

As shown above in Scenario 2, by reducing all TP from human activity (surface runoff from medium density urban and rural and septic tanks), mesotrophic status can be attained. This is theoretically the maximum that can be accomplished by Best Management Practices (BMP's).

5.2 Dowling

We considered four TP loading scenarios for Dowling. In the first scenario we eliminated the surface runoff TP from medium density urban and rural residents (Scenario 1). Secondly we removed all septic tanks loading of TP in addition to removing MD urban and rural loading (Scenario 2). Thirdly we reduced the total external TP loading by 50% (Scenario 3). Finally we increased the total TP loading by 25% (Scenario 4). The table below summarizes the expected Wisconsin TSI's for TP, Chlorophyll a and Secchi Depth for all four scenarios:

Scenario	TSI-TP	TSI-Chlorophyll a	TSI-Secchi Depth
1	54	53	55
2	53	52	54
3	50	50	52
4	57	55	57

Table 11

As shown above, even by reducing all TP loading by 50% in Scenario 3, Dowling lake is still only on the border of becoming Mesotrophic. This modeling indicates that employing BMP's alone would not be enough to bring Dowling Lake to Mesotrophic status.

As discussed in Section 3.3.3, significant internal loading is suspected in Dowling Lake. Based on WiLMS Modeling, we estimate 65 kg of the total phosphorus load of 155.4 kg (or 42%) comes from internal loading. If the external phosphorus loading to Dowling is reduced (as discussed above), phosphorus release from the sediment could have a larger effect on phosphorus concentration. If external phosphorus loading was reduced, phosphorus release from sediments would not be expected to decrease immediately. Therefore, the internal loading would be higher (relative to external loading) for several years and may result in higher in-lake phosphorus concentrations than expected given the lower external phosphorus loading.

6. Feasibility Studies

As summarized in the above section, reducing or eliminating all phosphorus loading from human activity (septic tank loading, surface water runoff from lawns and impervious surfaces) would definitely increase water quality in both lakes. Per scenario 2 for Amnicon Lake, this could theoretically bring Amnicon to Mesotrophic Status. However, eliminating all phosphorus loading due to human activity in Dowling would still leave the lake eutrophic (scenario 2). In fact reducing all external loading to Dowling by 50% would still leave Dowling classified as eutrophic (scenario 3). In addition, based on the

modeling performed, we estimate 42% of the loading in Dowling is from internal loading.

Therefore, it is logical that since limiting external loading to Dowling would not greatly change the water quality, we should evaluate in-lake solutions. Three possible restoration solutions were considered; Biomanipulation, Dredging and Alum Addition. Biomanipulation is adjusting the fish species composition in a lake as a restoration technique. After reviewing the fishery data and discussing both lakes with the DNR fish biologists, at this time biomanipulation does not make sense. Specifically, according to Cordell Manz, the pan fish population is relatively low in both lakes and the game fish population, especially bass is increasing. Since the typical biomanipulation strategy is to increase the predators and decrease the pan fish, biomanipulation probably would not work. At this time the DNR would not recommend adjusting the fish population in either lake. However, a comprehensive fish survey is scheduled for 2006 in Amnicon Lake. Once this work is completed, we recommend reviewing the data and reevaluate whether biomanipulation makes sense. Below is a discussion of the other two possible restoration solutions.

6.1 Dredging

Dredging is used to remove sediments, vegetation and debris from a water body. Dredging may be a solution to many problems a water body has, but may also have high costs, both monetary and biological. It is important to define the main reason for a dredging project when determining the feasibility of a project. The assumption made in this report is that the main reason to consider dredging is to develop defined channels for lake property owners to have lake access from their shoreline, but also as a possible means of improving the water quality.

