20 years, as typically the harvester hull deteriorates resulting in replacement.

4.4.2 Disposal

NLIA currently contracts out disposal of harvested material. They have 10 sites around the lake where harvesters can dispose of the cuttings and have the material hauled away. The frequency of these drop-off points limits the need for transporters. As harvesting efforts increase so do costs associated with disposal as there is more material to dispose. Plant materials are disposed of at a local farm for incorporation into the soil.

4.4.3 Staffing

Staffing needs for the scenarios are presented in Table 4. NLIA currently uses a team of two for its harvesting operations. Alternatives #1-3 assume the two staff members would continue to stay employed for harvesting by the project. Under alternative #4 there would be no staff needed for harvesting as the herbicide treatments would be conducted by a contractor.

The MFCRWD and NLIA have arranged to develop an agreement that ensures the long-term operation of the harvesting equipment.

For each alternative it is assumed that MFCRWD staff would complete the permitting and with DNR and NLIA members complete monitoring associated with the management plan.

5.0 Recommendations

Recommendations for this project were based on managed area, equipment costs, annual operations and a 15-year life cycle to create present worth values. Present worth values are evaluated based on a cost per acre per year expense as can be seen in Table 2. Detailed cost breakdown per scenario are provided in Attachment 3. As shown on the table below the least expensive cost per acre per year is Alternative #4 – Whole-Lake Herbicide Treatment (412 acres). However, this alternative has the largest annual cost and is probably not practical when accounting for the economic burden this alternative would place on benefitted properties.

**Table 2
Cost Estimates by Scenario**

Alternative	Acres	Present Worth	Annual Cost	Cost/Acre/Year
1	200	\$342,247	\$22,816	\$114
2	260	\$431,736	\$28,782	\$111
3	280	\$479,810	\$31,987	\$114
4	412	\$562,099	\$37,473	\$91

Based on the results of the cost analysis and project acceptance it is recommended that MFCRWD proceed with Alternative 3 for management of aquatic plants in Nest Lake.

6.0 Management Plan

The “Management Plan” for this Engineer’s Report incorporates, by reference, the Nest Lake Management Plan, 2009. The Nest Lake Management Plan was prepared by a committee of the NLIA, the MFCRWD and DNR. A copy of the plan is included as Attachment 2.

Specific management plan elements as part of this Engineer’s Report include both components for harvesting and herbicide treatment:

HARVESTING

- **The targeted amount of harvesting.** This Engineer’s Report sets an annual goal of 200 acres.
- **Priority acres for harvesting.** The priority areas were established through a workshops and board meetings held by the NLIA throughout 2009 and 2010. The priority areas were communicated by Joel Peterson to Wenck Associates, Inc. via telephone conversation. The highest priority identified by the group was:
 - To enable navigation throughout the lake, andthe second highest priority was to:
 - To enable private access where possible depending on physical, permit and vegetation management plan limitations.

The group further identified the following **primary area** for harvesting in relation to the first priority – navigation.

1. Areas adjacent to the public boat launches on the eastern edge of the lake.

These primary areas along with other limitations are shown on Figure 6. The goal is to continue private access harvesting efforts at existing levels with some expanded efforts to account for future development on the lake. However, the bulk of the expanded harvesting enabled by this project will be for the priority navigation areas. The plan also continues to use a contractor to complete disposal of materials.

Equipment preparation will take place March and April of each year with on-lake harvesting activities typically beginning the second week of May. Harvesting will continue until the curly-leaf pondweed dies in early July or until July 15. Special provisions can be made annually through the permitting process with Minnesota DNR for harvesting of other nuisance plants.

HERBICIDE TREATMENT

A herbicide treatment area of 80 acres will be applied to targeted areas as shown in Figure 6 in April or May depending on the water conditions. Managed areas shall be treated for five continuous years and will then be treated through spot treatments every other year after that. The current pilot treatment area will be treated from 2010 – 2015 and the additional 20 acres will be treated from 2012 – 2017. The herbicide application will be applied by a contractor as approved by the DNR. The MFCRWD will work with NLIA and DNR to confirm treatment areas each year. Coordination among the groups will ensure the application is effective in meeting the goals of this plan.

MFCRWD and DNR will conduct monitoring after each treatment year to confirm effectiveness of treatments, distribution of remaining curly-leaf and reestablishment of native vegetation.

PROJECT FACILITATION

MFCRWD will serve as the lead agency for the implementation of the project, but will work closely with NLIA and DNR regarding operation.

MFCRWD and NLIA have established they will develop an agreement to address the use of harvesting equipment and staffing of harvesting equipment. Upon approval of this project a contract will be develop which enables the project to be completed.

The MFCRWD will work with NLIA and DNR to confirm harvesting and herbicide treatment areas annually. Coordination among the groups will ensure the application and harvesting are effective in meeting the goals of this plan.

SUMMARY

Alternative #3 is the recommended alternative. This alternative will require the purchase of one conveyor, and the application of herbicide over 80 acres on Nest Lake for three years and spot treatments every other year thereafter.

7.0 References

- Aquatic Ecosystem Restoration Foundation, 2003. Draft Best Management Practices Handbook for Aquatic Plant Management in Support of Fish and Wildlife Habitat (www.aquatics.org).
- Crowell, W. 2003. Curlyleaf Pondweed: New Management Ideas for an Old Problem.
- Eisterhold, J. and K. Uhler. 2009. Point Intercept Aquatic Plant Survey-Nest Lake (Draft). Division of Ecological Services, MN Department of Natural Resources.
- Jacobson, S., J. Ruter, C. Anderson, S. Wright, B. Gilbertson, and J. Eisterholt. 2009. Lake Management Plan – Nest Lake, Kandiyohi County, Minnesota.
- James, William F., J.W. Banks, and H.L. Eazin, 2001. Direct or Indirect Impacts of Submersed Aquatic Vegetation or the Nutrient Budget of an Oxbow Lake. ERDC TN-APCRP-EA-02.
- Middle Fork Crow River Watershed District (MFCRWD) 2007. Middle Fork Crow River Watershed District Watershed Management Plan (2007-2017).
- MN Department of Natural Resources. 2008. Pilot Projects to control curly-leaf pondweed or Eurasian water milfoil on a lake-wide or bay-wide basis for ecological benefits during 2009 – 2009 Pilot Grant Project Grant Program Announcement (published December 2008).
- Sauk River Watershed District 2005. Alternatives for Aquatic Plant Management. Prepared by Wenck Associates for the SRWD in April 2005 (Wenck File No. 0019-13)
- Sauk River Watershed District 2004. Big Sauk Lake Aquatic Plant Harvesting Project Engineer's Report. Prepared by Wenck Associates for the SRWD in March 2004 (Wenck File No. 0019-12)
- U.S. Environmental Protection Agency. 2005. Re-Registration Eligibility Decision for Endothall. EPA 738-R-05-008. September 2005.
- Wilson, B., S. Wright, B. Gilbertson, and M. Leach 2004. 2004 Update of the Diagnostic Study (2002) for the Middle Fork of the Crow River, Kandiyohi County.

Attachment 1

Nest Lake Improvement Association Petition (CIP #10-01)

**STATE OF MINNESOTA
MIDDLE FORK CROW RIVER WATERSHED DISTRICT**

**In Re: Nest Lake Curly Leaf Pondweed
Mechanical Harvesting Equipment**

Project Petition

For their petition to the Board of Managers of the Middle Fork River Watershed District, Petitioners state and allege the following:

1. Petitioners are the Nest Lake Improvement Association and property owners around Nest Lake.
2. The proposed project is intended to benefit all properties adjacent to Nest Lake, as well as all properties with deeded access to Nest Lake.
3. The Nest Lake Improvement Association is a volunteer and member based citizen action association organized in 1964 under Chapter 317 of the Minnesota Nonprofit Corporation Act, and with an open application for 501(c)(3) status.
4. The Petitioners have an interest in the basic water management function of the Middle Fork Crow River Watershed District and relies, in varying degrees, on the water resources of the District as source water and a significant natural amenity for its members.
5. The Petitioners recognize the need to manage water quality and quantity within the Middle Fork Crow River Watershed, including the management of invasive aquatic species, in order to balance future economic and social growth with the water and other natural resources found within the watershed.
6. The Nest Lake Improvement Association has worked with mechanical weed harvesting equipment since 1986 to deal with longstanding problems created by nuisance levels of aquatic vegetation; the Association has invested considerable human (volunteer) and economic resources to control the spread of curly-leaf pondweed.
7. The antiquated equipment the Nest Lake Improvement Association currently possesses is undersized for significant harvesting, is subject to frequent problems and must be replaced.
8. The Petitioners seek to work cooperatively with the District, the Minnesota Department of Natural Resources and other interested parties in order to form an aggressive curly leaf pondweed program, consisting of mechanical harvesting and chemical treatment as well as surveying and effectiveness monitoring (as presented in the Nest Lake Management Plan).

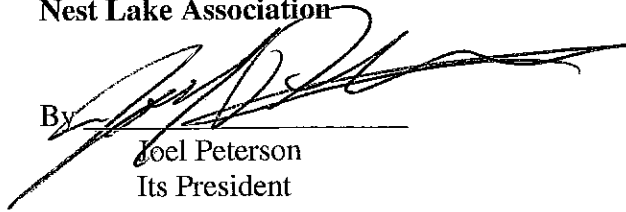
9. Petitioners believe that establishing a District project is necessary to facilitate the mechanical harvesting part of the Nest Lake curly leaf pondweed program, which is for the benefit of the public and the land and water resources of the region.
10. Petitioners believe that the project should entail the purchase of equipment required for mechanical harvesting of curly leaf pondweed:
 - a. Mechanical harvester (for cutting curly leaf pondweed);
 - b. Transport barge (to transport curly leaf pondweed from harvester to trailer);
 - c. Trailer with live bottom (for transportation of harvester and for disposal of curly leaf pondweed at compost site);
 - d. Vehicle for trailer transportation; and
 - e. Funding for personnel to operate curly leaf pondweed removal program.
11. Petitioners believe that the project will be conducive to public health, convenience, and welfare by:
 - a. Reducing the occurrence of curly leaf pondweed to non-nuisance levels (reduction of the degree and severity of vegetative mats, which hamper boating, fishing and swimming);
 - b. Reducing the severity and frequency of nuisance algae blooms as a result of phosphorus release into the water column from decomposing curly leaf pondweed (also a factor in recreational opportunities);
 - c. Reducing the degree and severity of anaerobic or anoxic conditions in the lake's hypolimnion as a result of (b) above (due to impacts on fish populations as a result of depleted dissolved oxygen concentrations); and
 - d. Reduce the negative impacts on property values as a result of prolific curly leaf pondweed infestation
12. The actions petitioned as part of this project are consistent with Minnesota Statutes Chapter 103D, the Watershed District's Watershed Management Plan, and the policies and bylaws of the Nest Lake Improvement Association.
13. Petitioners understand that the cost of the project, including the preliminary costs of project establishment, will be paid according to Minnesota Statutes Chapter 103D and Petitioners agree to be bound by the provisions of the statute.
14. Petitioners request that the Watershed District follow the procedures of Minnesota Statutes Section 103D.705 in establishing the Project.
15. This petition may be executed in counter-parts, which together shall be deemed a complete and conforming petition.

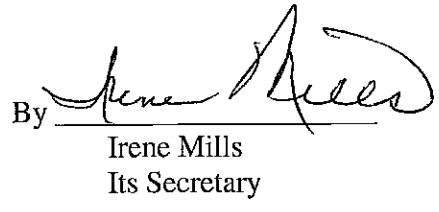
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The signature of the Nest Lake Improvement Association is supported by duly adopted resolution of the Nest Lake Improvement Association governing body, a copy of which is attached to this petition.

Dated 1-5-10

Nest Lake Association

By 
Joel Peterson
Its President

By 
Irene Mills
Its Secretary

Attachment 2

Nest Lake Management Plan

Nest Lake, Kandiyohi County, Minnesota

Lake Management Plan



S. Jacobson, Middle Fork Crow River Watershed District

J. Ruter, Nest Lake Improvement Association

C. Anderson, Middle Fork Crow River Watershed District

S. Wright, Minnesota Department of Natural Resources

B. Gilbertson, Minnesota Department of Natural Resources

J. Eisterhold, Minnesota Department of Natural Resources

Mission Statement:

The mission of the Nest Lake Improvement Association and this lake management plan is to protect and enhance the watershed resources for today and tomorrow by guiding citizen actions to restore Nest Lake to the highest achievable ecological standard.

Lake and Lakeshed Description

Nest Lake is located in Kandiyohi County, about two miles north of Spicer, Minnesota. It is classified by the Minnesota Department of Natural Resources (MN DNR) as a general development lake with regards to the lake shoreland and is assigned to Lake Class 27. Lakes in Class 27 are typically moderately deep, productive lakes with hard water and regular shorelines. The lake identification number of Nest Lake is 34-0154. Its legal description is Kandiyohi County, Township 121 North, Range 34 West, Sections 20, 21, 22, 27, 28, 29, 32, and 33. The center of Nest Lake is located at Township 121 North, Range 34 West, Section 28. According to Kandiyohi County, as of 2008, there are 204 parcels on Nest Lake, 187 of which are residential.

A watershed can be defined as an area of land above a specific location from which all water drains to that location. Nest Lake lies within the larger Middle Fork Crow River watershed. When the specific location receiving the water is a lake, the watershed is sometimes referred to as a lakeshed. The lakeshed of Nest Lake is 78,765 total acres; Nest Lake is 945 acres and 77,820 acres lie outside of Nest Lake (MFCRWD, 2006). The lakeshed area to lake area ratio is 79 to 1. The average depth of the lake is 15 feet, with a maximum depth of 40 feet. The littoral area of the lake, that which is 15 feet or less in depth is 525 acres, which is 56 percent of the total lake. Nest Lake has 5.5 miles of shoreline and there are 47 lakes and wetlands within the lakeshed area of Nest Lake (McComas, 2002). Two islands on the main lake have been transferred from the Bureau of Land Management to the MN DNR and are managed as Aquatic Management Areas (AMA). AMAs are areas of land acquired and managed by the Department of Natural Resources (DNR) to protect lakes, rivers, streams, wetlands, and other areas of land that are critical for fish and other aquatic life, water quality, public fishing, or other outdoor recreational uses (AMAAPC, 2007).

Nest Lake is located along the Middle Fork Crow River, so that the river acts as both the inlet and the outlet of the lake. The construction of dams on the Middle Fork Crow River at the inlet to Green Lake and at the present City of New London in 1867 enlarged Nest Lake. When Nest Lake was surveyed in 1857, it had an area of 734 acres, about 211 acres less than the current area. In terms of geological time, Nest Lake is young and therefore experiencing shoreline erosion (McComas, 2002). The topography of the lakeshed is dominated by rolling moraines which are part of the Alexandria Moraine Complex. The area is characterized by forested areas, lakes, and wetlands and elevation within the lakeshed is generally between 1,150 and 1,300 feet above sea level (Kandiyohi County, 2003).

Map 1A in appendix A shows the general location of the Middle Fork Crow River, major lakes, roads, municipalities, major watersheds, and legal boundaries of the Middle Fork Crow River watershed. Map 1B in appendix A indicates the major and minor sub-watersheds of the Middle Fork Crow River watershed. Major watersheds one, two, three, four, and five comprise the Nest Lake lakeshed. The topography of the entire Middle Fork Crow River watershed is shown in map 1L in appendix A.

