U.S. ENVIRONMENTAL PROTECTION AGENCY
CLEAN LAKES PROGRAM
PHASE II GRANT APPLICATION
FY 1995

HESS LAKE
NEWAYGO COUNTY, MICHIGAN

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Prepared for:
The Michigan Department of Natural Resources
The Hess Lake Improvement Board

Project No. F92347

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U.S. ENVIRONMENTAL PROTECTION AGENCY
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HESS LAKE
NEWAYGO COUNTY, MICHIGAN

The following information is presented in response to comments received from the Environmental Protection Agency (EPA) for the FY 94 Clean Lakes Grant Application for Hess Lake.

Public swimming is permitted at the Michigan Department of Natural Resources (MDNR) access facility located on the northwest side of Hess Lake.

Calculation of the internal phosphorous loading for Hess Lake is an extensive task and one that is obviously not cost-effective. The estimated cost to perform this task is over $12,000 with no real benefit to be gained. Previous reports have documented that alternatives to significantly reduce the internal phosphorus load (in addition to aquatic vegetation harvesting) are not feasible. Dredging has been recommended, but is cost prohibitive (Page 10, narrative statement; Page 15, 1993 Diagnostic Evaluation Report). The successful application of Alum treatments on a 750-acre lake is unlikely and would also be cost prohibitive (Page 10, narrative statement; Page 12, 1993 Diagnostic Evaluation Report). Banning motorized watercraft on one of the largest recreational lakes in the Grand Rapids area is not practical. However, community education, in regard to the best use areas for high-speed boating activities to encourage safety as well as environmental benefits, (i.e., reduction in the amount of sediment stirred up in shallow areas of the lake) is recommended. Maps will be distributed to lake residents and made available to lake users; signs will be posted at the public access site, and the topic of high-speed boating practices will be included in Lake Association newsletters and articles. The estimated cost for this educational component is $1,500 over three years and has been included in the implementation plan and budget.

The harvesting of aquatic macrophytes is the only viable implementation measure for the removal of internal phosphorous at this time. The Hess Lake Board has spent over $169,500 on aquatic plant harvesting since the program began in 1983, and is committed to continuing the program indefinitely. The 1982 Feasibility Study is estimated that between 100 and 200 kilograms of internal phosphorous are removed per 100 acres harvested. This correlates well with research done by Burton, et al. (1979) as referenced in Restoration and Management of Lakes and Reservoirs (Page 322), by Cooke, et. al, regarding the likely range of macrophyte biomass per unit area for northern U.S. lakes and research compiled by Mackenthun in a paper entitled Nutrients and Their Relationship to Weed and Algal Growths (1970), regarding percentage of phosphorous per dry weight of submerged vascular plants. The Hess Lake Board harvests approximately 75 percent of the lake area or between 500 and 600 acres. Conservatively, this corresponds to approximately 500 kilograms of internal phosphorous removed annually, or an estimated 6,000 kilograms of internal phosphorous removed during 12 years of harvesting. At the same time, plants are left rooted along the bottom to hold phosphorous enriched sediments in place. Additional benefits include reduced chemical applications. However, studies by Peterson et al. (1974) as referenced in Restoration and Management of Lakes and Reservoirs (Page 323)

by Cooke, et al., found that continued plant harvesting was ineffective in reducing phosphorous concentrations in lakes where a large external load was present, as is the case for Hess Lake. Therefore, measures to reduce the external phosphorous load are extremely important if any progress is to be made in improving lake quality.

The permitted septage disposal area located within the drainage district is regulated by Michigan environmental and public health laws. Isolation distances of a minimum of 500 feet are required from surface water bodies. Soils testing is required and maximum application rates are mandated so that adverse environmental impacts are avoided. After subsequent water quality testing by the Newaygo County Health Department, this was found to be a functioning site. There is no basis for petitioning to shut down this disposal area and relocate it to another watershed.

The MDNR is proposing to perform a fish flesh analysis for Hess Lake. A request will be made of the Surface Water Quality Division to include this task in its fish flesh monitoring program.

Estimates of projected phosphorous load reductions for each of the alternative measures are included in the 1982 Feasibility Study with the exception of macrophyte management and the sediment basins recommended for implementation. Macrophyte harvesting and sediment basin projections are presented here.

> The cost efficiency of macrophyte management is estimated conservatively at $28 per kilogram of phosphorous removed.
>
> The five sediment basins recommended are predicted to cumulatively remove approximately 840 kilograms of phosphorous entering Hess Lake per year. Calculations are attached. These calculations are based on a 60 percent removal efficiency for soil particles classified as silts with increasingly greater removal efficiencies for fine to course sands. Settling efficiency was increased over the 50 percent efficiency used in the 1993 Diagnostic Evaluation Report to meet the required reduction in phosphorous load. A 25 percent removal efficiency was estimated for total dissolved phosphorous from the wetland component of each sediment basin. The estimated project cost for sediment basin/wetland construction is $635,500 including operation and maintenance costs over a 30-year period, yielding a cost efficiency of $25 per kilogram of phosphorous removed.

The Hess Lake Association has an annual meeting which is held each June. The last such meeting was held in June 1994. The Newaygo County Drain Commissioner's Office is committed to hold a public hearing in response to petitions in the Wheeler or Alger Drain drainage districts. The last such meeting was held in June 1993. The Board is committed to hold another public meeting for the proposed project within the next six months (prior to grant award). Public input on specific lake quality improvement levels will be sought and documented. Documentation will include proceedings of the meeting, questions asked by the public, responses to those questions, and the results of any notes taken. Evidence of notification will be provided.

The Phase II frequency of wet weather stream flow sampling has been increased to five per year for the first and third implementation years only, and omitted for year two. Dry weather sampling locations have also been modified for year two to include only lake samples. These changes are justified to keep the cost of monitoring down, and because year two is anticipated to be a construction year which would tend to influence monitoring results.