Dredging can improve the ability to navigate waterways, provide deeper channels for fish in winter, and remove nutrients and plant life from the body of water. Removing sediments that are rich in nutrients may help reduce the amount of macrophyte vegetation and algae. Deeper water may also affect dissolved oxygen and water temperature positively. This is due to creating a larger epilimnion layer at the beginning of winter, reducing the chance that the lake may become anoxic and causing winter fish kills. Approximately 42% of the loading to Dowling Lake is from internal loading. Based on our research, if 50% of the total loading is due to internal loading from sediments, there may be some benefit in dredging (assuming the underlying sediments are lower in phosphorus concentrations). If internal loading is less than 50% of the nutrient budget, dredging may be of limited value.

Dredging may not be a permanent solution for the lake access problem, and will most likely not be a long term solution for plant growth and available nutrients which contribute to the plant growth. Erosion from the surrounding area needs to be further examined to determine the rate of sedimentation to the lake because having to repeatedly dredge would not be cost effective. This is especially true since both lakes are considered drainage lakes.

Disturbing the thriving Macrophyte vegetation would allow invasive plants to more readily establish themselves along with increasing the amount of available phosphorous that contributes to algae blooms. In 1993, Dan Ryan from the Wisconsin DNR stated, "Disturbance of the Macrophyte stands should be kept to an absolute minimum." This is still true given the high amount of phosphorus in the water and in the sediment. Sediment samples were collected in Amnicon and Dowling lakes in 2003. Five sediment samples from each lake were analyzed for lead, mercury and oil and grease. (See Appendix 7) Based on the results, the oil and grease levels are fairly high (ranged from 4,000 to 6,000 ppm). This oil and grease could be due to historic outboard motor use, runoff from roads or possibly other sources. This oil and grease level should be considered when contemplating dredging. High levels of lead, mercury and petroleum may affect the cost of removal and disposal of the dredged sediments and could be cost prohibitive. The approximate cost to remove the bottom 1 foot of Dowling would be \$1.5 million and to remove 3 feet from Dowling would be \$4.5 million. This is using a rate of \$6/cubic yard, which is at the low end of the price range.

Amnicon and Dowling Lakes are designated by the Wisconsin DNR as a Priority navigable waterway, and as an Area of Special Natural Resource Interest (ASNRI). Both Lakes are an ANSRI because of the naturally reproducing Muskellunge and Walleye, and Amnicon also has natural areas of Wild Rice. Dredging could endanger these areas of special interest. An Exemption would have to be applied for because of the ANSRI designation. A WDNR permit as well as approval by the Corps of Engineers would also be required prior to dredging being allowed.

Given the nature of the fishery, the current type of vegetation and the danger of exotic plant species such as, Purple Loosestrife and Eurasian Water Milfoil, several additional factors need to be examined before dredging can be recommended. The factors include but are not limited to the likelihood that the WDNR permits would be issued for dredging, a study to determine the yearly sediment loading into the lakes and a study to investigate the nutrient and pollutant make up of the sediments to be dredged.

6.2 Alum Addition

The addition of Alum or Aluminum Sulfate can significantly reduce the total phosphorus level in a lake. Without getting into a discussion of the technical details of the chemical interactions that reduce the phosphorus level, suffice it to say Alum ties up or reduces available phosphorus in the sediments into the water column. There are several things to consider before recommending Alum addition. The type of phosphorus present in the sediments is more important than the density of the sediments. For instance, calcium-bound phosphorus is more inert than iron or Aluminum bound phosphorus. Therefore, iron-bound or Aluminum-bound phosphorus is more likely to be exchangeable than calcium-bound phosphorus. Amnicon and Dowling Lakes are fairly soft lakes (lots of calcium and magnesium in the water). Prior to adding Alum, the water and sediments should be tested to determine the exchangeable phosphorus in the sediments and the hardness, buffering capacity, alkalinity and ph of the water.

