PHASE IV AND V LAKE MANAGEMENT PLANNING GRANT REPORT
ENGLISH LAKE
MANITOWOC COUNTY, WISCONSIN

WDNR Project Number LPL-437 and LPL-438

RMG File Number GB97001

Prepared For

English Lake Management District

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SUMMARY

During the time period from 1991 to 1997, the English Lake Management District (ELMD) completed three Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant studies. The three phases of study included water quality monitoring, aquatic plant assessment, identification of areas of concern, a recreational use survey, a review of sanitary systems, drain tile assessment, and preliminary remedial measure identification. The results of these studies indicated that English Lake is phosphorus limited, and, therefore, sensitive to increased phosphorus inputs. Drain tile assessment and phosphorus loading analysis found that agricultural drain tiles increased the English Lake watershed by approximately 78 acres (46 percent), and increased the phosphorus load to the lake by 34.8 pounds (7 percent). It was also determined that agricultural sources of nonpoint pollution accounted for 94 percent of the current English Lake annual phosphorus load. Of particular importance, a cattle barnyard and feedlot located east of the lake was estimated to contribute 77 percent of the annual phosphorus load.

In January, 1997, the ELMD was awarded WDNR Phase IV and V Lake Planning Grants to develop conceptual designs, cost estimates, funding plans, and feasibility determinations for best management practice projects designed to control nutrient loading to the lake, and to prioritize the identified projects.

Seven alternative control concepts were identified for English Lake and included:

1. A Natural Area Creation and Wetland Restoration South of English Lake to Treat Tile Discharges
2. Rerouting Tiles Located South of the Lake to Discharge Outside of the Watershed
3. A Detention Basin to Treat Tile Discharges South of the Lake
4. Relocating a Tile to Discharge Southeast of the Lake
5. Moving Cattle Associated with a Barnyard/Feedlot East of the Lake
6. A Wetland Detention Basin East of English Lake to Treat Runoff and Tile Discharge
7. Buffer Strip Installation

A cost-benefit analysis was conducted for the seven alternatives listed above based on cost required per pound of phosphorus removed from the annual English Lake budget. Based on this analysis, moving cattle associated with the barnyard east of English Lake and buffer strip installation were the most cost effective management strategies.

Through evaluation of factors including cost-benefit analysis, feasibility determination, risk evaluation, and funding availability it was concluded that the ELMD should actively pursue Alternatives 5 and 6 at this time. Moving the cattle associated with the barnyard/feedlot would be the most cost effective management strategy, and would also result in an estimated 77 percent reduction in phosphorus load to the lake. Because this alternative is dependent upon several circumstances that the ELMD cannot control and, as a result, has some inherent risk, it is also recommended that the ELMD pursue development of a wetland detention basin east of English Lake to treat runoff from the barnyard/feedlot.

Pursuit of buffer strip installation is also recommended despite its small potential for reduction in the English Lake phosphorus load (0.25 percent) because implementation of this control measure involves minimal cost and effort on the part of the ELMD.

Rerouting the tiles located south of English Lake is the only cost effective and feasible measure for controlling nutrient loading from the tiled watershed. However, further study will be necessary prior to implementation of this alternative to assess potential English Lake water level impacts and impacts to downstream waterbodies receiving the rerouted discharge.

1.0 INTRODUCTION

To date, the English Lake Management District (ELMD) has completed three Wisconsin Department of Natural Resources (WDNR) Lake Management Planning Grant studies. The first (Phase I) was completed in November, 1992 and included a baseline water quality and aquatic plant assessment and a public involvement program. The Phase II study included more intensive assessment of areas of concern in the watershed, continuation of the water quality monitoring and public involvement programs, an assessment of recreational use, and a review of sanitary systems for homes bordering the lake. The Phase II report was completed in February, 1995. In January, 1996 the ELMD was awarded a Phase III Lake Planning Grant. Phase III was intended to bridge the gap between the study phases of this project and future implementation phases wherein measures could be employed to remediate problems identified through the Phase I and II studies. Phase III included the final baseline water quality monitoring effort, an investigation to define the extent and location of drain tiles discharging into the lake, a preliminary analysis of alternative control measures pertinent to English Lake, continuation of the public involvement/education elements of the project, and coordination with the WDNR and other agencies to prepare an application for funding to conceptually design control measures for implementation.