Nest Lake Improvement Association, Inc

The Nest Lake Improvement Association, Inc was formed in 1967 by a group of concerned lake residents with the goal of improving water quality. In 1986 the Association purchased a lake weed harvester to deal with the longstanding problems created by nuisance levels of aquatic vegetation. At the time, giant coontail was the most problematic weed throughout the lake. The Association became less active and the harvester was frequently unused for a number of years due to a combination of problems with the used equipment and finding volunteer labor. In 2000, another group of dedicated lake residents resurrected the

inactive Association and its harvesting equipment. Invasive curly-leaf pondweed had become the aquatic vegetation needing management. Although each year since 2000 has resulted in more and more harvesting of curly-leaf pondweed, the weed continues to assist in degraded water quality and interferes with recreational opportunities on the lake. The Nest Lake Improvement Association, Inc is concerned about the overall health and water quality of the lake and continues to be active in monitoring the water quality as well as seeking ways to improve the ecological wellness of Nest Lake.

Presettlement vegetation

The MN DNR has inventoried the original vegetation of Minnesota through their Presettlement Vegetation Database (2006). According to the Presettlement Vegetation Database, the Nest Lake lakeshed was a unique mixture of forest and prairie prior to settlement. A large area of forested land stretched through the basin, from Belgrade southeast to Diamond Lake. Deciduous trees such as aspen, oak, maple, basswood, and hickory were common before settlement, as they are today. Forest ecosystems transitioned to prairie with buffers of oak openings and barren vegetation. The outer areas of the lakeshed were dominated by prairie vegetation. The deep soils of the moist uplands provided habitat for big bluestem and Indian grass while the thin soils of the dry uplands were covered with little bluestem and side oats grama. Generally, the lowland areas and wetlands were dominated by bluejoint, prairie cordgrass, rushes, and sedges. Fires, more than topography, influenced the location and boundaries of the different vegetative covers. Forests were highly susceptible to fire, and therefore their boundaries were largely controlled by the frequency of fires. Forested areas were restricted to locations where natural firebreaks such as rivers and lakes prevented the spread of fire from the adjacent prairie lands (Kandiyohi County, 2003). Map 1K in appendix A depicts the presettlement vegetation throughout the Middle Fork Crow River watershed. The Nest Lake lakeshed includes sub-watersheds one, two, three, four, and five of the Middle Fork Crow River watershed area.

Public Access

There are two public lake accesses on Nest Lake. A concrete public access is located on the west shore off Kandiyohi County Road 9. The second access is located near the east end of the lake near the state trail bridge crossing, off a frontage road south of the Minnesota State Highway 23 bridge. This concrete access was reconstructed when the highway was expanded and now includes double ramps and ample parking. Both accesses are owned and maintained by the MN DNR.

Water Level Management – Nest Lake to Green Lake

The dam located at the Olde Mill Inn Resort controls water levels on Nest Lake. The structure, which was originally used to mill flour and has been in existence for nearly 150 years, is owned and operated by the Olde Mill Inn Resort. It has a contributing watershed of 78,720 acres and serves as the primary inlet to Green Lake.

The Nest Lake Dam is a concrete structure with two bays containing wooden stop logs. The top of the stop logs equals 1165.4 (N.G.V.D. 1929) when all stop logs are in place. The highest known elevation (1166.7) occurred on June 20, 1986 with the lowest level (1162.8) occurring on November 12, 1976. The average level is 1165.4.

The state owned dam in New London, located about five miles upstream from Nest Lake on the Middle Fork Crow River, is the primary water control structure on the inlet to Nest Lake. The New London Dam is classified as a High Hazard Dam and is managed strictly according to an operating plan developed to address dam safety concerns and for maintaining a normal pool of 1203.5 (N.G.V.D. 1929) on Lake Monongalia. It has a contributing watershed of 65,920 acres.

The New London Dam has a concrete spillway with two vertical slide gates, which can be raised and lowered by an electric motor. The structure is operated by MN DNR Fisheries staff and like the Nest Lake Dam had its beginnings as a flour mill dam about 150 years ago.

Both of the dams are operated on a “run of the river” basis, meaning that when water levels exceed the normal lake elevations, water is released downstream. MN DNR Fisheries coordinates their operation of the New London Dam with the Manager of the Olde Mill Inn Resort. So when outflow is adjusted at the New London Dam an equivalent amount of water is released from the Nest Lake Dam so that outflows are matched as closely as possible.

A minimum flow of one to five cubic feet per second is maintained at the New London Dam during periods of low flow with the exception of periods of extreme drought. Similar minimum flows are maintained at the Olde Mill Inn through a small gate, which at one time was used for hydropower production.

Current plans to replace the New London Dam in 2009 include maintaining existing flow conditions even though the new structure will have a fixed crest with no operable gates. A v-notch weir will be installed in the new dam to maintain minimum flows. Discharge data from the New London Dam will be provided to the operators of the Olde Mill Inn Resort so that “run of the river” conditions are continued.

Lower than normal summer rainfalls during five of the last eight years have caused low water levels on Nest Lake. This has created problems for shoreline owners trying to maintain boat access to navigable depths. Similar conditions have been experienced on many lakes throughout Kandiyohi County (Wright, 2008).

Water Level Management – George Lake to Nest Lake

Prior to 1992, the connection between George Lake and Nest Lake included a 48 inch culvert which passed under Kandiyohi County Road 32. When the road was rebuilt in 1992, the 48 inch culvert was replaced with a 36 inch diameter, 110 foot long corrugated metal pipe culvert with ten foot aprons. Because the old culvert had been filling with sand, the MN DNR requested that the elevation of the new culvert be raised. The highway department complied, and the height of the culvert invert on the George Lake end was raised from 1162.5 feet to 1164.13 feet while the height of the culvert invert on the Nest Lake end was raised from 1161.9 feet to 1163.13 feet.

Before 1992, exchange of water between the lakes would have occurred at elevation 1161.9 feet. At the present time, exchange does not occur until the elevation of either lake reaches 1164.13 feet. An influencing factor on the free exchange of water between George and Nest lakes is the small wetland which lies between Kandiyohi County Road 32 and Nest Lake (McComas, 2002).

Geology

The Nest Lake lakeshed is underlain with rocks of pre-Cambrian age (older than 500 million years), Cretaceous age (65 to 130 million years), and Quaternary age (1.8 million years to present). In many areas a layer of sedimentary rock, usually less than 100 feet, overlies the pre-Cambrian rocks. A mantle of Quaternary age glacial drift overlies the bedrock of the entire lakeshed area. The glacial drift ranges in thickness from 125 to 500 feet (MFCRWD, 2006). As glaciers advanced across Minnesota, they picked up everything in their path, from large boulders to fine clay particles. As they melted and retreated northward, the material carried by the glaciers was left behind. Such deposits form the parent materials from which the soils of the lakeshed have been derived.

Nest Lake is categorized as ice-block basins in till. This means that the basins were created as a result of the melting of huge ice blocks that were buried in the glacial drift 10,000 years ago. Ice blocks that became stagnated and detached from the main glacial ice mass were buried under debris. When the main glacier

retreated, the buried ice blocks melted and left depressions that are now occupied by water (MFCRWD, 2006). The dominant bottom substrate of Nest Lake is sand, detritus, and gravel (MN DNR, 2003).

Soil Types

The majority of soils within the Nest Lake lakeshed are coarse textured sand outwash with a lesser percentage of glacial till soils. There are three soil associations in the lakeshed: Estherville-Hawick-Lena, Koronis-Hawick-Sunburg, and the Regal-Osakis (Kandiyohi County, 2003).

According to the United States Department of Agriculture Natural Resources Conservation Service (NRCS), Estherville and Hawick soils are loamy and sandy soils that are well drained to excessively drained (2008). They are formed from outwash and vary in slopes from 0 to 35 percent. The Lena soil is a very poorly drained organic soil. Erosion from wind and water are associated with these soils. The Koronis-Hawick-Sunburg soil association soils are moderately sloping to very steep. The Koronis and Sunburg soils are formed in glacial till, while the Hawick soils form in outwash. They are generally well drained to excessively drained soils. The soils in the Regal-Osakis soil association are nearly level sandy to loamy soils formed in glacial outwash. The Regal soil is poorly drained, but the Osakis soil is moderately well drained. Wind erosion is a problem associated with the Regal-Osakis soil association (USDA, 2008). Map 1J in appendix A shows the major soil associations throughout the Middle Fork Crow River watershed. Sub-watersheds one, two, three, four, and five make up the lakeshed area of Nest Lake.

Aquifers

Aquifers are defined as water-bearing porous soil or rock strata that yield significant amounts of water to wells. There are two principal aquifer types in the lakeshed: glacial drift and bedrock. Glacial drift aquifers are usually unconfined and have well depths ranging from 30 to 500 feet deep. These aquifers generally have yields ranging from 25 to 500 gallons per minute. Although the water in glacial drift aquifers is typically of good quality, some areas have high concentrations of iron and manganese. Nitrate contamination can also be a significant concern. Bedrock aquifers are typically confined and have well depths ranging from 340 to 500 feet deep. The yields from such aquifers typically range from 10 to 250 gallons per minute. The water in bedrock aquifers is generally hard, meaning that there are significant concentrations of mineral salts such as calcium and magnesium. Approximately 80 percent of the lakeshed is supplied by glacial drift aquifers (MFCRWD, 2006).

Watercourses

Watercourses within the Nest Lake lakeshed include streams, lakes, drainage ditches, tile lines, and city stormwater. The Middle Fork Crow River originates in Crow Lake near Belgrade and enters into Nest Lake just downstream of New London. According to the 2004 Kandiyohi County Ditch map, Judicial Ditch 3 and Kandiyohi County Ditch 37 also fall within Nest Lake's lakeshed. The lakes in the lakeshed include: Bear, Crow, Eight, Fish, George, Long, Monongalia, Shoemaker, Skull, and Stony lakes. An extensive network of public drainage ditches has been established throughout the agricultural areas of the lakeshed. Such systems serve as conveyance systems for surface water and as outlets for tile lines. There are 46 miles of public drainage ditches in the lakeshed (MFCRWD, 2006).

Stormwater from both Belgrade and New London also enters the river upstream of Nest Lake. The City of New London spreads over 796 acres and Belgrade covers 372 acres. In 2000 New London's impervious surfaces increased to 187 acres of the city's 657 acres, which is a 27 percent increase from the 147 acres of impervious surface in 1990 (Wilson, 2004). Such large areas of impervious surface greatly increase the amount of stormwater that runs off residential properties, streets, parking lots and other impermeable areas. That stormwater drains down storm drains and into the river. A higher concentration of phosphorus is often associated with stormwater runoff; therefore, phosphorus loading into local water bodies can be reduced by

decreasing stormwater runoff by implementing practices such as holding ponds and raingardens. High amounts of impervious surfaces also show a strong potential to cause irreversible degradation to streams (Wilson, 2004). Map 1C in appendix A shows the lakes and streams within the Middle Fork Crow River watershed. The lakes and streams in sub-watersheds one, two, three, four, and five are part of the Nest Lake watershed.

Fish Management

Past Management:

Nest Lake supports a multi-species fishery with walleye considered the primary species managed. Although walleye natural reproduction occurs during most years as measured by annual fall electrofishing, supplemental fingerling stocking may periodically be needed to sustain survey catches at or near nine or more walleye per gillnet. Nest Lake may be placed on the 'contingent' stocking list after a poor year of natural reproduction (as measured by fall electrofishing) if other factors such as forage levels, latest survey catch indices, etc. warrant.

Secondary species in Nest Lake can offer excellent angling opportunities. Bluegill and smallmouth bass angling, especially for larger fish, has improved in recent years. Reports of good angling for largemouth bass and northern pike are also common. Black crappie angling tends to be more cyclic. Angling pressure has been measured at very high levels. Creel surveys in the 1980s estimated 75 to 100 angler hours per acre of water on Nest Lake. A creel survey is a survey of fishermen to determine the type of species and number of fish captured in a specific region over a specified time.

Historically, fish management has consisted of various fish stocking and limited removal activities. Removal activities have consisted primarily of a commercial inlet trap operation (primarily carp harvested). A state operated walleye egg-take site was operated at the inlet trap from the 1970's through the early 1990's. Walleye fry stocking occurred in years of egg-take operations (10 percent of the eggs were returned to Nest Lake as fry). Walleye fingerlings were also regularly stocked at relatively low rates (0.5 to 1 pound per littoral acre). The last winter rescue northern pike stocking occurred in 1982. A northern pike spawning area near the south shore inlet was operated from 1991 through 1999 (Gilbertson, 2008).

Limiting Factors:

Blue-green algae blooms occur periodically during the summer months. Submerged aquatic vegetation, while important for water quality and fish habitat, grows at nuisance densities for recreation at various locations, and curly-leaf pondweed has developed dense stands at several locations, especially the north and northwest bay. Siltation has been a problem where the Middle Fork Crow River enters Nest Lake. Shoreline bank erosion is a problem in various locations (Gilbertson, 2008).

Present Fish Management:

Spicer Area Fisheries conducts fish population assessments and lake surveys on a four to five year rotation. A fish population assessment was conducted in 2008. MN DNR Fisheries utilizes annual fall electrofishing to determine walleye stocking needs. Fisheries will evaluate the goal of maintaining nine or more walleye per gillnet (which is above the 75th percentile for similar Lake Class 27 lakes), after the 2012 Lake Survey. Fisheries will consider potential stocking of other fish species if their abundance remains below Lake Management Plan goals for consecutive surveys, or consider options for experimental regulations to improve abundance or quality size. Regulation changes would be considered only after consultation with the Nest Lake Improvement Association and local interest groups. At this time, there does not appear to be local support for experimental regulations targeted at any particular species. Fisheries will continue to protect critical habitat through the Division of Waters permit review, Aquatic Plant Management permit process, land acquisition,

environmental review, and participation in watershed initiatives. Lakeshore property owners are encouraged to work with the MN DNR Shoreline Habitat Specialist, watershed district and local government agencies to restore degraded shore areas (Gilbertson, 2008). The latest fish population assessment or Lake Survey information can be obtained by contacting the Spicer DNR Fisheries office at (320) 796-2161, or on the DNR Website at www.dnr.state.mn.us.

Aquatic Vegetation

According to MN DNR Aquatic Vegetation Surveys which date from 2008 back to 1954, there are 39 different species of aquatic plants in Nest Lake. Of these, both curly-leaf pondweed and reed canary grass are listed as invasive species by the MN DNR. Despite the recorded abundance rating of rare to common on many of the aquatic vegetation surveys, curly-leaf pondweed is very prolific throughout spring and early summer months and historically becomes a nuisance for lake residents and recreational users. It usually dies back by early July, and therefore wasn't sampled in most late summer aquatic plant surveys.

The most common native plants, according to the MN DNR Aquatic Vegetation Surveys, include coontail, northern water milfoil, flat-stem pondweed, and filamentous algae. Numerous other native plant species are listed in the vegetation surveys, but frequently have a rare abundance in the lake. The following table lists the aquatic plants found in Nest Lake, as reported by the MN DNR through their aquatic vegetation surveys from 1999 through 2008.