Before considering dredging or alum addition, the sediment should also be analyzed at the surface and at depth to determine the pre-settlement (approximately 150 years ago) phosphorus conditions of the water column. This could be accomplished by collecting and analyzing sediment cores, specifically looking at the diatom community, which would give you the phosphorus concentrations in the water column at that time. It should also be possible to determine the accumulation rate in the lake(s), specifically the sedimentation rate and the soil erosion rate. Once this is completed, the pre-settlement conditions will be known, so we will know how good we can expect the lake(s) to get.

If it appears Alum addition would be effective after testing is completed, it could be done say once every five years, or perhaps the dosing could be increased to three times in five years. This could all be determined through a feasibility study. Regarding cost, a general rule of thumb for alum treatment is \$1000 per lake acre. So for Dowling Lake, the approximate cost would be \$154,000.

7. Lake Project Ideas for Protecting Both Lakes

The work performed for this project has given us a snapshot of lake conditions in 2003 and 2004. Compared to the last 25 years, Amnicon has remained stable, barely mesotrophic to eutrophic. Dowling has gotten progressively worse over the same time period, remaining eutrophic. The stage of eutrophication of both lakes is at a level where the possibility exists for significant water quality problems in the future. Phosphorus is a critical nutrient in the eutrophication of the lakes and all available measures should be employed to reduce or eliminate all controllable sources of phosphorus to both lakes. The following details how both lakes can be protected. The sections are broken up into three sections: Best Management Practices, Recommended Lake Projects and Lake Monitoring.

7.1 Best Management Practices (BMP's)

This study has shown that the main contributor of phosphorus load is from the watershed, not from human activities. However, the education of homeowners around the lake with respect to septic system and lawn maintenance and shoreline protection is crucial. This is because near shore activities are of greater significance in term of phosphorus loading due to the relatively natural undeveloped condition of the watershed. Minimizing the phosphorus loading that we can control will prevent the lakes from getting worse.

This is especially true considering the extremely high degree of development surrounding both Amnicon and Dowling Lakes. It is encouraged that land owners develop and maintain vegetative, shoreline buffer zones of 20 feet or more if possible. Buffer zones help reduce and interrupt nutrient runoff from associated yards and groundwater that would otherwise enter the lake, thus improving water quality and helping reduce the number of large algae blooms (which are common occurrences on Dowling Lake).

Buffer zones that allow the growth of trees, shrubs, and grasses also help to prevent erosion from wave and ice action that can occur, which is responsible for the destruction of important spawning and rearing habitat for fish species. Rip-rapping of shoreline areas is also discouraged unless native plants are planted along with the rip-rap, because of its similar nature to be detrimental to habitat important for spawning and rearing of fish species, through the wave action it usually generates along the shorelines. Buffer zones also enhance the appearance of the lakeshore by giving it a more natural profile. It is also recommended that home owners avoid activities such as excessive fertilization of lawns, clearing shoreline areas of aquatic plants to make "swimming beaches", dumping raked leaves or lawn clippings into the lake, high speed boating in shallow lake areas, and other similar activities. We recommend that the Lake District implement an information and education effort to advise residents of land use activities that could contribute nutrients to the lake system. Dumping leaves, ashes, animal waste, lawn clippings, excessive lawn fertilization, etc. are examples of practices that should be discouraged.

We also recommend that lake shore residents have their soil tested, so they do not use too much fertilizer. We recommend using phosphorus-free-fertilizer, the one with an "O" in the middle for the NPK (nitrogen-phosphorus-potassium) ratio.

We also recommend inspecting and repairing septic systems. Many individual septic systems are not working properly, or are improperly connected to tile lines. Maintain systems with periodic pumping and good use practices.

7.2 Recommended Lake Projects

Below are lake projects that can be completed to improve the lake quality on both lakes.