The ELMD was awarded Phase IV and Phase V Lake Planning Grants in January, 1997. Phases IV and V are the subject of this report. The ELMD contracted with Resource Management Group, Inc. (RMG) to perform the tasks outlined in the Phase IV and V grants. These two phases were completed concurrently and included:

- Identification and definition of potential best management practice projects that may reduce nutrient loading to the lake.
- Development of conceptual designs for potential projects within the watershed that may reduce or eliminate nutrient and sediment loading to the lake.
- Development of cost estimates and identification of funding sources for each potential project.
- A feasibility evaluation for each of the identified projects.
- Prioritization of the projects based on feasibility determinations and cost-benefit analyses.

The remainder of this report contains a summary of current English Lake nutrient sources based on results of Phase I through Phase III studies; a discussion of possible mitigative measures and their associated costs, sources of funding, pollutant removal efficiency, and feasibility; a prioritization of mitigative measures based on cost-benefit analyses; and conclusions regarding alternatives for implementation of high priority mitigative measures.

2.0 NUTRIENT SOURCES

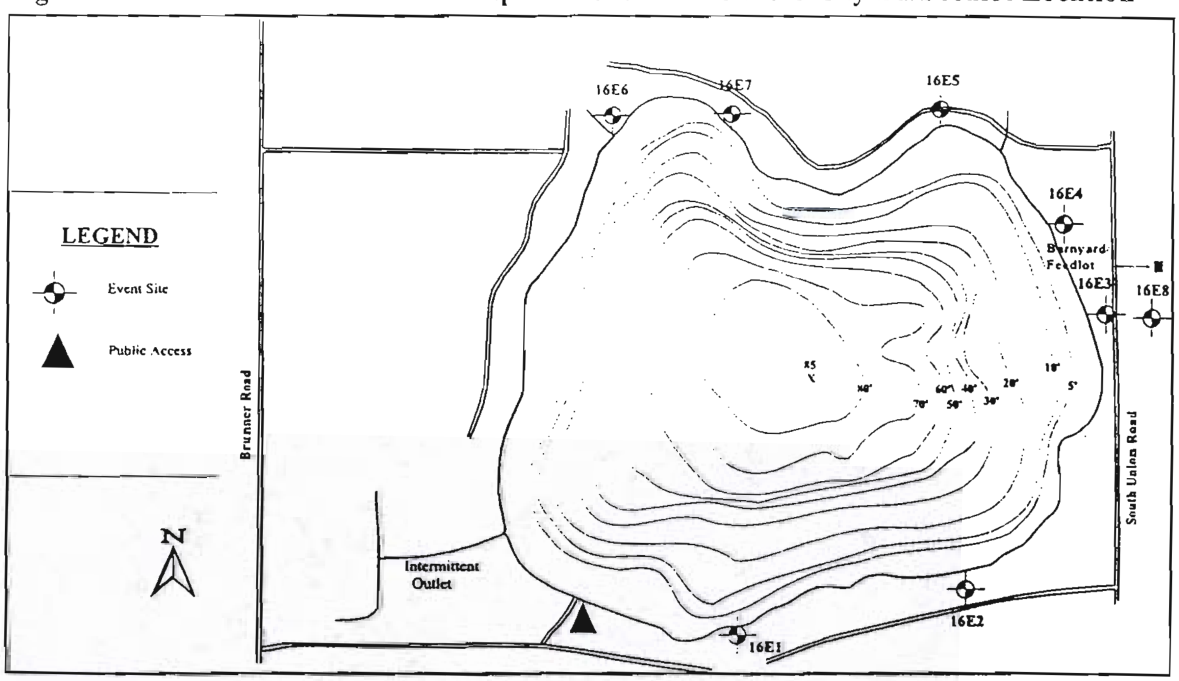
From 1991 to 1997, three English Lake studies were conducted using funds provided by WDNR Lake Planning Grants and the ELMD. The scope of work for the three phases of study included water quality monitoring and identification of areas of concern in the English Lake watershed. In-lake water quality monitoring was conducted intermittently from May 1991 to February 1997. An analysis of the cumulative data collected during all three phases of study indicated that the average in-lake total phosphorus concentration was .071 mg/l, and the average in-lake total nitrogen concentration was 1.36 mg/l (IPS and RMG, 1997). The average total phosphorus and total nitrogen values observed for English