Common Name	Scientific Name	Type	Abundance Rating
Arrowhead Group	Sagittaria spp.	Emergent	Rare
Bladderwort	Utricularia spp.	Submergent	Rare
Blue-green algae		Submergent	Rare
Bushy Pondweed	Najas flexilis	Submergent	Rare
Canada Waterweed	Elodea canadensis	Submergent	Rare
Cane	Phragmites australis	Terrestrial	Rare
Cattail Group	Typha spp.	Emergent	Rare
Clasping-leaf Pondweed	Potamogeton rishardsonii	Submergent	Rare
Coontail/Common hornwort	Ceratophyllum demersum	Submergent	Common
Curly-leaf Pondweed	Potamogeton crispus	Submergent	*Rare
Filamentous algae		Submergent	Common
Flat-stem Pondweed	Potamogeton zosteriformis	Submergent	Common
Floating-leaf Pondweed	Potamogeton natans	Floating-leaf	Rare
Fries' Pondweed	Potamogeton friesii	Submergent	Rare
Green-fruited Burreed	Sparganium chlorocarpum	Emergent	Rare
Hardstem Bulrush	Scirpus acutus	Emergent	Rare
Iris Group	Isis spp.	Terrestrial	Rare
Jewelweed Group	Impatiens spp.	Emergent	Rare

Leafy Bulrush	Scirpus atrovirens	Emergent	Rare
Leafy Pondweed	Potamogeton foliosus	Submergent	Rare
Lesser Duckweed	Lemna minor	Free-floating	Rare
Muckgrass Group	Chara spp.	Submergent	Rare
Needlerush Group	Juncus spp.	Emergent	Rare
Northern Milfoil	Myriophyllum exalbescens	Submergent	Common
Reed Canary Grass	Phalaris arundinacea	Terrestrial	Rare
River Pondweed	Potamogeton nodosus	Submergent	Rare
Sago Pondweed	Potamogeton pectinatus	Submergent	Rare
Smartweed Group	Polygonum spp.	Emergent	Rare
Spikerush Group	Eleocharis spp.	Emergent	Rare
Star Duckweed	Lemna trisulca	Free-floating	Rare
Swamp Milkweed	Asclepias incarnate	Terrestrial	Rare
Three-square species Group	Schoenoplectus spp.	Emergent	Rare
Water (wild) Celery	Vallisneria americana	Submergent	Rare
Water Meal	Wolffia columbiana	Free-floating	Rare
Water Moss Group			Rare
White Water Buttercup Group	Ranunculus aquatilis	Submergent	Rare
White Waterlily Group	Nymphaea spp.	Floating-leaf	Rare
Wild Rice	Zizania aquatica	Emergent	Rare
Yellow Waterlily Group	Nuphar spp.	Floating-leaf	Rare

** Typical surveying occurs in late summer, which is during the time when curly-leaf pondweed has already died back and is beginning to release turions. The MN DNR intends to maintain late summer surveying for historic and comparison purposes; however, they also intend to include additional early summer surveys to better identify the abundance of curly-leaf pondweed.*

Other Exotic Plant Species

In addition to curly-leaf pondweed and reed canary grass, there are several other non-native species that pose a threat in the lakeshed. The MN DNR has identified three species, including purple loosestrife, flowering rush, and yellow iris in the lakeshed of Nest Lake. The MN DNR is the primary agency addressing concerns related to these species through educational programs targeted primarily to boaters and lake residents (MFCRWD, 2006).

Curly-leaf pondweed

Curly-leaf pondweed is a non-native aquatic plant that was introduced into North America in the late 19th century. It was first discovered in Minnesota in 1910 and has been documented in over 540 lakes statewide, including Nest Lake (Moyle, 1945). The plant reproduces and spreads very successfully in Minnesota because it does not have any of its native predators as is does in Europe.

It generally prefers soft sediments; however, it grows in waters that are shallow or deep, still or flowing. Curly-leaf pondweed thrives in areas where many other aquatic plants do not, such as shaded, disturbed, polluted, or turbid waters. Typically, curly-leaf pondweed does not grow in waters deeper than 15 feet. New curly-leaf pondweed plants germinate and begin to grow during the fall. As part of its unique lifecycle, curly-leaf pondweed remains alive during the winter and is therefore the first species to appear after ice-out in the lake. Dense mats are often formed by the curly-leaf in late spring and early summer, interfering with swimming, boating, and other recreational activities. The weed produces turions, its version of seeds, during the early summer weeks. The turions are dispersed when the weed dies back in mid-summer (Wehrmeister, 1978). Subsequent decomposition of the curly-leaf pondweed contributes phosphorus to Nest Lake (MFCRWD, 2006). The turions lay dormant in the lake sediment throughout the summer when most native aquatic plants are growing, and then germinate in the fall when most native vegetation has died back (Catling, 1985). If the turions do not germinate during the first fall, they can remain viable in the lake bottom for up to five years and germinate in another year. According to both the MN DNR and the Middle Fork Crow River Watershed District (MFCRWD) Watershed Management Plan, long-term management of curly-leaf pondweed will require the reduction of turions to interrupt its life cycle. There is some evidence that early season cutting near the sediment surface or treatment with an Endothall herbicide when water temperatures are between 50 and 60 degrees Fahrenheit can prevent turion production (MFCRWD, 2006; Skagerboe et al., 2008).

In 1986, a lake weed harvester was purchased by the Nest Lake Improvement Association in an effort to mitigate the long-standing problems created by the profusion aquatic vegetation. In 2008, 116 loads of approximately three cubic yards of curly-leaf pondweed each were removed from the lake. Possible alternatives for treating curly-leaf pondweed are discussed further in the goals and objectives section of this plan. The table in Appendix B compares mechanical harvesting to herbicides as developed by Chip Welling, MN DNR (2003).

Phosphorus

Many lake study findings have concluded that phosphorus is the key nutrient to manage in order to meet and maintain water clarity and algae goals. Phosphorus is the critical factor influencing algae blooms and nuisance levels of curly-leaf pondweed. One pound of phosphorus can create 500 pounds of algae or other aquatic vegetation (Struss, 2003). Algae and aquatic plants use phosphorus and therefore their bodies contain phosphorus. When plants and algae die and decay, the organic phosphorus is released into the water column. The organic phosphorus will then follow two paths; it may bind with sediments in the water and settle to the lake floor, or it may be taken up by bacteria and converted into an inorganic form. Algae and plants can then use the inorganic phosphorus to grow and propagate (EBC, 2008).

The main sources of phosphorus to Nest Lake are from the Middle Fork of the Crow River (49 percent), and internal sources/lake sediments (36 percent). Phosphorus inputs from septic tanks had been estimated at 10 percent of the total phosphorus; however, such inputs will be eliminated with the completion of the sanitary sewer line around Nest Lake in 2009. Another source of phosphorus was eliminated when the Green Lake Sanitary Sewer District was relocated from upstream of Nest Lake to downstream of the lake (Wilson, 2004). According to the Resource Investigation of the Middle Fork Crow River Watershed, above average phosphorus loads in stormwater runoff situations are occurring at an area between the New London Dam and where the Middle Fork of the Crow River crosses County Road 40 near New London. The same study states that lake sediments can be a significant source of phosphorus for Nest Lake (McComas, 2002). Internal loading of phosphorus is occurring in Nest Lake (MFCRWD, 2006). There is phosphorus bound to the sediment on the lake floor. When the water becomes anoxic, a condition of very low dissolved oxygen, phosphorus is released from the sediment back into the water column. When the dense mats of curly-leaf pondweed die

during mid-summer, oxygen in the water is used by the bacteria to break down the dead plants. Anoxic conditions often result during this process. The subsequent release of phosphorus, both from the sediment and from the curly-leaf pondweed, becomes available for algae blooms and aquatic vegetation. Anoxic conditions may also lead to fish kills (EBC, 2008).

For many years, the Middle Fork Crow River has been a source of sediment from areas upstream of Nest Lake. Over time, the sediment has accumulated in the bay where the river enters the lake. Sediment enters the river through stormwater, erosion, or other sources and is carried by the moving water downstream. When the river enters Nest Lake and the velocity of the water is reduced, the sediment settles out of the water and accumulates. Identifying the sources of sediment, and finding ways to reduce the sediment entering the river upstream of Nest Lake would reduce the amount of sediment delivered to the lake. According to the University of Minnesota Extension, when soil particles are carried to a river or lake, phosphorus will be contained in this sediment (Bushman, 2002). Phosphorus in soils is associated more with fine particles than coarse particles. Small clay particles allow more phosphorus to bind with them than larger sand particles. When soil erosion occurs, more fine particles are removed than coarse particles, causing sediment leaving a soil through erosion to be rich in phosphorus. Vegetative filter strips, including filter strips and native shorelines, have been shown to effectively remove sediment and nutrients from runoff (Leeds). According to the University of Ohio, studies have shown up to 95 percent of sediment, 83 percent of phosphorus, and 87 percent of nitrogen can be removed from runoff by the implementation of filter strips. Protecting existing natural shoreland and restoring developed shorelands along Nest Lake and the Middle Fork Crow River has the potential to greatly reduce the amount of nutrient-laden sediment entering Nest Lake.

Monitoring Data

The United States Environmental Protection Agency (EPA) has distinguished the major ecoregions of the United States based on soils, landform, potential natural vegetations, and land use (EPA, 2008). The entire lakeshed of Nest Lake falls within the North Central Hardwood Forests ecoregion. Water quality standards have been established for lakes and rivers within each ecoregion.

Many years of monitoring data have been collected and recorded for Nest Lake. Water quality in the lake is directly tied to what is happening on the land throughout the lakeshed. Several parameters have received more consistent attention and are utilized by regulatory agencies as being significant indicators of water quality conditions. The parameters include secchi disk, chlorophyll, and total phosphorus. The following three graphs illustrate the trends in Nest Lake for such parameters.

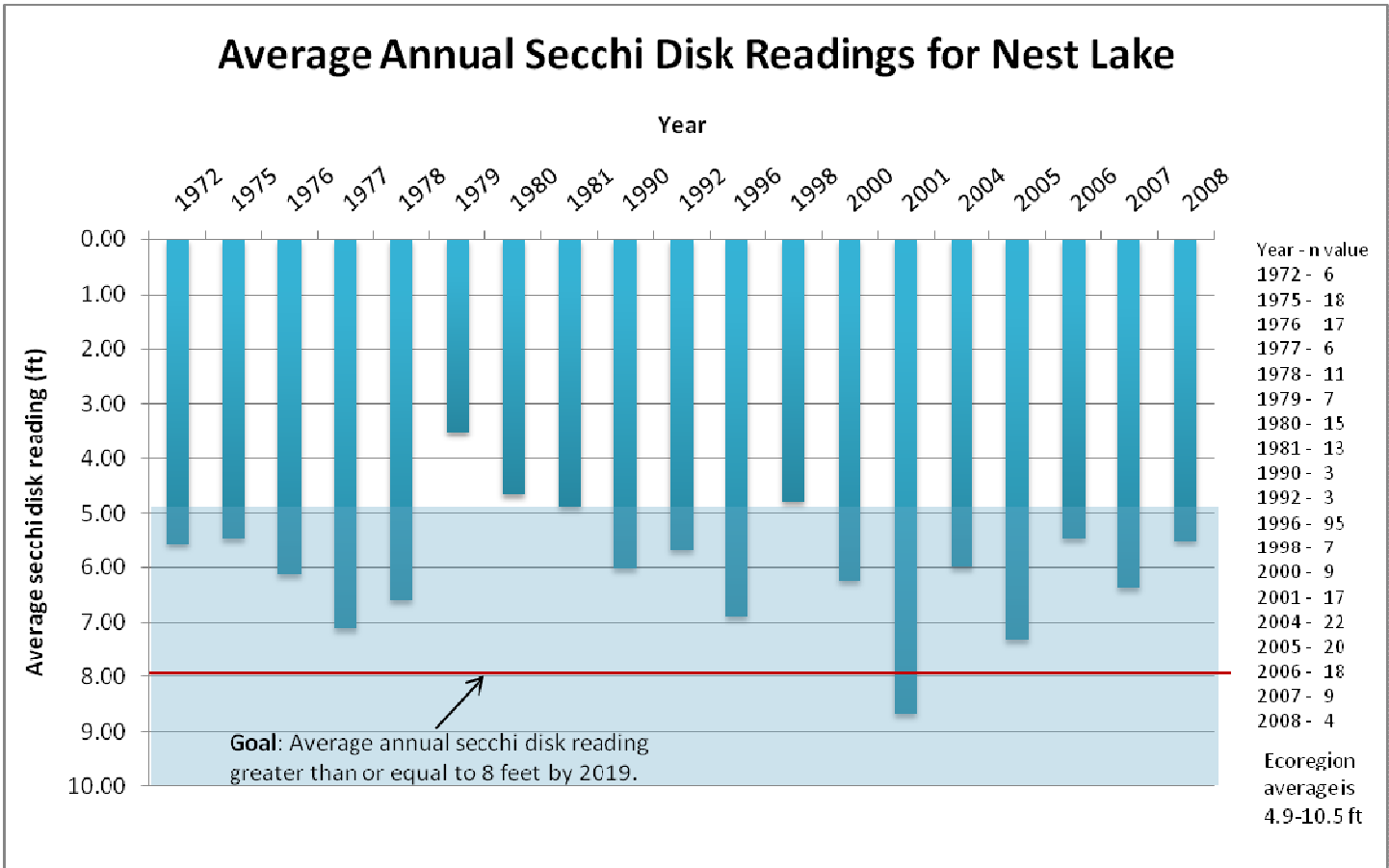


Figure 1. Figure 1 shows the average annual secchi disk readings for Nest Lake for non-consecutive years beginning in 1972 and ending in 2008. Secchi disk readings are measured in feet. The n values, the number of secchi disk readings per year, are also indicated in Figure 1. The ecoregion average for secchi disk is 4.9-10.5 feet. Four years have an average annual secchi disk reading that do not meet the ecoregion average.

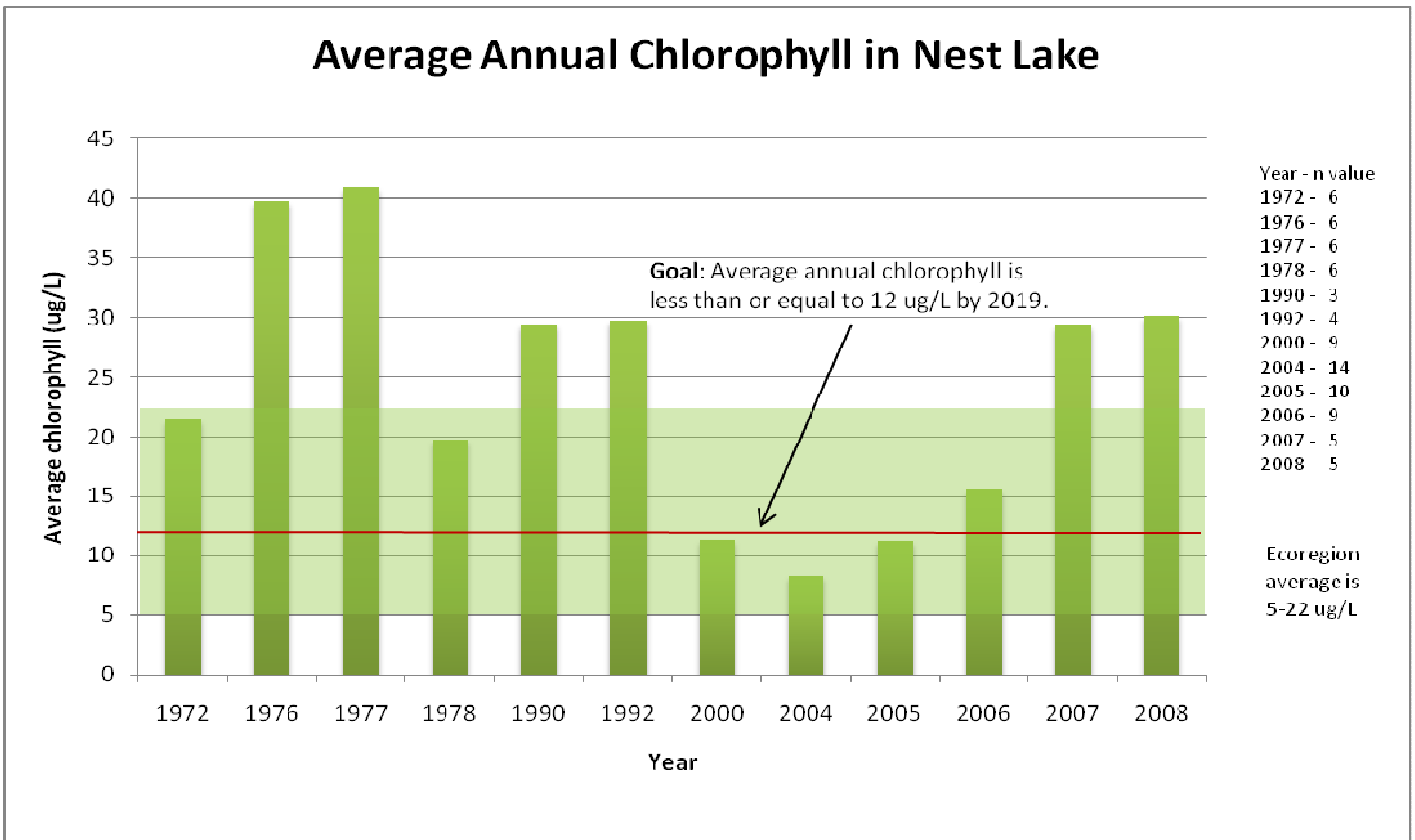


Figure 2. Figure 2 shows the average annual chlorophyll level in Nest Lake for non-consecutive years beginning in 1972 and ending in 2008. Chlorophyll is measured in micrograms of chlorophyll per liter of water. The n values, or the number of chlorophyll readings per year, are also indicated in Figure 2. The ecoregion average for the North Central Hardwood Forests for chlorophyll is 5-22 micrograms per liter. Half of the annual averages in Figure 2 are within the ecoregion average.