7.2.1 Shore Protection and Habitat Enhancement

In the spring of 2002 work was done to the shoreline of Amnicon on the west part of the north shore, adjacent to Tri-Lakes Road. The work was done by Ashland, Bayfield, Douglas and Iron (ABDI) County Land Conservation Department. The installation of large rock, rip-rap, fill, geotextile liner and native plants were done in an effort to reduce erosion of shoreline next to the road to protect the shoreline and increase habitat for animals. The plan for this work was designed by the USDA, Natural Resources Conservation Service (NRCS). This project accomplished two goals, reducing sediment loading into the lake and protecting walleye spawning area. Essentially the north shore from the Campground to Finn Point on the east is the preferred walleye spawning area on Amnicon Lake. See Appendix 12 for a map showing the preferred walleye spawning areas on Amnicon Lake.

We recommend a similar project as the above project for areas within the rest of the walleye spawning area on Amnicon Lake. In addition, in this same area we recommend that lakeshore owners "disconnect impervious surfaces", either driveways, manicured lawns, or roads, to the lake. This can be accomplished by redirecting stormwater to vegetated areas or possibly installing impervious "green" driveways.

Another project we recommend is to develop a prevention and control strategy for alien species near both lakes. For instance, purple loosestrife was noted along Dowling. There would be a benefit to removing or controlling this plant, in order to allow native species to again take hold and flourish.

7.3 Lake Monitoring

Both Amnicon and Dowling Lakes are high quality resources with excellent fisheries. There is some indication that any significant increase in the trophic level of both lakes may be manifested in the critical decrease of fisheries habitat in late winter. Specifically, low dissolved oxygen levels can reduce suitable living space to a few feet in the epilimnion during late winter. Therefore, we recommend dissolved oxygen testing in December, January, February and March to check for the possibility of winterkill. Dissolved oxygen conditions should be correlated with ice-on days and snow cover.

In addition, it is important to monitor both lakes during the growing season (May-September) to check the conditions of the lake. Dissolved oxygen and temperature profiles should be collected at the "deep hole" of both lakes at least once a month during the growing season. Secchi disk readings should also be taken at the same time.

The Self-Help Monitoring Program through the Wisconsin Lakes Partnership of the WDNR was utilized in Dowling Lake in 2001 and 2002. No monitoring records from the program were found for Amnicon at least back to 1995. In our opinion, the lake monitoring efforts need to be reenergized, so if the lake conditions are noticeably improving due to BMP's or lake projects, this can be observed. Similarly if the condition of the lakes is noticeably changing, the WDNR will be notified, so restorative measures may be taken.