The phytoplankton sample schedule has been adjusted as follows:

Spring	(1 time)
Summer	(2 times)
Fall	(1 time)

The shoreline management guidebook will follow the example of that prepared for Mitchell Lake. The estimated cost shown on Page 18 has been revised.

The State Historical Society/Officer will be consulted prior to any earth disturbances. Copies of this correspondence will be forwarded to the EPA.

There will be no negative downstream flood impacts by construction of the sediment basins because they are proposed to be constructed outside of the channel flood plain. A portion of the flood flows will bypass these basins and be conveyed by the channel as is presently the case.

A diversion of water from the Hess Lake watershed to an adjacent watershed is viewed as the transfer of a problem and is generally not allowed by the MDNR. The adjacent Rogue River is also a designated trout stream — one of the few in southern Michigan.

The 1982 Feasibility Report projected that 800 kilograms of external phosphorous would need to be removed from the Hess Lake system annually to mitigate the accelerated eutrophication of Hess Lake. Estimates of external phosphorous removal from the use of sediment basins total 840 kilograms per year, as shown in the attached calculations. In addition, estimates of internal phosphorous removed from the harvesting of aquatic plants is calculated to be 500 kilograms per year.

A cooperative educational and initiatives component between the Hess Lake Board, lake residents, local farmers, the Newaygo County Drain Office and the Soil Conservation District has been included in the project plan and will be implemented with the aid of grant monies if received.

Operation and maintenance (O & M) costs apply to the sediment basins proposed for implementation. Annual O & M costs are estimated at $6,400 per year, per basin, based on actual maintenance costs over the 9-year period that the Wheeler Drain sediment basin has been in operation. The present value of the sediment basin/wetland component (consisting of a series of five basins) is $635,500 for a 30-year design life.

An operation and maintenance program will be submitted within 90 days of receiving a Clean Lakes Award for all implementation measures included in the final project.

No water quality testing was completed for the update of the Hess Lake Report.

A quality assurance plan for sample collection, handling, and analysis will be submitted within 30 days of receiving a Clean Lakes Award.

I. NARRATIVE STATEMENT

DIAGNOSTIC STUDY

Identification and Location

Hess Lake is 755 acres in surface area and lies in the west central portion of Michigan's Lower Peninsula, Longitude 85°45'50" Latitude 43°22'49". Hess Lake is located in Brooks and Grant Townships in Newaygo County.

Major tributaries to Hess Lake include the Wheeler and Alger Drains located south of the Lake. An outlet channel is located on the north side of Hess Lake and connects to Brooks Lake, which then outlets via Brooks Creek to the Muskegon River. The Muskegon River eventually empties into Lake Michigan which is part of the St. Lawrence Seaway drainage basin. A vicinity map is included on the inside cover of the *Hess Lake Engineering Feasibility Report* (Feasibility Report) (Attachment 2). A map of the 15 square mile drainage area is included as Figure 3 of the same report.

Approved State of Michigan water quality standards are contained in the Michigan Administrative Code, Department of Natural Resources, Water Resources Commission General Rules, Part 4 - Water Quality Standards, adapted effective December 13, 1973, and amended effective January 18, 1985 and November 29, 1986.

Geology and Soils

The soils in the Hess Lake vicinity consist primarily of deep dry sands of the rubican, roselawn, and plainfield series. These soils do little to restrict the movement of water and nutrients beneath the surface. Previous studies have indicated that the direction of ground water flow appears to be toward the Lake except perhaps near the outlet and for a short stretch along the north edge of the Lake.

Soils in the southern portion of the drainage basin consist primarily of well drained loams and organic soils.

Estimates of soil loss are best illustrated by the graph of sediment accumulation in Hess Lake shown in Figure 5 of the Feasibility Report. Estimates from lake sediment borings indicate approximately 20 feet of deposition has occurred over the last 10,000 years, and approximately 5 feet of deposition

in the last 100 years. This translates to approximately 101,500 cubic yards of soil loss per year over the course of almost a century.

Public Access and Transportation

384 LAKE FRONT PARCELS

Hess Lake receives a great deal of use both during the summer and the winter. There are approximately 550 lake-front residents. The Michigan Department of Natural Resources (MDNR) maintains a three acre public access on the west side of the Lake. This is the point of entry for most nonresidential use, although the County owns two small riparian parcels that are lightly used. In general, the Lake is very accessible to the public.

Public transportation service to Hess Lake is not available although it is easily reached by automobile from Grand Rapids and Muskegon within an hour. It is conveniently located near M-37 and M-82, two major transportation routes. The Village of Newaygo lies about two miles north of the Lake. The Village of Grant lies approximately 3.5 miles southwest of Hess Lake. Residents of these Villages have long used Hess Lake as one of their recreational resources.

Population and Economic Structure

The majority of Hess Lake lies in Brooks Township. The Township is recreational based with a year round population in 1990 of 2,728. The current state equalized valuation for Brooks Township is $42,937,900. A small portion of Hess Lake also lies in Grant Township. Grant Township has a firm agricultural base with a permanent 1990 population of 2,558. The current state equalized valuation for Grant Township is $24,467,900. The entire permanent population for the Newaygo County was 38,202 in 1990 with a current equalized valuation of $531,602,376.

Tourism and recreation form the major economic base for the Hess Lake area. Sporting goods stores, marinas, restaurants, gasoline stations, and other support businesses are prevalent in the area and depend upon the high quality recreational resources. Many of the lake users are tourists who stay in nearby campgrounds and motels. There is also a substantial "downstate" non-resident component who own week-end cottages and homes. One previous study indicated the lake population can triple on busy weekends. Agriculture in the southern portion of the watershed is also still prevalent.