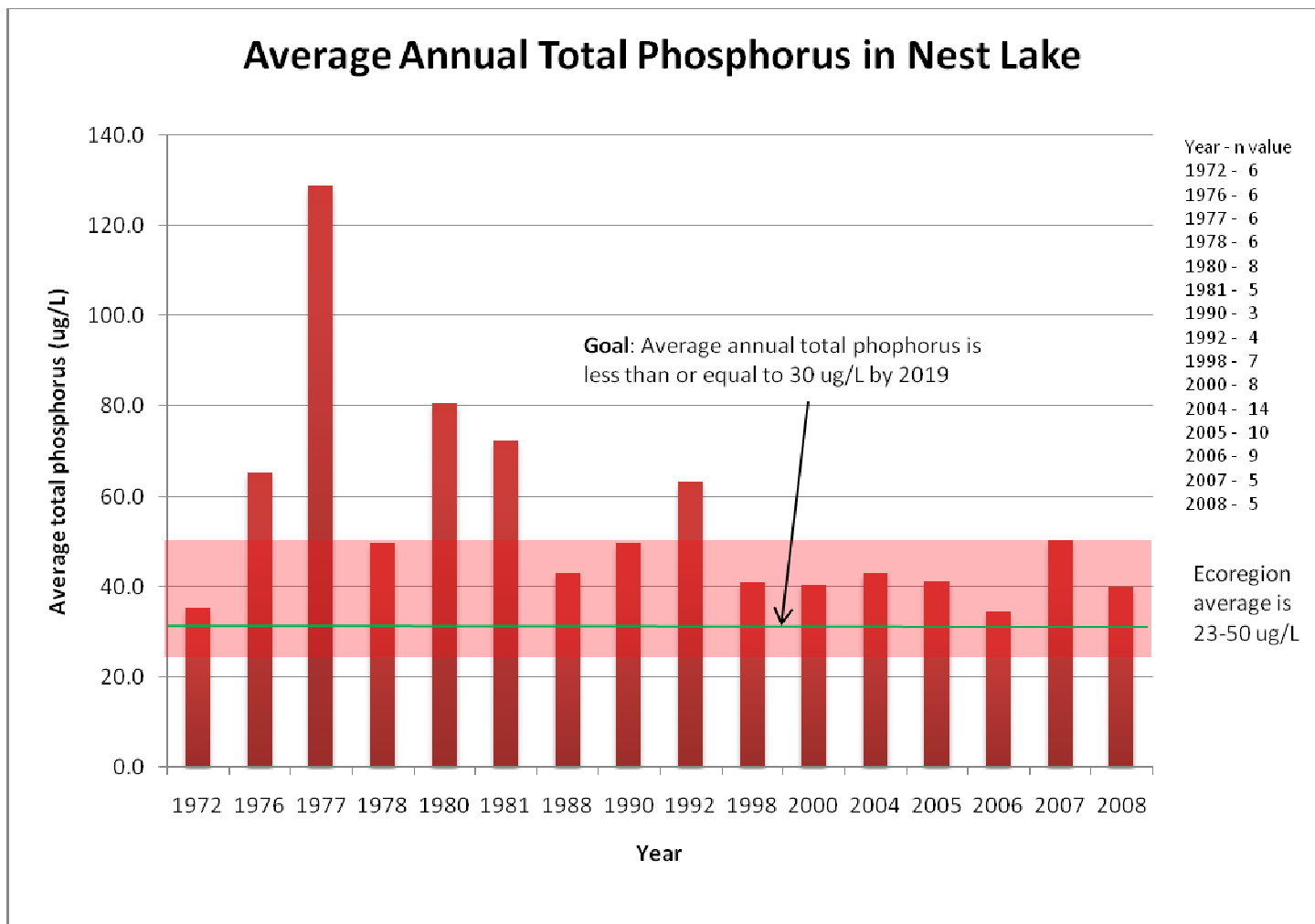


Figure 3. Figure 3 shows the average annual total phosphorus level in Nest Lake for non-consecutive years beginning in 1972 and ending in 2008. Total phosphorus is measured in micrograms of total phosphorus per liter of water. The n values, or the number of total phosphorus readings per year, are also indicated in Figure 3. The ecoregion average for the North Central Harwood Forests for total phosphorus is 23-50 micrograms per liter. Eleven out of the sixteen years in Figure 3 are within the ecoregion average.

Current Land Use

Nest Lake's lakeshed encompasses 78,684 acres. About 34,236 acres, or 43.5 percent, of the lakeshed is cultivated agricultural land. Urban and rural development makes up 2,610 acres, or 3.3 percent. Water covers 4,818 acres or 6.1 percent of the total land and there are 21,345 acres of wetlands within the lakeshed which is about 27.1 percent of the total area. There are also 78,684 acres of restorable wetlands in the lakeshed, which is 10.62 percent of the entire lakeshed (MFCRWD, 2006).

There are two cities in the lakeshed area: Belgrade and New London. They represent the two areas of greatest development concentration in the lakeshed. Monongalia Lake and Nest Lake also have more concentrated residential development.

There are three Wildlife Management Areas (WMA) within the Nest Lake lakeshed. The state WMA program aims to preserve wildlife habitat areas, primarily wetlands, from being destroyed by other land uses such as development or agricultural use. WMAs are managed for wildlife production and are open to public hunting and wildlife watching. The Burbank WMA is located in township 122 north, range 34 west, section 26 and spans over 450 acres. It is about eight miles northeast of Nest Lake. The New London WMA is in

township 121 north, range 34 west, section 4 and covers 39 acres. This WMA is located about five miles northeast of the lake. The Ringo Nest WMA sits in township 121 north, range 34 west, section 29 and encompasses 531 acres (MFCRWD, 2006). It is located one mile west of Nest Lake.

There are also numerous Waterfowl Production Areas (WPAs) in the lakeshed. WPAs are acquired and managed under the United States Fish and Wildlife Service. These areas work to preserve wetlands and grasslands that are critical to waterfowl and other wildlife. There are multiple recreational opportunities provided to the public in WPAs, such as hunting, fishing, trapping, wildlife observation, and photography (MFCRWD, 2006). Map 1L in appendix A shows the land use throughout the Middle Fork Crow River watershed in 2000. Sub-watersheds one, two, three, four, and five comprise the lakeshed for Nest Lake.

WATER RESOURCES GOALS

Water Resources Goal 1: *Water Quality.* Restore surface water quality using sound research and monitoring, and Best Management Practices (BMPs). Attempt to meet aggressive water quality goals for secchi disk, chlorophyll, and total phosphorus as shown on previous graphs.

Objective A: Identify, prioritize, restore, protect, and enhance wetland areas that improve surface water quality and promote groundwater recharge.

Actions:

1. Identify and prioritize areas in the lakeshed where there are sites with the potential for improving water quality and water storage.
2. Support efforts by property owners and the resource agencies to restore wetlands in high priority areas.
3. Support efforts by the appropriate local government units to protect wetlands in the lakeshed. Periodically review the decisions made by local officials.

Objective B: Advocate and support the use of BMPs relating to surface water for all land uses and activities in the lakeshed. Develop an educational program to inform lakeshed residents of the merits and advantages of BMPs with regard to water quality improvements.

Actions:

1. Support efforts by the MFCRWD, Soil and Water Conservation Districts (SWCDs), state and federal agencies, and landowners to implement BMPs in shoreland areas including lakes, rivers, and streams through planning and zoning permits and other government approvals.
2. Support efforts by the Cities of Belgrade and New London as well as townships and counties in the lakeshed to apply BMPs for stormwater management on road construction and land development projects.
3. Support efforts by the MFCRWD, SWCDs, state and federal agencies, and land owners to implement BMPs on agricultural lands including applications such as conservation tillage, erosion control practices, runoff management, riparian buffers, agricultural waste management, integrated pest management, and others.
4. Include at the annual meeting a water quality education topic such as lawn care, aquatic plant identification, etc. Invite guest speakers.
5. Periodically gather, organize, and distribute literature on BMPs to property owners and other land and water uses.

Objective C: Support and assist in the collection of water monitoring data at the lake and lakeshed levels.

Actions:

- 1: Continue to work with the MFCRWD and Minnesota Pollution Control Agency (MPCA) through the Citizen Lake Monitoring program to monitor and document water quality data for Nest Lake. Offer financial support to help pay for laboratory analysis of water samples.
- 2: Continue to work with the MFCRWD and MPCA through the Citizen Stream Monitoring program to monitor and document water quality data for the Crow River and Nest Lake.
- 3: Work with the MN DNR Division of Waters to monitor and record lake levels.
- 4: Work with the MFCRWD to monitor precipitation in the lakeshed.

Objective D: Partner with agencies, groups, property owners, and other constituents to identify pollution problems and establish priority areas within the lakeshed. Foster partnerships with constituents and resource agencies to design, construct, fund, and maintain the priority water quality projects.

Actions:

1. Partner to diagnose monitoring data generated by the MFCRWD, MPCA, and other agencies or individuals to prioritize which drainage areas in the lakeshed are contributing the greatest amount of pollution to Nest Lake.
2. Support the development of stormwater management plans by local officials for their jurisdictions. Address snow removal and dumping and their impacts on water quality.
3. Support efforts to require stormwater management plans for new subdivisions in the lakeshed so the post development runoff should not exceed predevelopment runoff conditions.
4. Support efforts to inventory all culverts and box channels in the lakeshed. Inventory the items such as culvert size, elevations, flow direction, maximum capacity, flow conditions, etc.
5. Conduct an annual assessment/implementation meeting sometime during the winter months with agencies working in the Nest Lake lakeshed to develop a list of pollution problem areas and then prioritize these sites and start to develop implementation plans on how to address these areas.
6. Work with partners to develop corrective options to address the priority areas and solicit funding to complete a minimum of three water quality improvement projects on an annual basis.
7. Work with the MFCRWD to monitor water quality trends in relation to the projects and programs implemented through partnerships and assess the effectiveness of corrective actions taken.

Water Resources Goal 2: *Curly-leaf pondweed.* Reduction and future control of nuisance curly-leaf pondweed.

Objective A: By the year 2019, reduce curly-leaf pondweed to levels no longer considered nuisance and continue to manage curly-leaf pondweed to avoid present densities and nuisance levels.

Actions:

1. To the extent possible, work with the MN DNR to create a point-intercept map of curly-leaf pondweed distribution and stem densities prior to treatment.
2. Adopt one of the alternatives listed below and work with the MN DNR and MFCRWD to develop comprehensive steps to carry out the alternative, or work with the MN DNR and MFCRWD to develop a plan to manage patches and large areas of curly-leaf pondweed for long-term control.

- Utilize weekly secchi disk readings and monitor the effects of curly-leaf pondweed treatments. Evaluate treatment success based on distribution, stem densities, and relative nuisance level (interference with boating, swimming, and other recreational activities). Continue with the current treatment plan, modify the treatment plan, or adopt a new treatment plan based on the effectiveness of the current treatment plan.

Alternatives for Treatment of Curly-leaf Pondweed:

Alternative 1: Mechanical harvesting.

Use mechanical harvesting to manage curly-leaf pondweed by cutting and removing curly-leaf pondweed from the lake prior to turion production.

Alternative 2: Combination of mechanical harvesting and chemical herbicide treatment.

Use both mechanical harvesting and chemical herbicide treatment to treat curly-leaf pondweed within and adjacent to areas with high densities prior to turion production. Continue herbicide treatment at least three consecutive years.

Alternative 3: Chemical herbicide spot treatments.

Use a MN DNR approved chemical herbicide to treat spot treat areas of curly-leaf pondweed prior to turion production to reduce high densities in high traffic and sensitive areas. Continue herbicide treatment at least three consecutive years.

Alternative 4: Chemical herbicide whole-lake treatments.

Use a MN DNR approved chemical herbicide to treat curly-leaf pondweed lake-wide prior to turion production to reduce high densities. Continue herbicide treatment for at least three consecutive years.

Alternative 5: No treatment.

Do not treat curly-leaf pondweed with mechanical harvesting, chemical herbicides, or any other treatment form.

Pre-treatment and Post-treatment surveys and monitoring:

It is important to gather adequate data about the condition, distribution, and densities of the curly-leaf pondweed prior to implementing any treatment. To the extent possible, work with the MN DNR annually to gather pre-treatment data using point-intercept surveys to determine the distribution and stem-densities of curly-leaf pondweed. In addition, continue to work with the MFCRWD to collect water quality data and record weekly secchi disk readings. At least one year of pre-treatment data should be collected to develop more comprehensive treatment alternatives. To the extent possible, monitoring similar to that completed for the pre-treatment studies should be continued throughout the years of treatment. Following the implementation of a treatment, the same monitoring and surveys should be completed to more thoroughly evaluate the effectiveness of the treatment. Post-treatment monitoring should be carried out for at least four years, or whatever is practical.

Objective B: Reduce phosphorus inputs from the lakeshed to reduce the frequency and duration of nuisance algae blooms.

Actions:

- Continue treatment of curly-leaf pondweed prior to turion formation.
- Work with Nest Lake property owners to install raingardens, buffer strips, shoreline restorations, and other erosion and nutrient management practices. Install 100 best management practices (BMPs) by 2019 on Nest Lake.
- Work with property owners and users, and other individuals within the lakeshed to install similar erosion and nutrient management practices.

4. Encourage stormwater management in the Cities of Belgrade and New London to reduce the amount of stormwater and related phosphorus being released into the river and Nest Lake.

Water Resources Goal 3: *Aquatic vegetation.* Restore desirable native aquatic vegetation in Nest Lake. Prevent the spread and presence of exotic aquatic vegetation species, other than curly-leaf pondweed.