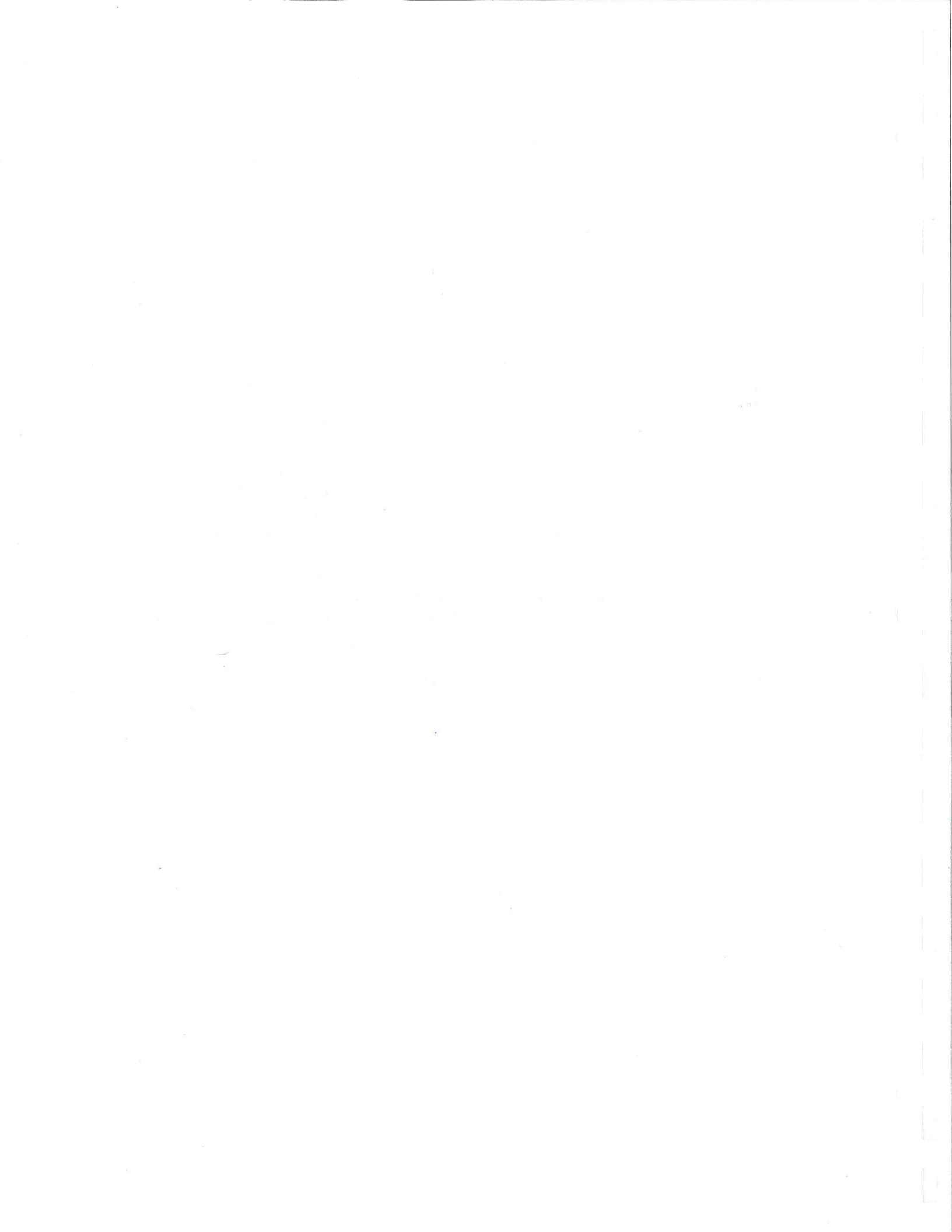