Historical Uses

Lake use has paralleled lake quality. A condensed history is included in Table 1 of the *Hess Lake Diagnostic Evaluation and Feasibility Report* (Diagnostic Evaluation Report) (Attachment 1). Hess Lake was heavily developed in the first half of this century. Initially, a lumber mill was operated at the west end of the lake. Two resorts that included water sports and recreation equipment were operated on Hess Lake until the 1950's. Sport fishing was a major activity through the 1950's but reached a low in the late 1970's and early 80's. It is the general consensus of realtors and assessors that lake property values have also followed the trends in lake quality, reaching a low in the 1970's and early 80's. Values seem to be rebounding now, at least partially due to the perception of an active Hess Lake Board and Lake Improvement Association undertaking lake rehabilitation projects.

Hess Lake has long been a popular recreation area for both local residents and people from the larger cities to the south, such as Grand Rapids and Muskegon. The lake's relatively large size, circular shape, productive fishery, and accessibility have aided its popularity.

Impacts of Lake Degradation

The deteriorating lake quality over the last two decades has affected lake use. In the 1950's and 1960's Hess Lake was a prime fishing lake for panfish and northern pike. Water skiing was also very popular and swimming was enjoyed in the shallow and relatively warm water. Schools, churches, and civic groups often used the lake for picnics, parties, and swimming instruction. All of these uses saw a substantial decline over the last 20 years. Excessive macrophyte growth, summer long blue-green algal blooms, a deteriorating fishery, and high turbidity put Hess Lake on the "less than desirable" list for many former visitors.

The group hardest hit by the deteriorating quality of Hess Lake is the riparian land owners. In the early 1980's the Hess Lake Improvement Board became increasingly active in lake improvement policy and actions. The group held meetings and informed their members through newsletters on proposed actions. The Board also actively advised the Lake Association to help with project decision making. The Board quickly became the leader in the harvesting program and now does the actual harvesting work contracted through the Lake Association. This involvement is a primary example of the homeowner's response to a critical situation and their dedication to finding a solution. To aid in this process, and clarify the relationship between those factors contributing to the present status of the lake, a cause-and-effect flow chart was compiled and is shown in Figure 3 of the Diagnostic Evaluation Report.

Relative Status

There are a number of other lakes within a half hour's drive of Hess Lake. Newaygo, Bills, Fremont, Diamond, Brooks, Sand and Baptist Lakes all have public accesses. There are many other small lakes and ponds in the area, but most are privately owned and/or are inaccessible. Hess Lake is one of the largest lakes in Newaygo County, and as such has attracted a large percentage of use.

Fremont Lake is included in the Brooks Creek Watershed Project. Brooks Creek is a neighboring watershed which is currently receiving Clean Water Act, Section 319 monies.

Inventory of Point Source Discharges

Industrial and other point sources of pollution do not exist in the Hess Lake watershed.

Land Use and Nonpoint Source Inputs

The largest part of the 15 square mile Hess Lake watershed lies to the south of the lake. Two established county drains, the Wheeler and Alger, transport most of the water to the lake. They drain an area of mixed forest, vacant land, residential land, and farm land. Figure 4 in the Feasibility Report and Appendix A of the Hess Lake Watershed Third Quarter Report (Attachment 4) show the Hess Lake watershed and its land uses, which have remained generally unchanged in the last decade as confirmed with aerial reconnaissance during the spring of 1993.

A water and nutrient budget were completed as part of the Feasibility Report to define nonpoint source inputs. The water and nutrient budgets were based on sampling data for most sources. All the surface streams and drains were sampled several times throughout the one year study period. Cross sectional flow was measured with a pygmy velocity meter with phosphorus samples taken at the same time.

Both snow melt and rainfall events were measured on surface input streams. These flow-per-time profiles were then increased or decreased in amplitude according to the intensity of the average 40 rainfall events per year and the flows summed. The phosphorus concentration was similarly graphed over the course of the flow increase due to the rainfall event. The phosphorus concentrations and flows were related through regression and the total annual input of phosphorus was calculated.

Groundwater input was calculated according to the average velocity through known soil types and at known grades for a distance of up to 500 meters from the lake shore, depending on the watershed boundary. Phosphorus concentrations in groundwater were based on values found commonly throughout Michigan. Septic input was based on the same amount of water use and phosphorus concentrations used to design wastewater treatment systems for rural areas. Results of the analysis indicated that a total of approximately 2050 kilograms (kg) of phosphorous was entering Hess Lake from all external sources per year. This is 800 kg more than the lake can permissibly tolerate. Annual water and phosphorous inputs are shown in Figure 6 of the Feasibility Report. Although these figures were compiled in 1982, they are still believed to be valid with the following considerations.

The major changes which have occurred in the drainage basin in the past decade directly affecting phosphorous inputs to Hess Lake include additional homes and septic systems build around the lake, a sediment basin constructed at the outlet of the Wheeler Drain, and annual weed harvesting in Hess Lake.

The Feasibility Report indicated that phosphorous from septic systems makes up 12 percent of the total input. The number of lake residences has increased from 384 in 1972 to 548 in 1992 for an additional 164 homes. Therefore, by direct proportion, the estimated increase in phosphorous input is 103 kg or 5 percent of the total estimated annual input of 2050 kg.

The sediment basin at the outlet of the Wheeler Drain prevents a large amount of course sediment from entering Hess Lake. However, previous studies have stated that a 0- to 25-percent reduction in phosphorous concentrates is all that was observed upon monitoring. Assuming 25 percent removed during base flow and an average of 12.5 percent removed during rains and snow melt, this equates to removing a maximum of 150 kg of phosphorous annually, or 7 percent of the total input. Therefore, very little reduction in phosphorous load (offset by the additional increase from septic input) would be expected from this improvement.