Objective A: Develop monitoring strategies and prevention measures to prevent additional exotic species from entering the lake.

Actions:

1. Develop an education program for lake residents and lake users to address the benefits of native vegetation and the importance of preventing exotic species from entering the lake.
2. Develop a detailed plan that outlines actions to help prevent the spread of exotic species and a list of actions that should be taken if they are found in the lake.
3. Develop a volunteer program that monitors the presence of exotic and nuisance vegetative species.
4. Document and report the invasion of exotic species to the MN DNR, MFCRWD, and the lake association on a periodic basis.

Objective B: Plant, restore, and maintain native aquatic vegetation in Nest Lake.

Actions:

1. Continue to work with the MN DNR to inventory aquatic vegetation in Nest Lake.
2. Partner with the MN DNR to identify and inventory critical habitat areas in Nest Lake.
3. Support the maintenance and replanting of native species where appropriate in the critical habitat areas in the lake. Provide volunteer labor to assist the MN DNR in installing and maintaining vegetation in the critical areas.
4. Support efforts by private lakeshore owners to plant, restore, and maintain native plant species along the shoreland areas adjacent to their properties.
5. Obtain and distribute literature from resource agencies that describe the benefits and importance of native vegetation, and ways to better manage human activities on the lake.
6. Conduct a workshop for lakeshore residents on aquatic vegetation identification.

Objective C: Support efforts by permitting and enforcement agencies to protect native aquatic vegetation in Nest Lake.

Actions:

1. Support the introduction and continuation of aerial photography of the lake to inventory aquatic vegetation patterns and any changes or disruption to the existing vegetative patterns.
2. Work with the MN DNR and Kandiyohi County Planning and Zoning officials to administer the permitting process. The lake association should maintain a list of sites permitted for aquatic vegetation removal as well as persons at the MN DNR to contact for permit applications. Review and comment on permit applications that impact critical aquatic habitat areas.

LAND RESOURCES GOALS

Land Resources Goal 1: *Development.* Promote wise and sustainable development and land management in the lakeshed.

Objective A: Support the adoption and administration of local comprehensive plans and policies including subdivision regulations and zoning ordinances that are based on sound water and land related resource principles.

Actions:

1. Support efforts by counties and municipalities to review and revise their zoning ordinances and subdivision regulations in ways that protect water resources in the lakeshed and promote sustainable land development.
2. Work with local regulatory agencies to identify critical lakeshed areas such as wetlands, the hardwood hills area, etc. Support the protection and restoration of such critical areas.
3. Support local agencies to maintain Resource Management zoning districts in the lakeshed.
4. Development a program to establish the protection of agricultural land and open space in the lakeshed.

Land Resources Goal 2: *Erosion.* Promote and encourage land use activities that prevent or minimize soil erosion.

Objective A: Identify and prioritize soil erosion areas.

Actions:

1. Conduct an inventory of existing erosion areas within the lakeshed to determine the highest priority areas where erosion is occurring and then identify and prioritize areas for erosion control projects.
2. Work with the SWCDs to develop an inventory of the riparian buffers in the lakeshed.

Objective B: Work with resource agencies to implement incentive programs and projects on private and public lands that improve water quality in Nest Lake.

Actions:

1. Support projects being developed by landowners and the resource agencies in the lakeshed that increase the amount of riparian buffers.
2. Support practices by landowners in the lakeshed that increase the amount of crop residue and decrease soil erosion.
3. Support the activities that minimize soil erosion during and after maintenance of ditches. Where appropriate, support projects that reduce the slope of ditches in order to decrease erosion.
4. Increase awareness by landowners of the effects of drainage systems and the benefits of retention on water quality.
5. Encourage construction erosion control measures for all lakeshore residents during home construction.
6. Support activities that minimize the impacts on water quality from road construction and maintenance.

7. Support activities that minimize the impacts on water quality from new land and building development. Work with landscape contractors to construct landscaping improvements that minimize erosion and stormwater runoff impacts on the water resources.

Land Resources Goal 3: *Livestock.* Promote and encourage the raising of livestock while balancing the need to protect water and land resources.

Objective A: Promote efforts by resource agencies to assist feedlot operators and livestock producers to use Best Management Practices (BMPs) related to livestock operations in the lakeshed.

Actions:

1. Support efforts by the counties and the MPCA to enforce the current feedlot regulations.
2. Support efforts by landowners and agencies to make corrective actions and improvements to feedlots within the lakeshed.
3. Support the installation of fencing through programs sponsored by resource agencies that keep livestock out of critical riparian areas.

RECREATIONAL RESOURCES GOALS

Recreational Resources Goal 1: *Fisheries Resources.* Protect and enhance the fish resources in the watershed.

Objective A: Promote efforts by the MN DNR to plan fisheries and habitat management efforts in the lakeshed.

Actions:

1. Provide support to the MN DNR to conduct fish population surveys, and creel surveys, and other methods of inventorying fishing activities.
2. Provide local input to the MN DNR in regards to fishing management topics such as desired fish populations, stocking rates, and management practices, including size limits and other fishing regulations.
3. Support efforts to increase the awareness for the need to protect and enhance aquatic vegetation and its value as cover and as a food source.
4. Encourage the shoreland management practices that protect the water quality of Nest Lake.
5. Work with the MN DNR to identify and preserve sensitive shoreland areas for aquatic management purposes.

Recreational Resources Goal 2: *Surface Water Use Management.* Promote the safe and wise use of the surface waters in the watershed for multiple recreational uses.

Objective A: Promote and coordinate education efforts on the safe and wise use of surface waters in the lakeshed.

Actions:

1. Support and inform the public of existing programs that train youth and adults on the proper use and laws regarding boats, personal watercrafts, snowmobiles, and ATVs.
2. Distribute literature and publish reminders in the newsletter and on the website on the safe use of lakes for winter activities (ice thickness, fish houses, trash).
3. Provide information to property owners through newsletters, the website, signage, and other methods of current regulations regarding boating and recreational use of surface waters in the lakeshed.

Objective B: Support surface water use regulations and enforcing regulatory agencies.

Actions:

1. Review current surface water use regulations and provide feedback to enforcement agencies.
2. Work with regulatory agencies to provide local support and feedback when regulations are being developed that address conflicts pertinent to the use of surface water and recreational activities on Nest Lake.

ADMINISTRATIVE/FISCAL GOALS

Administrative/Fiscal Goal 1: *Public Involvement.* Encourage and promote active, broad, and ongoing involvement by citizens throughout the implementation of the Nest Lake Management Plan.

Objective A: Establish sustainable approaches for recruiting and organizing volunteers to implement specific projects and programs as outlined in this Plan and as determined by the lake association.

Actions:

1. Develop a targeted and sustained program to recruit citizens living and recreating in the lakeshed to support the implementation of this Plan.
2. Periodically inventory and assess the support from the local community to determine the amount of support the lake association and their constituents have to implement this plan.
3. Maintain a list of “volunteer opportunities” for persons to become active in the implementation of this plan. Work to link volunteers with opportunities they are interested in.
4. Maintain and update on a regular basis, a Resource Directory. The directory should include the membership list for the implementation committees, lake association board and members, agency representatives, etc.
5. Award and/or recognize citizens and local officials who have made valuable contributions to the protection and improvement of resources in the lakeshed.

Objective B: Develop consistent and ongoing methods for informing the public about efforts being taken to improve Nest Lake and the water resources in the lakeshed as well as those efforts that have been successfully completed.

Actions:

1. Distribute a copy of the summary of the Nest Lake Management Plan to all property owners on Nest Lake.
2. Continue to prepare and distribute a newsletter to all lake association members.
3. Prepare an annual Lakeshed Report that summarizes the completed and upcoming projects, education programs, volunteer efforts, and water quality trends. Distribute to all property owners in the lakeshed.

4. Provide awards and/or recognition to private landowners and public sector agencies that have significantly improved or enhanced conditions for water quality in Nest Lake. Categories for awards may include ditches, buffers, tillage, shoreland, and urban settings or projects.

Objective C: Continue annual meetings for the Nest Lake Improvement Association.

Actions:

1. Hold annual meetings to provide the necessary means to support the functions of the lake association (discussion on issues, voting, setting dues, etc.).
2. Present the highlights of the Annual Report to the citizens attending the annual lake association meeting. Invite the attendees to participate on one of the working subcommittees and the various implementation projects.

Administrative/Fiscal Goal 2: *Governmental Coordination.* Encourage active and ongoing involvement with public sector agencies, from local to federal, that have jurisdiction within the watershed to more successfully implement the Nest Lake Management Plan.

Objective A: Support and coordinate efforts with governmental agencies that manage land and water resources in the lakeshed.

Actions:

1. Stay active in land use decisions within the lakeshed, including conditional use permits and variances to zoning ordinances.
2. Meet with resource agency representatives and land use officials as appropriate to review projects and programs to be undertaken. Ways to improve the review of new land development proposals (subdivision plats, conditional use permits, variances, etc.) with local land use officials should also be addressed at these meetings.
3. Develop a data sharing agreement with the counties and resource agencies to freely share any and all data related to this plan.

Administrative/Fiscal Goal 3: *Fiscal Management.* Promote the implementation of the Nest Lake Management Plan in a fair, transparent, and fiscally responsible manner.

Objective A: Maintain and update an inventory of funding resources for implementing the Nest Lake Management Plan including local, state, federal, non-profit, foundation, and private sources.

Actions:

1. Middle Fork Crow River Watershed District. Explore the use of alternative financing tools, available to watershed districts as authorized by state law. Some of the alternative financing tools include: assessment levies, the sale of bonds, and the collection of charges or fees.
2. County Water Plan Programs. Explore the use of financing tools provided through county water plans.
3. Conservation Programs. Explore and support the use of existing funding programs offered through the SWCDs, state agencies and federal agencies including the U.S. Natural Resource Conservation Service (NRCS). Some of the water protection programs include CRP, RIM, EQIP, WRP, etc.

4. Maintain a list of potential funding sources for programs and projects proposed in this Plan.

Objective B: Develop an annual budget for the lake association.

Actions:

1. Solicit public input on the proposed budget at the annual meeting.
2. Prepare an annual budget for the implementation of the Nest Lake Management Plan.

References

- Aquatic Management Area Acquisition Planning Committee (2007, October). *Minnesota's aquatic management area acquisition plan 2008-2033*. Retrieved January 13, 2009 from, Department of Natural Resources Web site: <http://files.dnr.state.mn.us/aboutdnr/reports/strategic-documents/ama-acquisition-report.pdf>
- Busman, L., Lamb, J., Randall, G., Rehm, G., & Schmitt, M. (2002). *The nature of phosphorus in soils*. Retrieved March 11, 2009 from University of Minnesota, Web site: <http://www.extension.umn.edu/distribution/cropsystems/DC6795.html>
- Catling, P.M., & Dobson, I. (1985). The biology of Canadian weeds. *Journal of Plant Science*, 65, 665-668.
- Educational Broadcasting Corporation (2008). *Phosphates: what are they and how can they hurt us?* Retrieved December 10, 2008 from, Web site: <http://www.thirteen.org/edonline/studentstake/water/schoolwater/Phosphorous/phosphorous.htm>
- Environmental Protection Agency (2008, March). *Ecoregions of the United States*. Retrieved December 9, 2008 from, Web site: <http://www.epa.gov/bioindicators/html/usecoregions.html>
- Gilbertson, B (2008, December). Minnesota Department of Natural Resources. Personal communication.
- Kandiyohi County, & Mid-Minnesota Development Commission (2003). *The Kandiyohi County Comprehensive Local Water Plan*.
- Leeds, R., Brown, L., Sulc, M., & VanLieshout, L. (). *Vegetative filter strips: application, installation and maintenance*. Retrieved March 12, 2009 from Ohio State University, Web site: <http://ohioline.osu.edu/aex-fact/0467.html>
- Main Center for Invasive Aquatic Plants (2004). *Curly-leaf pondweed*. Retrieved July 29, 2008 from, Web site: <http://www.mciap.org/herbarium/Curly-leavedPondweed.php>
- McComas, S., Schuler, D., Bonde, T., Wilson, B., & Wright, S. (2002). *Resource Investigation of the Middle Fork Crow River Watershed, Kandiyohi County, Minnesota*.
- McComas, S., Schuler, D., Bonde, T., Wilson, B., & Wright, S. (2002). *Resource Investigation of the Middle Fork Crow River Watershed, Kandiyohi County, Minnesota Technical Appendix*.
- Middle Fork Crow River Watershed District, & Mid-Minnesota Development Commission (2006). *Middle Fork Crow River Watershed District Watershed Management Plan*.
- Minnesota Department of Natural Resources (2003, June). *Lake information report*. Retrieved May 19, 2008 from, Web site: <http://www.dnr.state.mn.us/lakefind/showreport.html>
- Minnesota Department of Natural Resources-Division of Forestry (2006, August 9). *Presettlement vegetation*. Retrieved January 13, 2009 from, Department of Natural Resources Web site: http://deli.dnr.state.mn.us/metadata/pveg_mrschpy1.html
- Minnesota Department of Natural Resources Fisheries (2008). *Standard Lake Survey Report Draft Version*.
- Moyle, J.B., & Hotchikiss, N. (1945). The aquatic and marsh vegetation of Minnesota and its value to waterfowl. *Technical Bulletin of the Minnesota Department of Conservation*, 3, 122.

- Skogerboe, John G., Angela Poovey, Kurt D. Getsinger, Wendy Crowell, Eric Macbeth. 2008. Early-season, low-dose applications of endothall to selectively control curlyleaf pondweed in Minnesota lakes. Aquatic Plant Control Research Program Technical Notes Collection (ERDC/TN APCRP-CC-08 [June]) U.S. Army Engineer Research and Development Center, Vicksburg, MS.
- Struss, R. (2003, July). *The "500 lbs algae adage"*. Retrieved December 16, 2008 from, Web site: http://www.cleanmn.org/app_themes/cleanwater/pdfs/forTeachers/Algae.pdf
- United States Department of Agriculture Natural Resources Conservation Service (2008, November). *Web soil survey*. Retrieved December 9, 2008 from, Web site: <http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx>
- Wehrmeister & Stuckey (1978). The life history of *Potamogeton crispus* with emphasis on its reproductive biology. *Ohio Journal of Science*, 78, 16.
- Wilson, B., Wright, S., Gilbertson, B., Leach, M., & Bonde, T. (2004, April 14). *Middle Fork of the Crow River, Kandiyohi County, Minnesota 2004 Update of the Diagnostic Study*. Retrieved September 30, 2008 from, Web site: <http://www.greenlakespicer.com/Middle%20Fork/middleforkofthecrowriver.htm>
- Wright, S (2008, December). Minnesota Department of Natural Resources. Personal communication.