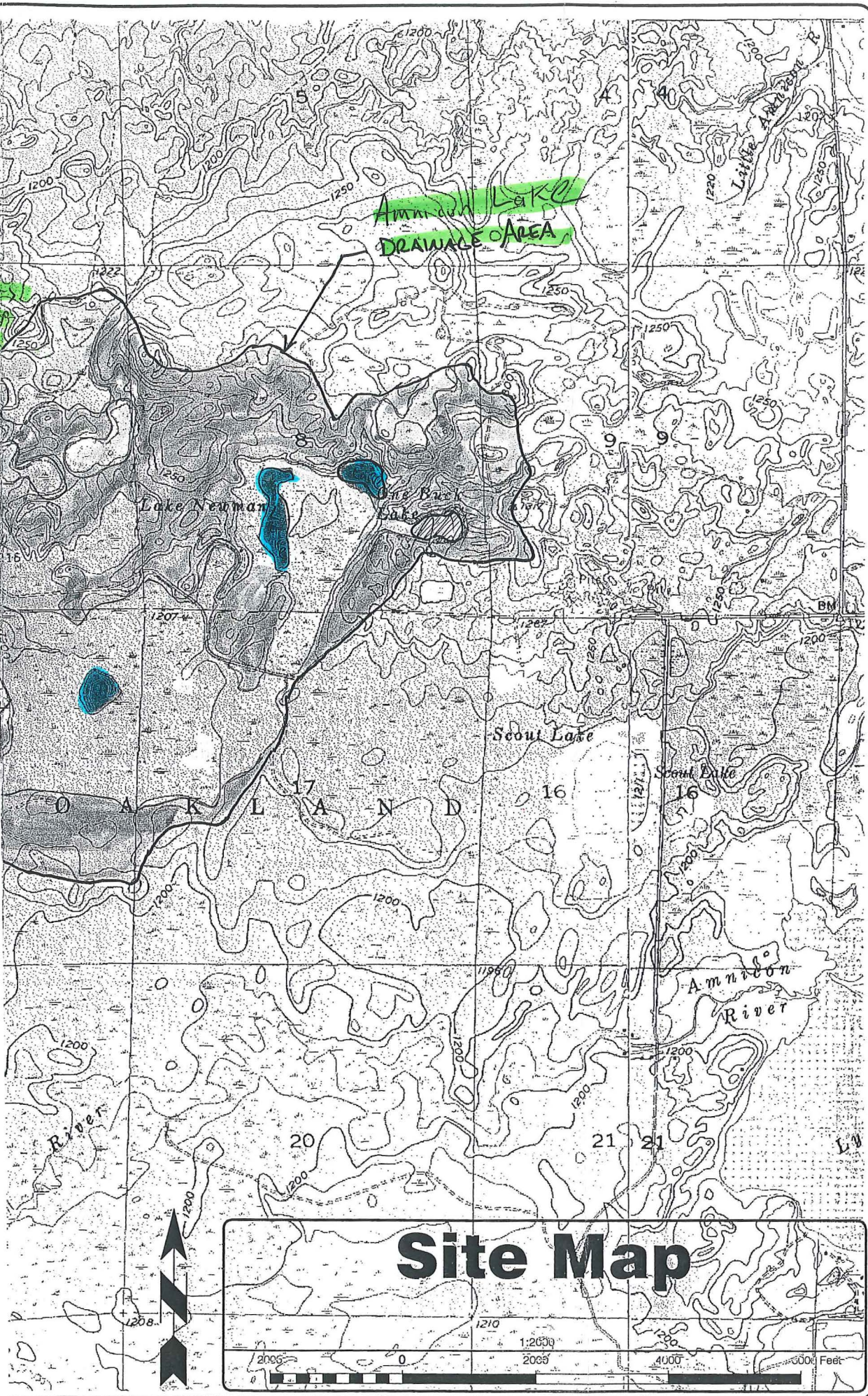