A weed harvesting program was begun in 1983 and removes an average of 200 tons of weeds annually from Hess Lake. It is estimated that between 500 and 600 acres, or approximately 75 percent of the Lake is harvested annually. The Feasibility Report indicates that the cutting of 100 acres would remove approximately 100 to 200 kg of phosphorous annually. By conservative estimates, approximately 500 kg of phosphorous is removed annually by harvesting. However, because this represents removal of both internal phosphorous (already present in the lake in bottom sediments) as well as external phosphorous (input from various non-point sources) the 500 kg cannot be directly subtracted from nutrient input totals. A detailed analysis of the amount of internal phosphorous load

available to Hess Lake has not been completed. It is recognized that internal phosphorous loading is a significant source of nutrients. Studies by Gertrude Nurnberg, a Canadian researcher, have indicated that for shallow, eutrophic lakes such as Hess Lake, up to 50 or 60 percent of the total phosphorous load can be internal. Therefore, it is concluded that the total annual phosphorous load in Hess Lake from both external and internal inputs is greater than 2050 kg per year.

It is evident that no lasting and substantial lake improvement can be expected until both the internal and external phosphorus load is significantly reduced. Emphasis has been placed on eliminating external sources due to the magnitude of the problem of remediating internal phosphorous loads.

It is clear from the nutrient budget that the Wheeler Drain is the single most significant input of water and phosphorus. It is important to note that the south portion of the Wheeler Drain (upstream of 112th Street) has a low grade, minimal base flow, and carries primarily fine particulate matter following rainfall events. It was estimated that this portion of Wheeler Drain contributes 52 percent of the water and 60 percent of the phosphorous load carried by the drain (approximately 1/3 of the external phosphorous input to Hess Lake). Flows in the southern section are also very erratic. The northerly portion (downstream of 112th Street) has a steeper grade, is less impacted by immediate runoff, has a significant base flow, and carries a substantial coarse particle load when flows increase.

The Alger Drain contributes the second largest phosphorous input to Hess Lake. The channel is not experiencing the severe streambank erosion observed in the lower reaches of the Wheeler Drain; however, it carries some of the highest phosphorous concentrations recorded during sampling. The outlet of the Alger Drain has been diverted, and flows through a natural wetland area prior to entering Hess Lake. A permitted septage disposal area is also actively used adjacent to the Alger Drain near 96th Street.

Limnological Data

Water quality data, dating back to 1972, shows a steady lake quality decrease to 1982. Carlson's Trophic State Index (Carlson 1977) Values are shown in Table 3 of the Diagnostic Evaluation Report. In 1982, lake management began in earnest including harvesting, some chemical control, coarse sediment removal, and implementation of best management practices upstream. In 1985 the water quality of Hess Lake increased for the first time in 12 years. Data from 1991 and 1992 indicates a slight backsliding trend. Although lake quality has been seen to improve since the 1970s and early 1980s, Hess Lake needs to make significant progress to be considered a good quality, warm water inland lake.

Major studies and water quality data gathering for Hess Lake began in 1972. At that time, a study of sediment resuspension contained many water transparency measurements. In 1974, the Michigan Department of Natural Resources (MDNR) conducted its first periodic water quality sampling. The MDNR sampled again in 1985. This information is presented as the STORET data in Attachment 3.

A more encompassing study in 1982 included lake quality definition, watershed analysis, and improvement project proposals. Water quality information is well defined in the *Hess Lake Engineering Feasibility Report*, which recounts the known lake quality measurements from 1972 through 1981.

Additional water quality data was gathered in 1980, 1982, 1984, and 1985 as part of the Self-Help Program, and consisted of transparency measurements and chlorophyll a counts. Nutrient testing was also done in 1991 and 1992 at the direction of the Hess Lake Improvement Board. An Executive Summary and subsequent Diagnostic Evaluation and Feasibility Report were prepared in 1993 to present past information in a concise format and provide guidance for pragmatic and economically feasible improvement projects. Taken together, these studies form a very complete picture of the historical lake quality, the problems, and the most reasonable solutions for the improvement of Hess Lake.

In summary, both the 1982 and the 1992 data indicate excessive phosphorous concentrations entering Hess Lake from external sources. The nutrient budget completed in 1982 shows that external inputs exceed the nutrient balance by approximately 800 kg per year, taking into account internal phosphorous loading, a much higher actual annual load is realized. The vertical temperature and dissolved oxygen data indicates that due to the shallowness of the lake, the hypolimnion remains aerobic, although turbidity is consistently high.

A lake vegetation inventory map was prepared and is included as Figure 6 in the Diagnostic Evaluation Report. Primary species of macrophytes in Hess Lake include Elodea, Curly Leaf Pondweed, Bushy Leaf Pondweed, and Eurasian Milfoil. An algal survey was completed in 1982 as part of the Feasibility Report. Data showed drastic increases in algal cell concentrations from April through August with a slight rise in September. The dominant algae species during the summer season was a bluegreen algae known as Microcystis that can be toxic to humans and livestock. Benthos samples were also taken in 1981 and 1982 and are presented in the Feasibility Report.

Fish flesh and bacteriological analysis were not completed during the 1982 study to concentrate efforts on developing an accurate nutrient and hydrologic budget, which would reveal the most

important information about the problems observed in Hess Lake. Water samples were not taken at the frequency recommended in the EPA guidelines because the sampled frequency was sufficient to determine the hydrologic and nutrient budget and draw important conclusions about the condition of Hess Lake. Water samples were also not analyzed for suspended solids and alkalinity.

The physical aspects of the lake and its watershed are defined in the 1993 Diagnostic Evaluation Report and in Figures 1 and 2 of the Feasibility Report and will not be reiterated here. The average hydraulic residence time is calculated to be six months.