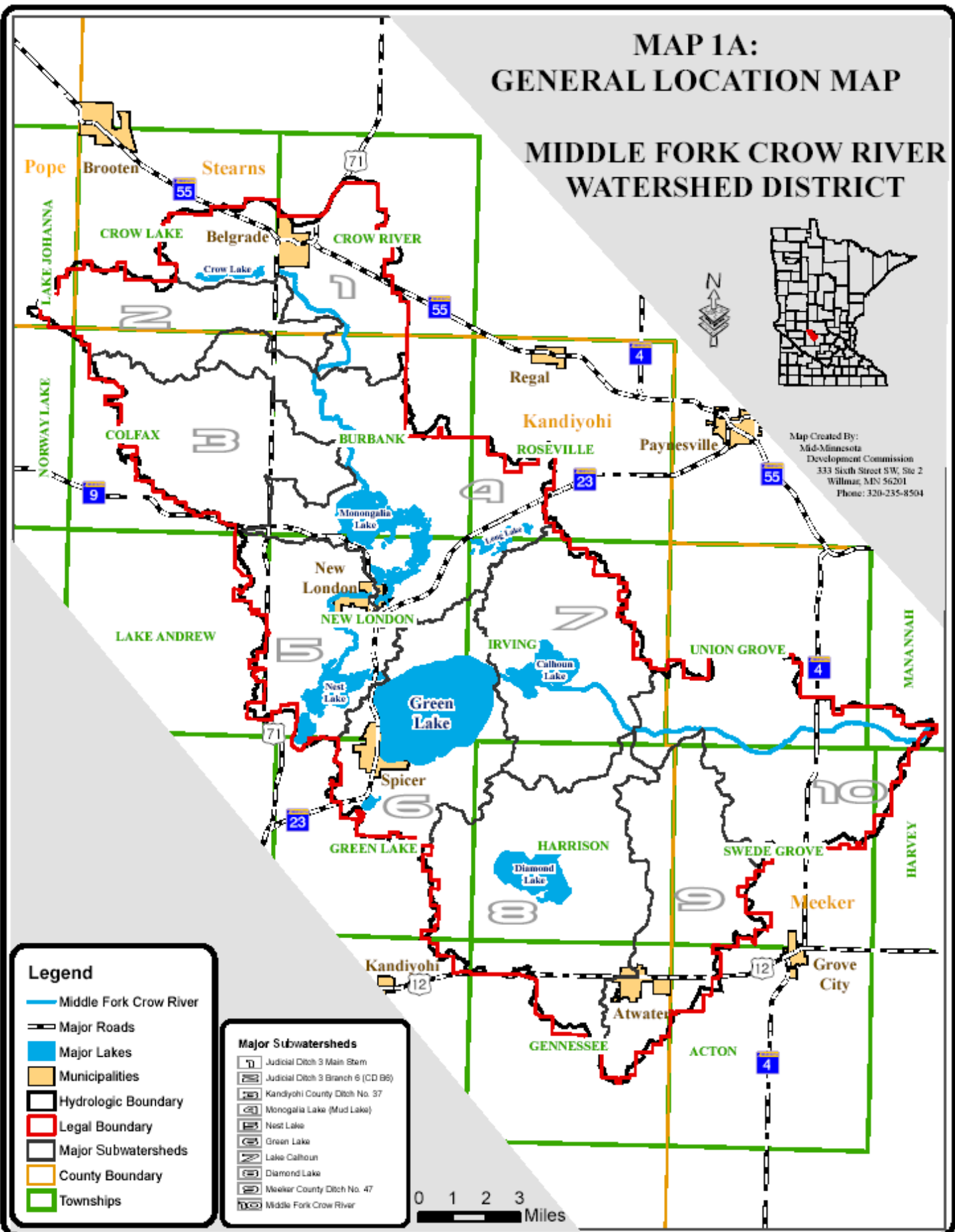
Appendix A

Maps

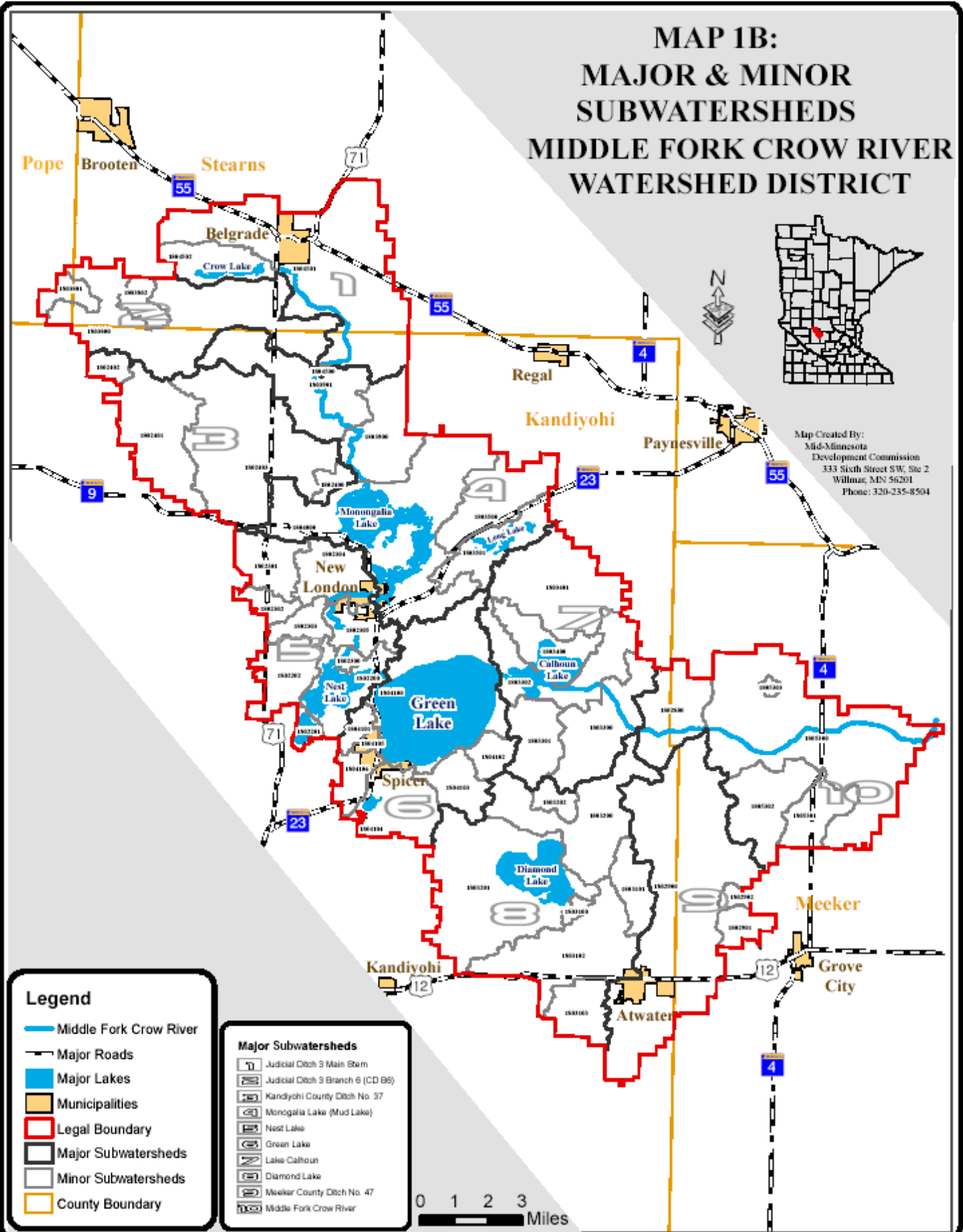
MFCRWD Watershed Management Plan 2007-2017

MAP 1A: GENERAL LOCATION MAP

MIDDLE FORK CROW RIVER WATERSHED DISTRICT



MAP 1B: MAJOR & MINOR SUBWATERSHEDS MIDDLE FORK CROW RIVER WATERSHED DISTRICT



Map Created By:
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Phone: 320-235-8504

Legend

- Middle Fork Crow River
- Major Roads
- Major Lakes
- Municipalities
- Legal Boundary
- Major Subwatersheds
- Minor Subwatersheds
- County Boundary

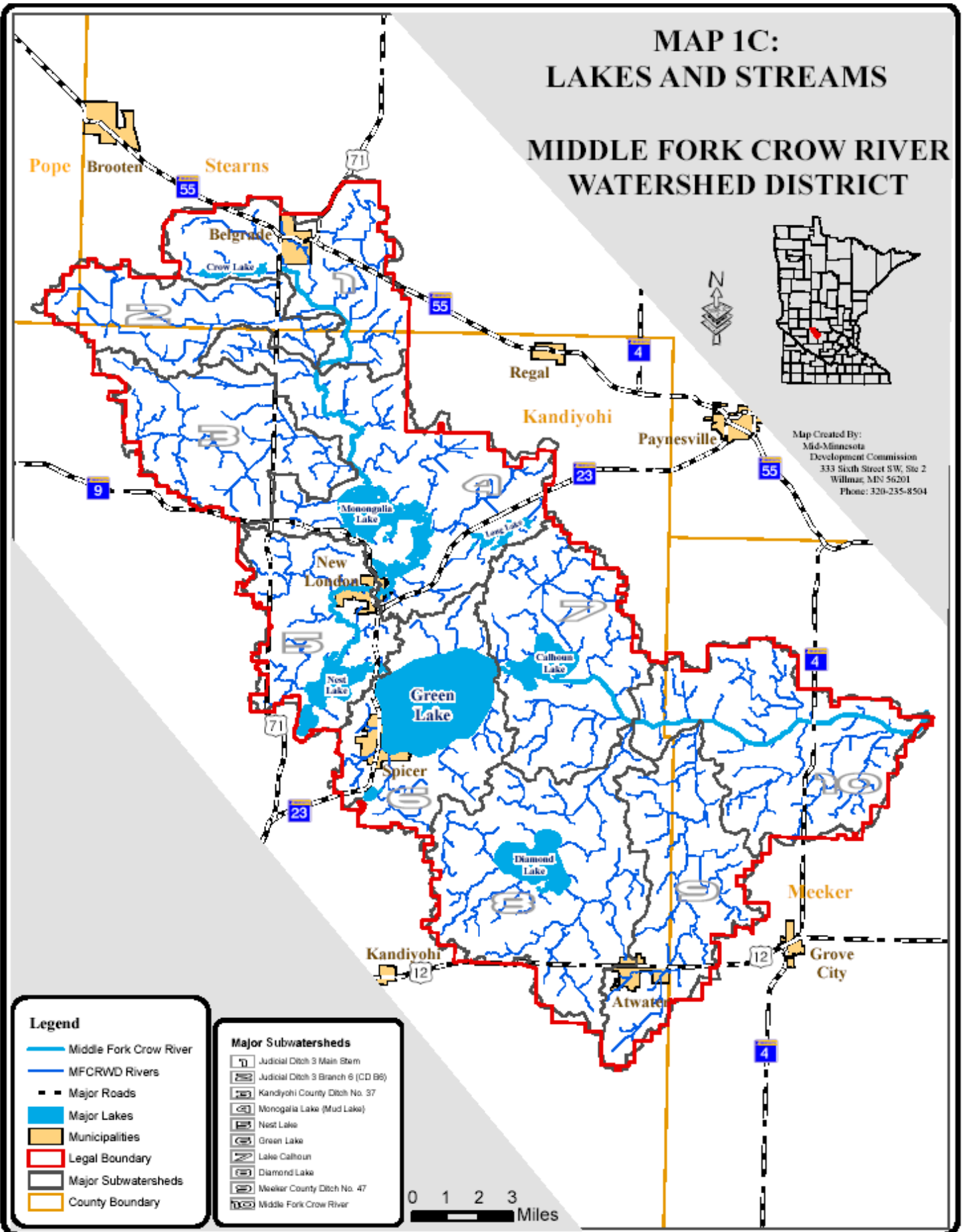
Major Subwatersheds

- Judicial Ditch 3 Main Stem
- Judicial Ditch 3 Branch 6 (CD B6)
- Kandiyohi County Ditch No. 37
- Monogalia Lake (Mud Lake)
- Nest Lake
- Green Lake
- Lake Calhoun
- Diamond Lake
- Meeker County Ditch No. 47
- Middle Fork Crow River

0 1 2 3
Miles

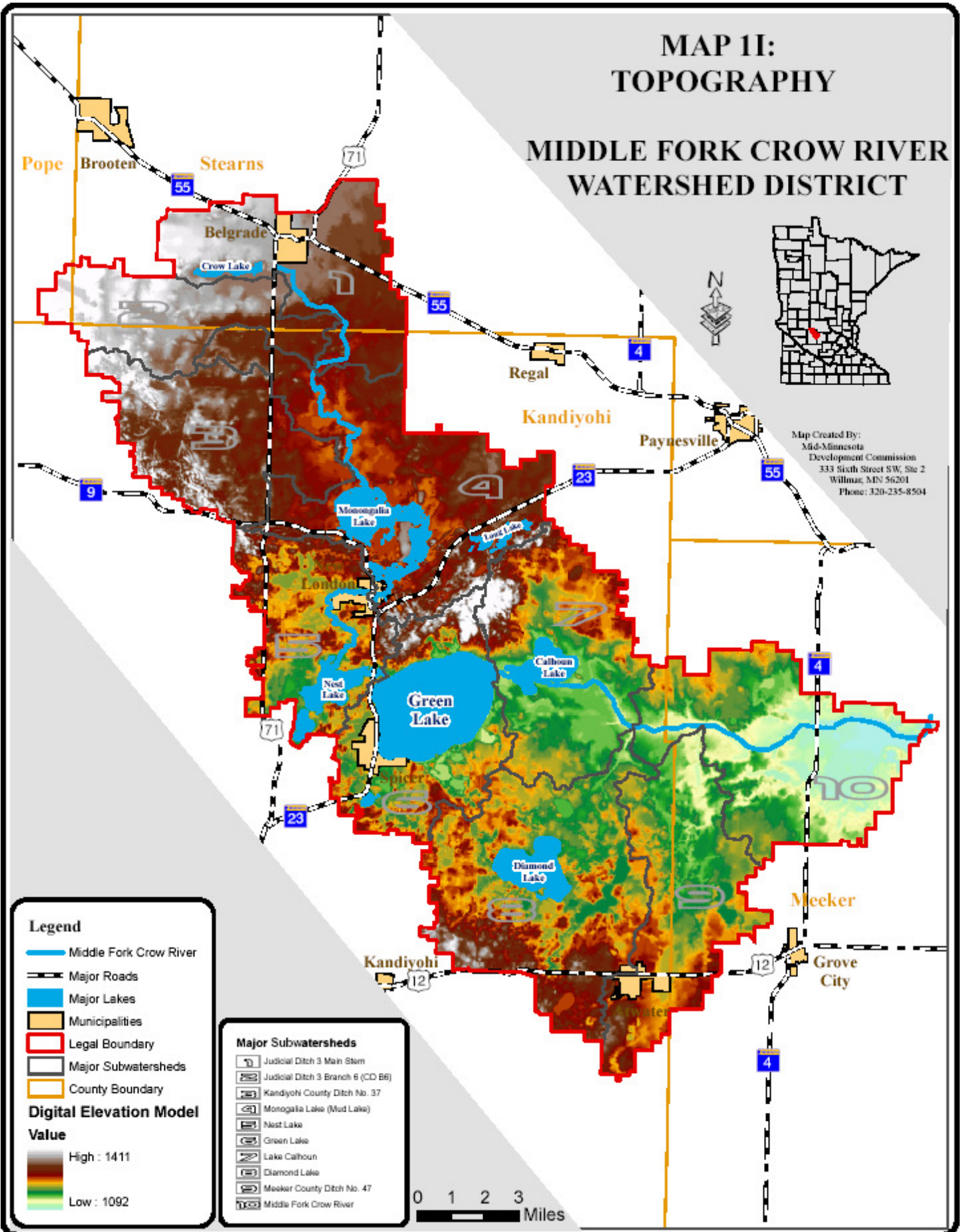
MAP 1C: LAKES AND STREAMS

MIDDLE FORK CROW RIVER WATERSHED DISTRICT



MAP 11: TOPOGRAPHY

MIDDLE FORK CROW RIVER WATERSHED DISTRICT



Map Created By:
Mid-Minnesota
Development Commission
333 Sixth Street SW, Ste 2
Willmar, MN 56201
Phone: 320-235-8504