Figure 1

General Location/Watershed Map

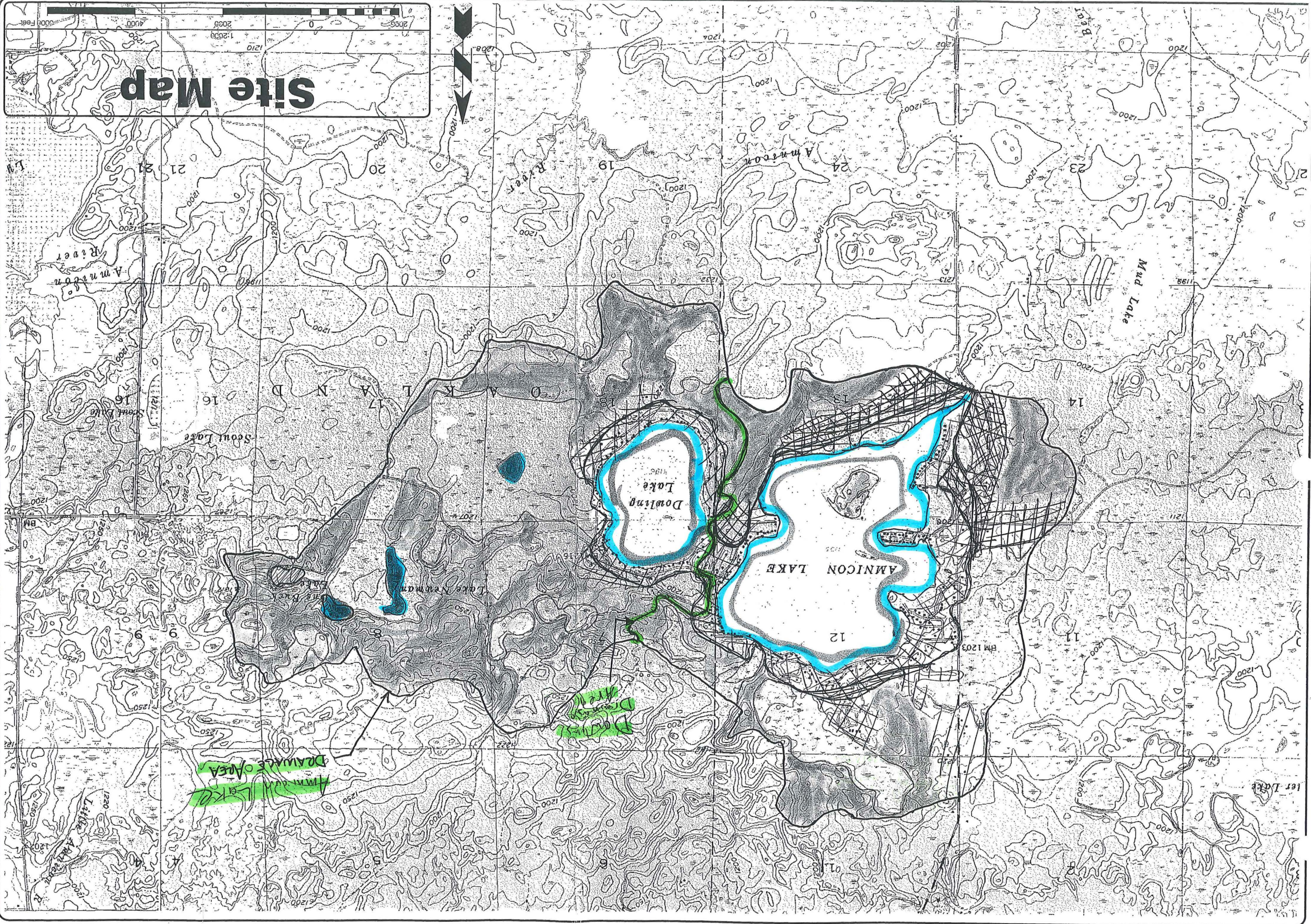


PROJECT TITLE: Amnicon/Dowling
 DRAWING TITLE: Site Map
 PROJECT LOCATION: Amnicon/Dowling, WI
 LEAK #:
 SCALE:
 DRAWN BY: TOM

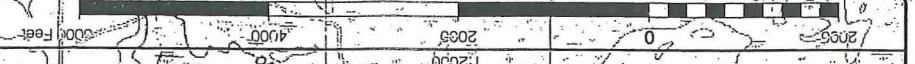
FIGURE: 1

-  = wetland (per topog)
-  = forest
-  = mounds (4000' radius)
-  = lake

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Site Map



Wetland (per top)
 Forest
 Mud and
 Rnmls
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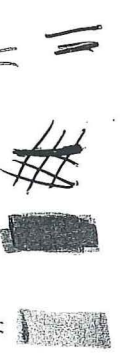


FIGURE:

1

PROJECT TITLE: Amnicon/Dowling

DRAWING TITLE: Site Map

PROJECT LOCATION: Amnicon/Dowling, WI

SCALE: DRAWN BY: TOM

LEAK #:

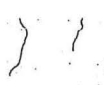
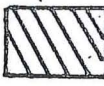

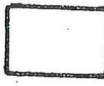
Figure 2
Regional Glacial Geology Map

FIGURE 2

GLACIAL DEPOSITS IN DOUGLAS COUNTY

153.8 ACRES
 3 FT. 8
 T. 0
 2 ACRES P.P.M.
 5 MI.

LEGEND

-  PITTED OUTWASH
-  GROUND MORAINE
-  END MORAINES
-  GLACIOLACUSTRINE DEPOSITS