Related Activities

Harvesting of macrophytes began in 1983 and has been an important component of the ongoing lake improvement program. Between 500 and 600 acres are harvested annually. This activity has not only helped preserve recreational use but has also removed a significant amount of nutrients. The Lake Board has invested over $169,500 into this effort in the 12 years since it began. Chemical control of in-lake weeds has been used since 1986. Approximately 100 acres is treated annually. Treatments of 2,4-D helped open up areas previously difficult to harvest. The chemical treatments also helped gain control over the Eurasian milfoil. The Lake Board has committed over $184,000 to chemical applications over the past 10 years. A lake vegetation management plan was prepared and followed in 1993 in response to concerns over an apparent low fish population voiced by the MDNR fisheries division during the fall of 1992.

In 1986, a sediment basin was constructed just upstream from Hess Lake on the Wheeler Drain. This structure is about three acres in size and 4 to 6 feet deep with continuous flow-through. It captures large amounts of coarse sediment moving downstream that would otherwise enter the lake. The Wheeler Drain Drainage District spends an average of $6,400 annually to maintain this basin.

During 1985 and 1986, an interagency watershed improvement program called the Hess Lake Watershed Project identified upstream areas in need of erosion control. These areas were then targeted for bank stabilization, rip-rap, and seeding. Several drop structures were also installed on the Wheeler Drain in 1986 and 1987. This work has contributed to a reduction in coarse particle transport; however, remaining work needs to be done as evidenced by the amount of sediment removed during sediment basin maintenance operations and the visible delta at the inlet of the basin.

Despite the recent increase in water quality, Hess Lake remains in poor shape. Bluegreen algal blooms are still common throughout the summer. Turbidity is high. Recreation is impacted and property

values are reduced. The recent improvement activities have had positive results but much work remains to be done before acceptable lake quality is obtained.

Biological Resources

Hess Lake is a shallow, eutrophic lake which has predominantly a bass, bluegill, and northern pike sport fishing population. Crappies and sunfish are also commonly caught by anglers. The lake is the site of two or three fishing tournaments per year, and the participants are successful enough that they often come back.

Historically, Hess Lake has been considered a good fishing lake with an excellent northern pike fishery. However, over the last 10 to 15 years, the fishery has declined, and the lake residents have noted that the lake is not as clear and is more weedy than it had been. Many studies have been funded by Hess Lake residents in an attempt to define the source of the slow deterioration and to reverse this trend.

Modifications to the weed harvesting and control program were initiated with the advice of a professional lake management consultant. Based on the program results, further evaluation of the weed control program, and concerns about weed control expressed by the MDNR, a long-term weed management plan is being developed which will address the fisheries, recreational, and biological needs of the lake. The goal is to obtain a lake management plan which incorporates water quality protection with the multiple uses of this important resource.

FEASIBILITY STUDY

Pollution Control and Restoration Alternatives

Numerous lake improvement alternatives were evaluated in the 1982 Feasibility Report and are summarized in the 1993 Diagnostic Evaluation Report. The 1993 report also presents some additional pollution control alternatives based on the recent development of Best Management Practices (BMPs) for watersheds. These were the alternatives that were found to be most feasible and were recommended for implementation through a comprehensive non-point source pollution control program.

Elements of this program are designed to reduce non-point source pollution in the watershed and restore natural buffers and filters that have been destroyed by unconscientious land use practices.

The intent is to control pollution before it starts, through incentives, education, structural measures, providing resource people to work with citizen groups, public participation, and monitoring.

However, satisfactory improvements to Hess Lake will not be realized without accomplishing two things:

1. Reduction of the external phosphorous inputs through prudent land management practices and structural measures to target the source of the inputs, and through in-channel controls to provide a more complete pollutant reduction program.

2. Reduction of the internal phosphorous load, which may be accomplished in a variety of ways. In accomplishing this objective, an increase in lake depth would also serve to improve the quality of Hess Lake.

Recommended pollution control alternatives to meet the first objective include streambank stabilization, wetland protection, and land use BMPs as well as in-stream control measures designed to remove the excess phosphorous and fine sediment loads entering Hess Lake. These in-stream measures are included to compliment and improve the efficiency achieved using source controls alone.

Alternatives available to accomplish the second objective are not as readily implemented due to high cost, regulatory constraints, and land acquisition. Dredging or the use of alum technology to remove internal phosphorous were determined to be cost prohibitive for lake district residents. Dredging a minimum of 30 percent of the lake area to a depth of 15 feet is estimated to cost $12 million or more. The use of alum was determined to be ineffective given the shallowness of the lake and the turbulence created by motorized watercraft use. The large surface area of the lake makes this alternative extremely costly as well with estimates of $1,500,000 for startup and $40,000 for annual maintenance over an indefinite period of time. Therefore, implementation of this type of project is not included in the FY 1995 Phase II Clean Lakes Grant Application, although it is recognized that in order to have a comprehensive lake improvement program, measures to reduce internal phosphorous are necessary. The Lake Board plans to continue with a prudent program for the management of macrophytes to aid in the removal of internal phosphorous from the lake system.

Specific elements of the non-point source pollution control program are listed below:

1. **Sediment Basin Retrofitting.** Retrofitting of the existing sediment basin at the mouth of the Wheeler Drain to lengthen suspension time and incorporate wetland features into the basin is

recommended as an effective in-channel measure for nutrient removal. The estimated cost for this work is $45,000. Expected water quality benefits include the capture of finer soil particles and adsorbed nutrients. It was determined during the 1989 Sand Filtration Feasibility Study that the fine soil particles are contributing significantly to the nutrient overload in Hess Lake. Conceptual drawings of the proposed sediment basins are shown in Figure 4 of the Diagnostic Evaluation Report.

2. **Sediment Basin/Wetland Area Construction.** Installation of three sediment basins/wetland areas on the Wheeler Drain and one on the Alger Drain are proposed for upstream areas. These would be designed in accordance with recommended MDNR guidelines and would be used as in-channel measures for nutrient and sediment removal. Environmental impacts due to the installation of the basin structures is discussed later. The estimated cost for this work is $150,000. Expected benefits are similar to those described in Item 1.