Legend

- Middle Fork Crow River
 - Major Roads
 - Major Lakes
 - Municipalities
 - Legal Boundary
 - Major Subwatersheds
 - County Boundary
- Digital Elevation Model**
Value
- High : 1411
 - Low : 1092

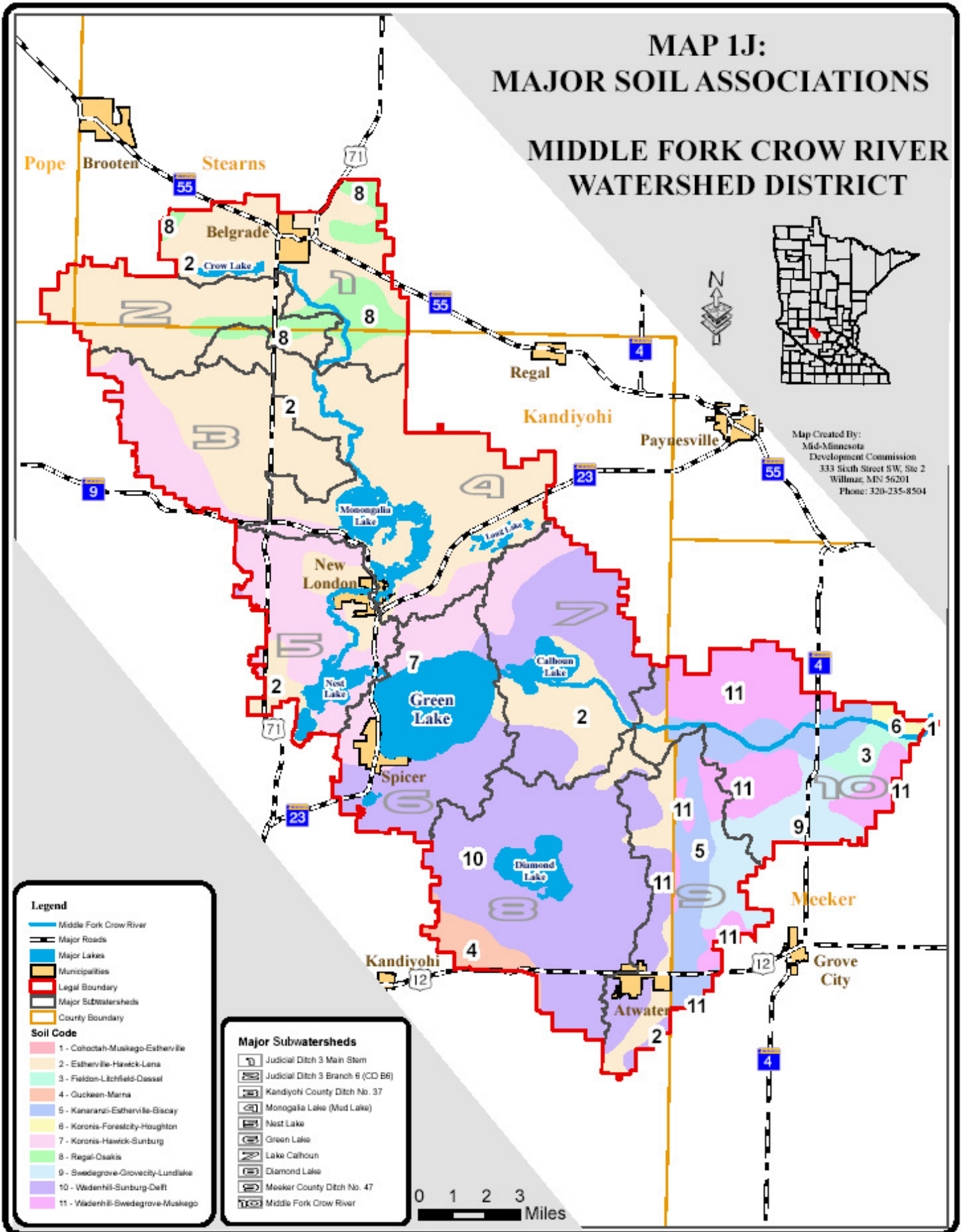
Major Subwatersheds

- Judicial Ditch 3 Main Stem
- Judicial Ditch 3 Branch 6 (CD 66)
- Kandiyohi County Ditch No. 37
- Monogalia Lake (Mud Lake)
- Nest Lake
- Green Lake
- Lake Calhoun
- Diamond Lake
- Meeker County Ditch No. 47
- Middle Fork Crow River

0 1 2 3 Miles

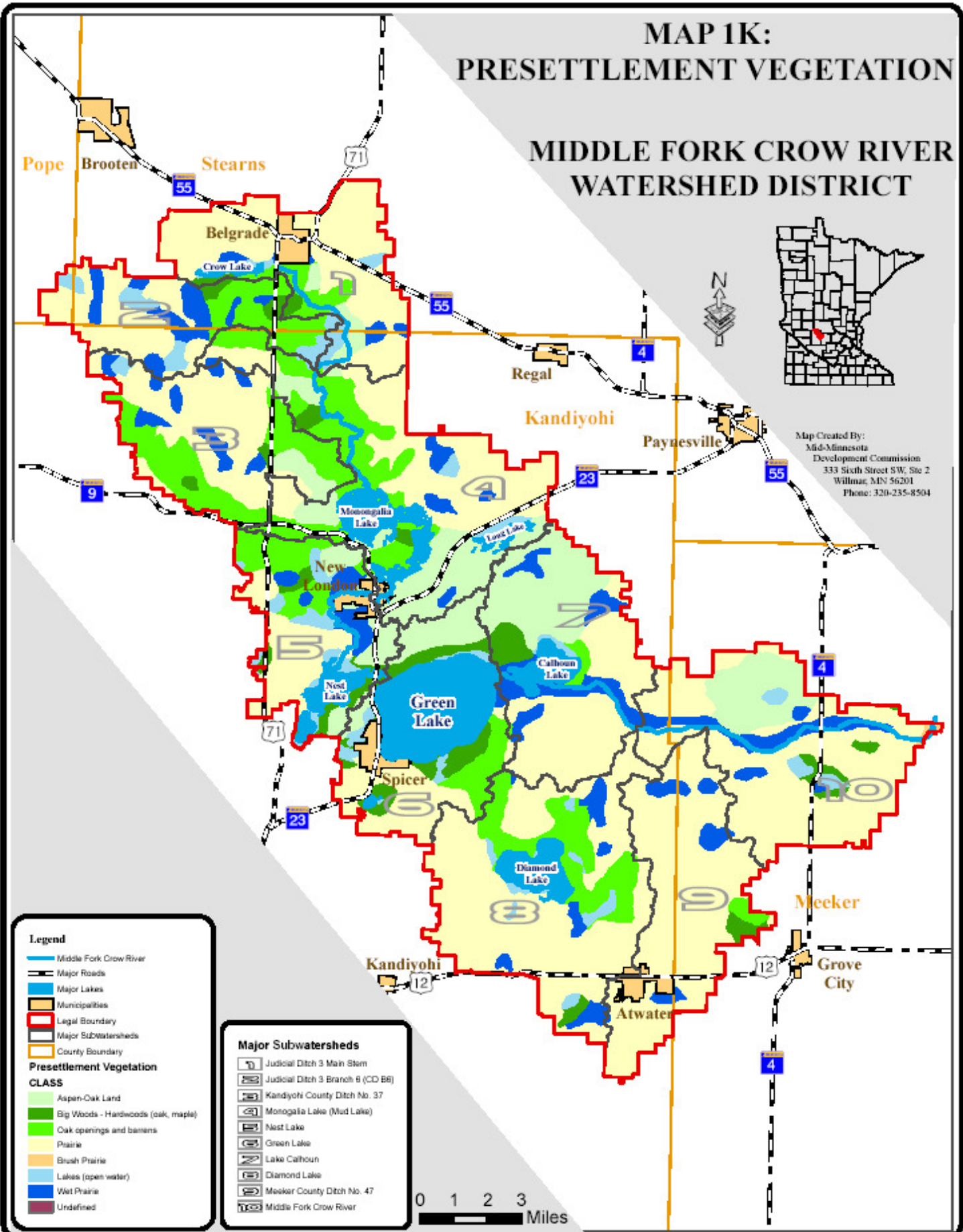
MAP 1J: MAJOR SOIL ASSOCIATIONS

MIDDLE FORK CROW RIVER WATERSHED DISTRICT



MAP 1K: PRESETTLEMENT VEGETATION

MIDDLE FORK CROW RIVER WATERSHED DISTRICT



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Legend

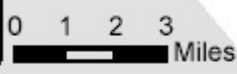
- Middle Fork Crow River
- Major Roads
- Major Lakes
- Municipalities
- Legal Boundary
- Major Subwatersheds
- County Boundary

Presettlement Vegetation CLASS

- Aspen-Oak Land
- Big Woods - Hardwoods (oak, maple)
- Oak openings and barrens
- Prairie
- Brush Prairie
- Lakes (open water)
- Wet Prairie
- Undefined

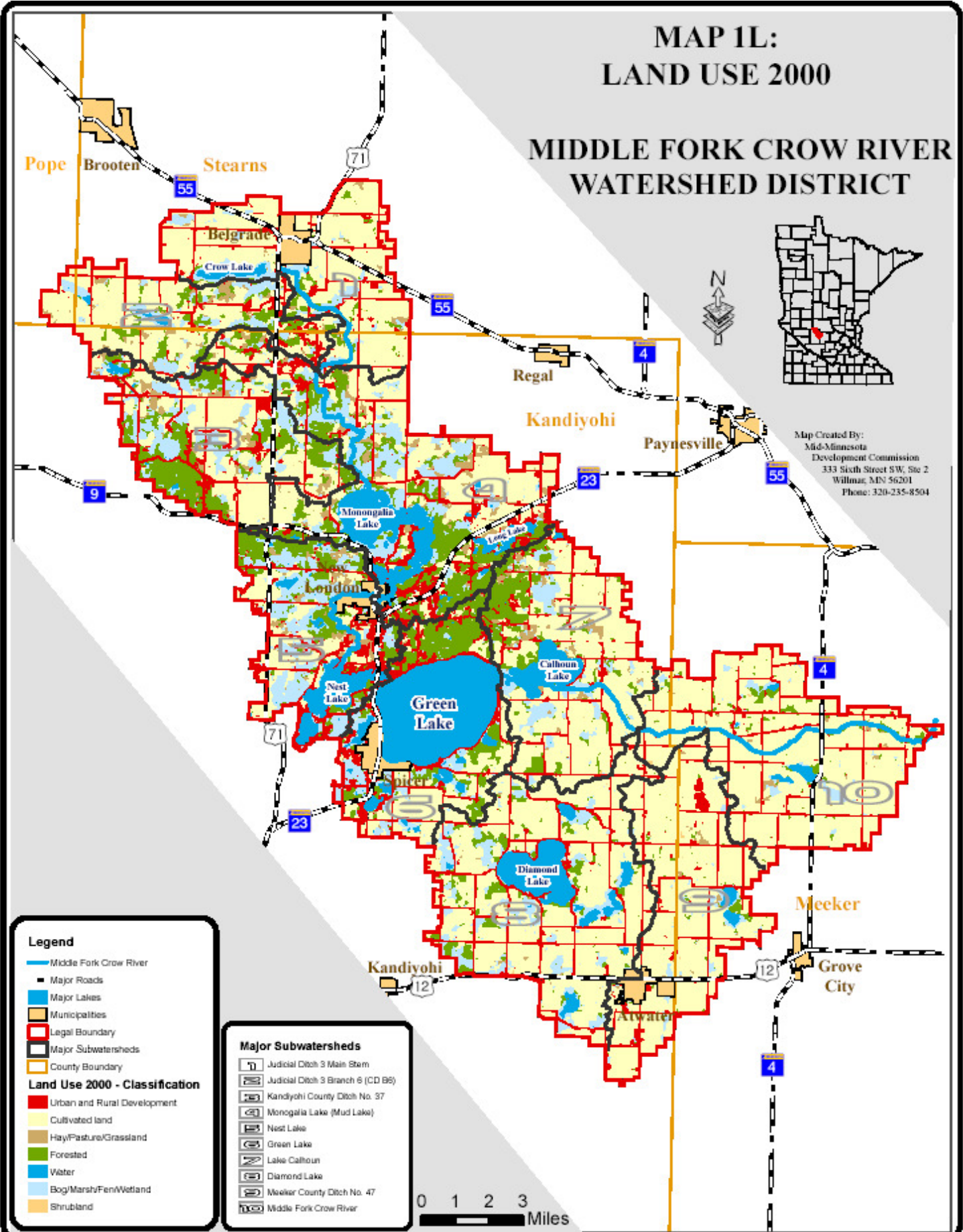
Major Subwatersheds

- Judicial Ditch 3 Main Stem
- Judicial Ditch 3 Branch 6 (CD B6)
- Kandiyohi County Ditch No. 37
- Monogalia Lake (Mud Lake)
- Nest Lake
- Green Lake
- Lake Calhoun
- Diamond Lake
- Meeker County Ditch No. 47
- Middle Fork Crow River



MAP 1L: LAND USE 2000

MIDDLE FORK CROW RIVER WATERSHED DISTRICT



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Development Commission
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Willmar, MN 56201
Phone: 320-235-8504

Legend

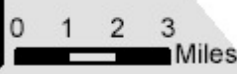
- Middle Fork Crow River
- Major Roads
- Major Lakes
- Municipalities
- Legal Boundary
- Major Subwatersheds
- County Boundary

Land Use 2000 - Classification

- Urban and Rural Development
- Cultivated land
- Hay/Pasture/Grassland
- Forested
- Water
- Bog/Marsh/Fen/Wetland
- Shrubland

Major Subwatersheds

- Judicial Ditch 3 Main Stem
- Judicial Ditch 3 Branch 6 (CD B6)
- Kandiyohi County Ditch No. 37
- Monogalia Lake (Mud Lake)
- Nest Lake
- Green Lake
- Lake Calhoun
- Diamond Lake
- Meeker County Ditch No. 47
- Middle Fork Crow River



Appendix B

Comparison of Mechanical Harvesting vs. Herbicides

Chip Welling, MN DNR, 17 December 2003

	Mechanical Harvesting	Herbicides
Effectiveness of Control		
Reliability [difficulty in obtaining consistent results in different lakes (Potential failure of treatments)]	Never fails	Can fail
Time to relief	Immediate	7 to 14 days (45-60 with fluridone)
Vegetation is collected and removed from the lake	Yes (Nutrients in plants are removed from the lake)	No (Nutrients in plants are NOT removed from the lake)
Duration of control (and need for multiple treatments)	Shorter?	Longer?
Creation of channels	Good	Not so good
Control of plants over a large area	Not so good	Good
Additional Considerations		
Cost	Often higher	Often lower
Variability in cost	Higher	Lower
Disposal of harvested plants	Can be difficult to find a place where plants can be delivered	Not applicable (plants decompose in lake)
Potential spread within a lake	Should not be employed on lakes where the distribution of milfoil is limited	Can be employed on lakes where the distribution of milfoil is limited
Effects on non-target organisms or lake ecosystem		
Removes invertebrates, fish, frogs, snakes, turtles, etc.	Yes	No
When target plant is exotic, removal or destruction of native vegetation	Yes	Yes or no, depending on particular herbicide used
Increased fragmentation	More	Less
Disturbs sediment and causes suspension of sediment in the water column, which in turn may reduce water clarity	Often does, likely to a greater extent	May do so, likely to a lesser extent
Potential negative effects of introducing chemicals into the aquatic environment	No (except hydraulic fluid and oil from breaks in lines)	Yes
Restrictions on use of water after treatment	No	In some cases
Selectivity	Limited or none	Some are, some are not
Minnesota Regulations (M.R. 6280)		
Small area can be treated without a permit to control milfoil or other submersed aquatic plants	Yes	No (<u>Always</u> requires a permit from the DNR)
Limit on the amount of area that may be treated	50% of the littoral zone	15% of the littoral zone

Attachment 3

Detailed Cost Breakdown

Middle Fork Crow River Watershed District Curly Leaf Management Alternative Analysis Net Present Value Costs

Note: All costs are assumed due at the beginning of each year.