3. **Streambank Stabilization.** Installation of grade control structures and streambank erosion control measures along the 2 miles of the Wheeler Drain north of 112th Avenue and along 1 mile of the Alger Drain north of 104th Avenue is recommended to reduce the sediment load entering the system. The estimated cost for this work is $100,000. Expected benefits include reducing the amount of coarse sediment transported by the drains, reducing erosion and aiding in the improvement of fish habitat by promoting a channel bottom free of excess sediment deposition. This work is viewed as a continuation and an extension of the streambank stabilization measures installed during the 1986-1987 Hess Lake Watershed project.

   Soil Conservation Service techniques for river restoration will be used for bank protection. These techniques include the use of treetops and branches strategically placed in channel and secured to the bank to divert erosive flow velocities and promote sediment deposition. Conventional methods for grade control will be used such as rip rap and culvert drop structures.

4. **Agricultural BMPs.** Study findings indicate that phosphorous loads from the Wheeler and Alger Drains, which are located in agricultural watersheds, are the primary source of pollution input to Hess Lake. Therefore, developing a non-point source control strategy for agricultural areas is an important component to protect Hess Lake and the surrounding water resources in the long term.

Aerial reconnaissance and field surveys were completed in 1993 to document and identify critical areas. Representatives of the United States Department of Agriculture (USDA), Soil Conservation Service (SCS), and the Newaygo County Soil Conservation District (SCD) were contacted to discuss implementation strategies for developing individual conservation plans. Grant monies will be used to retain a SCD technician to work with farmers in the Hess Lake Watershed. A district conservationist is presently working with the Brooks Creek Watershed Project, and would be available to commit approximately 30 percent of his/her time to the Hess Lake project. The estimated cost of employing a SCD technician for a period of three years is $30,000.

In addition, as a result of the Brooks Creek Watershed Project, a Geographic Information System (GIS) data base will be available for soils, land ownership, and other information that will aid in development of the non-point source pollution control strategy. This state-of-art scanning and mapping system will be utilized for the Hess Lake project by working through the SCD.

Existing federal cost share programs would be utilized to implement BMPs included in individual conservation plans.

Specific BMPs that will be considered include:

- Permanent Vegetative Cover Establishment
- Reduced Tillage or No Till Practices
- Cropland Protective Cover
- Surface Runoff Diversions
- Integrated Pest Management
- Fertilizer Management

5. **Shoreline Management.** Education in regard to shoreline management and incentives for lakeside property owners will be promoted through the continued circulation of the quarterly Hess Lake Newsletter, as well as the publication of a guidebook with specific "dos and don'ts" for the protection of Hess Lake. Grant monies will be used for the organization and publication of a guidebook to be made available to riparian land owners, residents within the watershed, and other interested parties. The estimated cost for this task is $6,500.

Encouragement for eliminating phosphorous fertilizer use will be continued. This will be implemented by education and encouragement for improved shoreline management through riparian zone green belting. The sandy soils adjacent to Hess Lake are not extremely conducive for the support of lush, green lawns. The use of alternative native species of vegetation could help reduce fertilizer use. Grant monies will be used to educate riparian land owners in good shoreline management, and to purchase nursery stock for use in demonstration plots around the lake. The estimated cost for this work is $7,500.

6. **Wetland Protection.** The creation of wetland areas in conjunction with sediment basins is being proposed as one component of the non-point source pollution control program. Protection of existing wetlands is also key in obtaining long-term water quality benefits. Wetland areas over 5 acres and those contiguous to inland lakes and streams are protected under Michigan's Goemaere-Anderson Wetland Protection Act (Act 203, PA 1979, as amended). However, because Newaygo County is under 100,000 in population, the MDNR has not conducted a wetland inventory and some smaller wetlands may be exempt from state regulation. Farming activities are also not under the regulatory scrutiny of the state. For this reason, a wetland inventory is proposed to be conducted to better define this natural resource in the watershed. The wetland inventory would aid the USDA in carrying out the Swampbuster provisions in the Food Security Act of 1985, which denies subsidies to farmers who implement certain farming practices in natural wetland areas. This work will tie in directly with the GIS system being developed as part of the Brooks Creek Watershed Project. The inventory will be completed by the SCD technician utilizing the GIS data base.

Programs for wetland restoration are also available to private land owners through organizations such as the Michigan Wildlife Habitat Foundation that works with interested farmers and riparian owners to find wetland restoration projects to promote wildlife habitat. Communication of available programs such as this will be included in the educational effort through the work of the SCD technician and publication of the Hess Lake guidebook.

The wetland area at the outlet of the Alger drain is generally protected under the provisions of Act 203. To ensure the maximum possible benefit from this wetland area, consideration was given to the future purchase of this property by the Lake Board or the Newaygo County Drain Commissioner's office.

7. **Macrophyte Management.** In an effort to reduce the internal phosphorous load in Hess Lake, the Lake Board has committed to implementing a program for macrophyte management.

Specific measures in the lake vegetation management plan include the careful harvesting of macrophytes to remove plant biomass from the lake, while leaving root systems in tact to stabilize bottom sediments. Selective harvesting is also a key component. The lake board is committed to performing this work as part of the local match in funding. The average annual costs for harvesting and limited chemical treatment, multiplied out over three years, is $106,400.

8. **Monitoring.** The proposed three-year water quality and biological monitoring program is discussed in detail in following sections.

Public Benefits

In general, pollution control and restoration measures are expected to have numerous advantages, including

Economic:

- Increased property values of riparian land owners.
- Increased draw of visitors/tourists from the surrounding area.

Environmental:

- Long-term eutrophication abatement.
- Wetland restoration.
- Reduction of soil loss.
- Increased understanding of the lake and watershed ecosystem and the effectiveness of non-point source pollution control.
- Preservation of fish and wildlife communities.