Updated 10/6/2010

Discount Rate = 4%

Alternative 1 -Harvesting Only

Area Treated = 200 acres

Capital Costs

Year	Cost	PV	Notes
1	\$57,750.00	\$57,750.00	New Conveyor; New Harvester 2020

Annual Costs

Years 1-15	\$25,588.00	\$284,497.30	Harvesting Annual Cost
------------	-------------	--------------	------------------------

Total Cost =	\$342,247.30
Annual Cost =	\$22,816.49
Cost Per Ac/Yr =	\$114.08

**Middle Fork Crow River Watershed District
Curly Leaf Management Alternative Analysis
Detailed Cost Breakdown**

10/6/2010
CJM

Alternative 1 - Harvesting Only

Equipment		Quantity	Unit Cost	Present Worth Cost	Total Cost
	New Conveyor (2010) (1)	1	LS	\$38,000	\$38,000
	Replacement Harvester (2020) (2)	1	LS	\$17,000	\$17,000
				Total Capital Cost =	\$55,000
				Contingency (5%) =	\$2,750
				Total Cost =	\$57,750
O&M					
Equipment	Fuel/insurance (3)	1	Per year	\$3,000	\$3,000
	Maintenance (3)	1	Per year	\$3,000	\$3,000
Labor	Crew (3)	1	Per year	\$10,000	\$10,000
	Permit (3)	1	Per year	\$750	\$750
Storage	Harvester Storage (3)	1	Per year	\$500	\$500
Disposal	Aquatic Plant Disposal (3)	1	Per year	\$5,000	\$5,000
				Total Annual Cost	\$22,250
				Contingency (15%) =	\$3,338
				Total Cost =	\$25,588

(1) Based on average of vendor quotes

(2) Assumes a used harvester would be purchased in 2020 to replace original harvester. Present worth cost assumes a 4% discount rate

(3) Based on Association's Harvesting Program Costs (2009-2010) and comments from Joel Peterson

Middle Fork Crow River Watershed District Curly Leaf Management Alternative Analysis Net Present Value Costs

Note: All costs are assumed due at the beginning of each year.

Updated 10/6/2010

Discount Rate = 4%

Alternative 2 - Harvesting (200 acres) with Herbicide Treatment (60 acres)

Area Treated = 260 acres

Capital Costs

Year	Cost	PV	Notes
1	\$57,750.00	\$57,750.00	New Conveyor; New Harvester 2020

Annual Costs

1	\$37,778.00	\$36,325.00	Harvesting and Herbicide Treatment
2	\$49,278.00	\$45,560.28	Harvesting and Herbicide Treatment
3	\$49,278.00	\$43,807.96	Harvesting and Herbicide Treatment
4-15yr	\$25,588.00	\$213,488.27	Harvesting Only Annual Cost

Herbicide Treatment Only

Spot Treatments - Years 5,7,9,11,13,15

5	\$8,510.00	\$6,994.60	Herbicide Spot Treatment (25%)
7	\$8,510.00	\$6,466.90	Herbicide Spot Treatment (25%)
9	\$8,510.00	\$5,979.01	Herbicide Spot Treatment (25%)
11	\$8,510.00	\$5,527.93	Herbicide Spot Treatment (25%)
13	\$8,510.00	\$5,110.89	Herbicide Spot Treatment (25%)
15	\$8,510.00	\$4,725.30	Herbicide Spot Treatment (25%)

Total Cost = \$431,736.15

Annual Cost = \$28,782.41

Cost Per Ac/Yr = \$110.70

Middle Fork Crow River Watershed District Curly Leaf Management Alternative Analysis Detailed Cost Breakdown				10/6/2010			
				CJM			
Alternative 2 - Harvesting (200 acres) with Herbicide Treatment (60 acres)							
Harvesting							
Equipment		Quantity	Unit Cost	Present Worth Cost	Total Cost		
	New Conveyor (2010) (1)	1	LS	\$38,000	\$38,000		
	Replacement Harvester (2020) (2)	1	LS	\$17,000	\$17,000		
				Total Capital Cost =	\$55,000		
				Contingency (5%) =	\$2,750		
				Total Cost =	\$57,750		
O&M - Harvester							
Equipment	Fuel/Insurance (3)	1	Per year	\$3,000	\$3,000		
	Maintenance (3)	1	Per year	\$3,000	\$3,000		
Labor	Crew (3)	1	Per year	\$10,000	\$10,000		
	Permit (3)	1	Per year	\$750	\$750		
Storage	Harvester Storage (3)	1	LS	\$500	\$500		
Disposal	Aquatic Plant Disposal (3)	1	Per Site	\$5,000	\$5,000		
				Total Annual Cost	\$22,250		
				Contingency (15%) =	\$3,338		
				Total Annual Cost =	\$25,588		
Herbicide Treatment							
Year 1	Primary Treatment (4)	60	AC	\$260	\$15,600		
	Permitting	1	Per Year	\$1,000	\$1,000		
	Monitoring (5)	1	LS	\$4,000	\$4,000		
	DNR Grant	1	LS	(\$10,000)	(\$10,000)		
				Total Annual Cost	\$10,600		
				Contingency (15%) =	\$1,590		
				Total Annual Cost =	\$12,190		
Years 2-3	Primary Treatment (4)	60	AC	\$260	\$15,600		
	Permitting	1	Per Year	\$1,000	\$1,000		
	Monitoring (5)	1	LS	\$4,000	\$4,000		
				Total Annual Cost	\$20,600		
				Contingency (15%) =	\$3,090		
				Total Annual Cost =	\$23,690		
Years 5,7,9,11,13,15	Spot Treatment (4)	15	AC	\$260	\$3,900		
	Permitting	1	Per Year	\$1,000	\$1,000		
	Monitoring (5)	1	LS	\$2,500	\$2,500		
				Total Annual Cost	\$7,400		
				Contingency (15%) =	\$1,110		
				Total Annual Cost =	\$8,510		
(1) Based on average of vendor quotes							
(2) Assumes a used harvester would be purchased in 2020 to replace original harvester. Present worth cost assumes a 4% discount rate							
(3) Based on Association's Harvesting Program Costs (2009-2010).							
(4) Based on Lake Association costs treating 80 acres in 2010							
(5) Monitoring assumed 2 staff would be required to complete 56 hrs of monitoring including vegetation sampling, water quality, and sediment sampling							

Middle Fork Crow River Watershed District Curly Leaf Management Alternative Analysis Net Present Value Costs

Note: All costs are assumed due at the beginning of each year.

Updated 10/6/2010

Discount Rate = 4%

Alternative 3 - Harvesting (200 acres) with Herbicide Treatment (80 acres)

Area Treated = 280 acres

Capital Costs

Year	Cost	PV	Notes
1	\$57,750.00	\$57,750.00	New Conveyor; New Harvester 2020

Annual Costs

1	\$43,758.00	\$42,075.00	Harvesting and Herbicide Treatment
2	\$55,258.00	\$51,089.13	Harvesting and Herbicide Treatment
3	\$55,258.00	\$49,124.16	Harvesting and Herbicide Treatment
4	\$37,318.00	\$31,899.58	Harvesting and Herbicide Treatment
5	\$37,318.00	\$30,672.68	Harvesting and Herbicide Treatment
6-15yr	\$25,588.00	\$184,503.73	Harvesting Only Annual Cost

Herbicide Treatment Only

Spot Treatments - Years 7,9,11,13,15

7	\$10,005.00	\$7,602.98	Herbicide Spot Treatment (25%)
9	\$10,005.00	\$7,029.38	Herbicide Spot Treatment (25%)
11	\$10,005.00	\$6,499.06	Herbicide Spot Treatment (25%)
13	\$10,005.00	\$6,008.74	Herbicide Spot Treatment (25%)
15	\$10,005.00	\$5,555.42	Herbicide Spot Treatment (25%)

Total Cost = \$479,809.85
Annual Cost = \$31,987.32
Cost Per Ac/Yr = \$114.24

Middle Fork Crow River Watershed District Curly Leaf Management Alternative Analysis Detailed Cost Breakdown					10/6/2010				
					CJM				
Alternative 3 - Harvesting (200 acres) with Herbicide Treatment (80 acres)									
Harvesting									
Equipment			Quantity	Unit Cost	Present Worth Cost	Total Cost			
	New Conveyor (2010) (1)		1	LS	\$38,000	\$38,000			
	Replacement Harvester (2020) (2)		1	LS	\$17,000	\$17,000			
					Total Capital Cost =	\$55,000			
					Contingency (5%) =	\$2,750			
					Total Cost =	\$57,750			
O&M - Harvester									
Equipment	Fuel/Insurance (3)		1	Per year	\$3,000	\$3,000			
	Maintenance (3)		1	Per year	\$3,000	\$3,000			
Labor	Crew (3)		1	Per year	\$10,000	\$10,000			
	Permit (3)		1	Per year	\$750	\$750			
Storage	Harvester Storage (3)		1	LS	\$500	\$500			
Disposal	Aquatic Plant Disposal (3)		1	Per Site	\$5,000	\$5,000			
					Total Annual Cost	\$22,250			
					Contingency (15%) =	\$3,338			
					Total Annual Cost =	\$25,588			
Chemical Treatment									
Year 1	Primary Treatment (4)		80	AC	\$260	\$20,800			
	Permitting		1	Per Year	\$1,000	\$1,000			
	Monitoring (5)		1	LS	\$4,000	\$4,000			
	DNR Grant		1	LS	(\$10,000)	(\$10,000)			
					Total Annual Cost	\$15,800			
					Contingency (15%) =	\$2,370			
					Total Annual Cost =	\$18,170			
Years 2-3	Primary Treatment (4)		80	AC	\$260	\$20,800			
	Permitting		1	Per Year	\$1,000	\$1,000			
	Monitoring (5)		1	LS	\$4,000	\$4,000			
					Total Annual Cost	\$25,800			
					Contingency (15%) =	\$3,870			
					Total Annual Cost =	\$29,670			
Years 4-5	Primary Treatment (4)		20	AC	\$260	\$5,200			
	Permitting		1	Per Year	\$1,000	\$1,000			
	Monitoring (5)		1	LS	\$4,000	\$4,000			
					Total Annual Cost	\$10,200			
					Contingency (15%) =	\$1,530			
					Total Annual Cost =	\$11,730			
Years 7,9,11,13,15	Spot Treatment (4)		20	AC	\$260	\$5,200			
	Permitting		1	Per Year	\$1,000	\$1,000			
	Monitoring (5)		1	LS	\$2,500	\$2,500			
					Total Annual Cost	\$8,700			
					Contingency (15%) =	\$1,305			
					Total Annual Cost =	\$10,005			
(1) Based on average of vendor quotes									
(2) Assumes a used harvester would be purchased in 2020 to replace original harvester. Present worth cost assumes a 4% discount rate									
(3) Based on Association's Harvesting Program Costs (2009-2010).									
(4) Based on Lake Association costs treating 60 acres in 2010									
(5) Monitoring assumed 2 staff would be required to complete 56 hrs of monitoring including vegetation sampling, water quality, and sediment sampling									

Middle Fork Crow River Watershed District Curly Leaf Management Alternative Analysis Net Present Value Costs

Note: All costs are assumed due at the beginning of each year.

Updated 10/6/2010

Discount Rate = 4%

Alternative 4 - Whole Lake Herbicide Treatment Only

Area Treated = 412 acres

Capital Costs

Year	Cost	PV	Notes
1	-\$29,000.00	-\$29,000.00	Sell Existing Equipment

Annual Costs

1	\$117,438.00	\$112,921.15	Whole Lake Herbicide Treatment
2	\$128,938.00	\$119,210.43	Whole Lake Herbicide Treatment
3	\$128,938.00	\$114,625.41	Whole Lake Herbicide Treatment
4	\$113,988.00	\$97,437.42	Harvesting and Herbicide Treatment
5	\$113,988.00	\$93,689.83	Harvesting and Herbicide Treatment

Herbicide Treatment Only

Spot Treatments - Years 7,9,11,13,15

7	\$16,284.00	\$12,374.50	Herbicide Spot Treatment (10%)
9	\$16,284.00	\$11,440.92	Herbicide Spot Treatment (10%)
11	\$16,284.00	\$10,577.78	Herbicide Spot Treatment (10%)
13	\$16,284.00	\$9,779.75	Herbicide Spot Treatment (10%)
15	\$16,284.00	\$9,041.93	Herbicide Spot Treatment (10%)

Total Cost =	\$562,099.12
Annual Cost =	\$37,473.27
Cost Per Ac/Yr =	\$90.95

**Middle Fork Crow River Watershed District
Curly Leaf Management Alternative Analysis
Detailed Cost Breakdown**

10/6/2010

CJM

Alternative 4 - Whole Lake Chemical Treatment (412 acres)

Harvesting

Equipment	Quantity	Unit Cost	Present Worth Cost	Total Cost
Old Harvester (1)	1	LS	(\$6,000)	(\$6,000)
New Harvester (1)	1	LS	(\$23,000)	(\$23,000)
			Total Capital Cost =	(\$29,000)
			Total Cost =	(\$28,000)

Chemical Treatment

Year	Item	Quantity	Unit Cost	Present Worth Cost	Total Cost
Year 1	Primary Treatment (2)	412	AC	\$260	\$107,120
	Permitting	1	Per Year	\$1,000	\$1,000
	Monitoring (3)	1	LS	\$4,000	\$4,000
	DNR Grant	1	LS	(\$10,000)	(\$10,000)
				Total Annual Cost	\$102,120
			Contingency (15%) =	\$15,318	
			Total Annual Cost =	\$117,438	
Years 2-3	Primary Treatment (2)	412	AC	\$260	\$107,120
	Permitting	1	Per Year	\$1,000	\$1,000
	Monitoring (3)	1	LS	\$4,000	\$4,000
				Total Annual Cost	\$112,120
				Contingency (15%) =	\$16,818
			Total Annual Cost =	\$128,938	
Years 4-5	Primary Treatment (2)	382	AC	\$260	\$94,120
	Permitting	1	Per Year	\$1,000	\$1,000
	Monitoring (3)	1	LS	\$4,000	\$4,000
				Total Annual Cost	\$99,120
				Contingency (15%) =	\$14,868
			Total Annual Cost =	\$113,988	
Years 7,9,11,13,15	Spot Treatment (2)	41	AC	\$260	\$10,660
	Permitting	1	Per Year	\$1,000	\$1,000
	Monitoring (3)	1	LS	\$2,600	\$2,500
				Total Annual Cost	\$14,160
				Contingency (15%) =	\$2,124
			Total Annual Cost =	\$16,284	

(1) Based on average of vendor quotes

(2) Based on Lake Association costs treating 60 acres in 2010

(3) Monitoring assumed 2 staff would be required to complete 56 hrs of monitoring including vegetation sampling, water quality, and sediment sampling.