Specifically, expected lake improvements include a shift in algal species to more desirable types, a reduction in algal densities, a resultant improvement in the quality of the zooplankton community, an improvement in the quality, diversity and density of the benthic community, and a shift to more diverse and desirable species of macrophyte. To the lake user, this means "cleaner" looking water, less algae to contend with, and a healthier and more abundant fish population.

It is recognized that specific in-lake benefits may not be realized at once, due in large part to the amount of internal phosphorous bound to bottom sediments, and the shallowness of the lake. The

turbulence and resuspension of sediments caused from the use of large motor boats and the introduction of jet skies on Hess Lake within the last several years has served to keep this phosphorous in the water column where it promotes the prolific growth of macrophytes and algae. With controlled lake usage and implementation of measures to remove internal phosphorous through macrophyte management, visible improvements to Hess Lake may be sooner in coming.

Brooks Lake (293 acres) is located immediately downstream from Hess Lake and receives nearly all of its water from the Hess Lake outflow. Improvements in water quality for Hess Lake will also carry through to Brooks Lake.

Phase II Monitoring

Water quality and biological monitoring of Hess Lake and its major tributaries is included to meet the following objectives:

- To evaluate water quality conditions in Hess Lake and its major tributaries.
- To evaluate the effectiveness of the implemented improvements.
- To detect any trends in water quality and plant communities.

The proposed Phase II water quality monitoring program will consist of the analysis of surface water samples for the following parameters:

Total Dissolved Solids
Total Suspended Solids
Total Phosphorous
Dissolved Phosphorous
Total Inorganic Nitrogen
Total Organic Nitrogen
Dissolved Oxygen (lake samples only)
Chlorophyll a (lake samples only)
Fecal Coliform

Other physical parameters that will be measured include:

Transparency by secchi disk (lake samples only)
pH
Temperature
Flow

A three-year monitoring program is proposed for Hess Lake. Sampling depths for lake samples will include both surface and bottom. Tributary samples will be taken mid-depth. Samples will be taken for both dry-weather and wet-weather flow on the following schedule:

Water Quality Sampling Frequency		
Year	Dry-Weather	Wet-Weather
1	Spring (1x) Late Summer (1x)	Spring through Fall (5x)
2	Spring (1x) Late Summer (1x) (Hess Lake only)	None
3	Monthly (12x)	Spring through Fall (5x)

Eleven sampling locations are proposed as follows and are shown on Figure 1.

Hess Lake Samples:
West side of lake (H-10)
Northeast side of the lake at outlet to Brooks Lake (H-2)

Tributary Samples:
Alger Drain
-Outlet (H-7)
-96th Street (H-8)
-M-37 (new location)

Wheeler Drain
-Outlet (H-5)
-Upstream of sediment basin (new location)
-112th Street (H-6)
-120th Street (new location)

Dowling Drain
-Willow (new location)
-M-37 (new location)

The proposed Phase II Biological monitoring program for Hess Lake will be integrated with the recommended five-year lake vegetation management program indicated in the Diagnostic Evaluation Report. Macrophytes will be mapped annually in the spring. Samples for the qualitative analysis of phytoplankton will be taken at one lake sampling location in the deep basin of the lake according to the following schedule:

Phytoplankton Sampling Frequency			
Year	Spring	Summer	Fall
1	(1x)	(2x)	(1x)
2	(1x)	(2x)	(1x)
3	(1x)	(2x)	(1x)

Phase II Schedule

Item of Work	Duration
Sediment Basins/Wetland Creation	
Design and Easement Acquisition	Fall 1995 to Summer 1996
Bidding	Fall 1996
Construction	Fall 1996 to Summer 1997
Streambank Stabilization	Summer 1996
Agricultural BMPs and GIS	Fall 1995 to Fall 1998
Shoreline Management	
Guidebook	Winter 1995 to Fall 1996
Riparian Green Belt Education	Winter 1995 to Fall 1998
Education for Boating Practices	Spring 1996 to Fall 1998
Wetland Protection	
Inventory	Spring 1996 to Winter 1996
Macrophyte Management	Ongoing
Phase II Monitoring	Fall 1995 to Fall 1998

Phase II Budget and Payment Schedule

Description	Total Cost	Federal Share	Non-Federal Share
MDNR Administration	15,000	15,000	0
Phase II water quality monitoring (MDNR laboratory fees)	26,200	26,200	0
Professional Consultant Fees Design and Inspection 39,000 Monitoring and QAP 22,300 Guidebook Preparation 4,000 Macrophyte Mapping 5,000	70,300	22,300	48,000
SCD Consulting Fees Conservation Plans GIS Wetland Inventory	30,000	30,000	0
Sediment Basin/Wetland Creation	171,000	41,000	130,000
Streambank Stabilization	85,000	10,000	75,000
Shoreline Management Guidebook 2,500 Riparian Greenbelts 7,500 Boating Practices 1,500	11,500	11,500	0
Macrophyte Management	106,400	0	106,400
Total	515,400	156,000	359,400

The proposed budget provides for a 70 percent match of non-federal funds based on total project cost, and a 62 percent match of non-federal funds excluding the macrophyte management component.

Technical and Monetary Resources

The technical resources available at the local level are significant and proven. The Hess Lake Association has long been active in monitoring lake quality through the Self-Help Program administered by the MDNR. Secchi disk transparency and chlorophyll a measurements have been taken for several summers by the Association. The Association has also been continuously active in an advisory and public information role particularly concerning proposed lake improvement projects. Their active participation in the weed harvesting program was previously noted. It is expected that the Association will continue to be actively involved.

The Hess Lake Improvement Board is an advisory group consisting of representatives from the Lake Association, Grant and Brooks Townships, the Newaygo County Drain Commissioner, and representatives of the MDNR. The office of the Drain Commissioner brings with it expertise in drain and construction work and administration of projects. Other members bring their knowledge of local needs and political forces to the Lake Board.

Other technical resources are also available to help in guiding lake improvement projects. The local Soil Conservation Service is actively working on watershed management. Michigan State University experts in limnology and fisheries are often available for consultation through the Cooperative Extension Service. Contracted services are available for civil engineers, consulting lake biologists, and excavation contractors to help implement desired projects.

Monitory resources available at the local level are collected primarily through taxation. The Hess Lake Improvement Board is the legally constituted government entity that has the power to levy special assessments for lake improvement projects and the power to carry out those projects. The Board currently assesses a total of about $37,500 annually for lake improvement activities. The public has been very supportive of the Lake's Board activities and the Board feels it has considerable flexibility in approaching future lake improvement projects.

The Drain Commissioner also levees special assessments for projects deemed necessary under Michigan drainage law. Both the Wheeler and Alger Drains are legally established county drains and the districts are liable for assessment for projects and maintenance initiated under the Michigan Drain Code.

Relation to Other Pollution Control Programs

At the present time, no other state or federally funded pollution control programs are being used for Hess Lake. However, elements of the non-point source pollution control program will directly involve USDA SCS staff. Agricultural BMPs implemented in the Hess Lake watershed will be financed in large part through USDA cost-share programs.

Public Participation

Two formal hearings were held to solicit comments regarding the proposed implementation plan and generally inform the public of the activities of the Hess Lake Improvement Board and results of the 1993 Executive Summary Report, which was later expanded into the Diagnostic Evaluation and Feasibility Report.

The first meeting held in June 1993, was the annual meeting of the Hess Lake Association. The second meeting held in August 1993, was a Board of Determination required by state law in response to a petition filed with the Drain Commissioner for improvements to the Wheeler Drain.

Support for the proposed project was high at the first meeting. Many positive verbal comments were received, and a petition was filed with the Drain Commissioner to initiate the proposed work on the Wheeler Drain. The Board of Determination elicited many negative responses from landowners in the Wheeler Drain drainage district, and demonstrates the work that is needed in public education relating to lake and watershed management.

The Hess Lake Association also keeps lake residents abreast of current Lake Board and Lake Association activities through their quarterly newsletter. Copies of two recent newsletters are included in Attachment 4.

As with former lake improvement activities, members of the Lake Association and interested public will be welcome and encouraged to participate in water sampling, observation, and record keeping. Volunteers will be utilized to assist professionals in water quality sampling to defray costs and contribute toward the local-match. Documentation of public participation in the program to improve Hess Lake is included as Attachment 4.

ENVIRONMENTAL EVALUATION

Displacement

The proposed project will not displace any people.

Defacement

The proposed project will not deface existing residences or residential areas.

Land Use Patterns

The creation/protection of wetland areas in the watershed is an important part of the proposed plan. Shoreline property owners and farmers will be encouraged and aided in altering certain land use practices in favor of BMPs for the good of the watershed. No other significant changes or restrictions on land use patterns are proposed.

Impact on Agricultural Lands

Construction of the proposed sediment basins/wetland areas adjacent to the Wheeler Drain may take some agricultural land out of production. The areas set aside for wetland creation and particle settling will be lands that would better serve in this capacity. An integral part of the proposed plan is to reduce soil erosion and over application of nutrients in the Hess Lake Watershed utilizing methods accepted by the USDA SCS. It is anticipated that the proposed plan will be beneficial to both agricultural operations and downstream receiving waters.

Impacts on Parkland

The proposed project will not have an adverse impact on parkland, other public land, or lands of recognized scenic value.

Impacts on Cultural Resources

The state historical society has not been contacted. However, the proposed project should have no impact on lands or structures of historic value.

Energy Demands

No long-term increase in energy demands is anticipated as a result of the proposed project.

Air Quality and Noise Levels

There will be no significant or long-term adverse changes in ambient air quality or noise levels. During construction of the sediment basins, operation of heavy equipment will result in short-term, local increases in noise levels. However, there are no residences within close proximity to the construction sites, and therefore construction activities should not cause problems due to noise levels.

Chemical Treatment

No in-lake chemical treatment is proposed as part of this project.

Proximity to Floodplains and Impacts on Watercourses

The sediment basins/wetland areas proposed are located within floodplain areas. However, design will incorporate features to allow flood flows to be conveyed without damage to the basin structures or negative impacts on upstream properties due to backwater.

The sediment basins/wetland areas will have some physical effects on the watercourses along which they are installed. Water temperature and dissolved oxygen levels may be impacted. However, given the level of sensitive resources present in an artificially dug, agricultural drainage ditch, these modifications are not anticipated to cause an adverse environmental impact. On the contrary, the sediment and nutrient removal anticipated will have a positive impact on the watershed.

Effects of Dredging or Shoreline Modifications

The proposed project does not involve any physical modification of the lake.

Impacts on Wetlands

A portion of the proposed project is aimed at creating/protecting wetland areas. The wetlands inventory completed with aid of the SCS will enforce local wetlands protection by strengthening the SCD's ability to implement Swampbuster provisions of the 1985 Farm Bill.

Feasible Alternatives

Alternatives proposed to improve conditions in the Hess Lake Watershed were selected and evaluated on the basis of their technical feasibility, cost-effectiveness, and environmental acceptability. No prudent or feasible alternative to achieve the desired objective of water quality protection and improvement was rejected. Water quality conditions in Hess Lake have deteriorated to a point where large-scale in-lake restoration is warranted; however, alternatives to accomplish this cannot be implemented cost-effectively. Economically feasible alternatives for in-lake restoration are part of the long-term plan for Hess Lake.

Mitigation of Environmental Impacts

As discussed previously, no adverse environmental impacts are expected to result from the implementation of the pollution control and water resource protection measures recommended for the Hess Lake Watershed.