Lake were similar to overall averages reported for lakes located in the Southeast Region of Wisconsin (.079 mg/l and 1.43 mg/l respectively; Lillie and Mason, 1983). Lakes located in the Southeast Region typically have water quality and clarity below average when compared to the rest of the state. Trophic State Index analysis indicated that English Lake was dominated by eutrophic conditions and representative of the regional trend in water quality (IPS and RMG, 1997).

The average nitrogen to phosphorus ratio for English Lake was 18.1:1 (IPS and RMG, 1997). This value suggests that English Lake is phosphorus limited (Krenkel and Novotny, 1980), and, similar to the majority of lakes in Wisconsin (Lillie and Mason, 1983), is especially sensitive to increased phosphorus inputs. Because of this, pollutant loading analyses for English Lake focused on identification of phosphorus loading sources. Further, evaluations regarding alternative control measures focused on phosphorus treatment.

The current total annual phosphorus load to English Lake is 507.8 pounds (IPS and RMG, 1997). Of the total load, 94 percent is from agricultural sources. A single dairy barnyard/feedlot on the east side of the lake produces 77.3 percent of the phosphorus load. Based on the results of the Phase I, II and III storm event monitoring studies, the approximate 37 acre watershed containing this barnyard/feedlot produced the highest observed phosphorus concentrations (sample sites 16E8 and 16E3 - see Figure 2-1). The mean total phosphorus concentrations at these sites were approximately 400 percent higher than the next highest event monitoring site (sample site 16E1).

Figure 2-1. Location of Event Sample Sites in Relation to Barnyard/Feedlot Location



The above results indicate that implementation of control measures that reduce agricultural sources of phosphorus will result in the greatest benefit to English Lake. Specifically, control measures that address runoff originating from the barnyard/feedlot and its tributary watershed will produce the greatest reduction in phosphorus loading to the lake.

3.0 MITIGATIVE MEASURES

RMG utilized a review and analysis of available information pertinent to English Lake, including previous Lake Planning Grant studies, and a comprehensive field reconnaissance of the lake and watershed to identify sites which may be amenable to the implementation of some remedial or mitigative measures to improve lake water quality. A total of seven alternative control concepts have been identified and include:

1. A Natural Area Creation and Wetland Restoration South of English Lake to Treat Tile Discharges
2. Rerouting Tiles Located South of the Lake to Discharge Outside of the Watershed
3. A Detention Basin to Treat Tile Discharges South of the Lake
4. Relocating a Tile to Discharge Southeast of the Lake
5. Moving of Cattle Associated with Barnyard/Feedlot East of the Lake
6. A Wetland Detention Basin East of English Lake to Treat Runoff and Tile Discharge
7. Buffer Strip Installation

The remainder of this section contains an expanded description of each of the alternatives. A brief summary of the design concept, estimated pollutant removal efficiency, estimated costs, funding sources, and feasibility is presented for each of the mitigative measures identified.

3.1 Alternative 1: Natural Area Creation and Wetland Restoration South of English Lake

Design Concept and Basis

Tile A is located south of English Lake (Figure 3-1), drains approximately 54 acres of land, and contributes an estimated 4.8 percent of the total phosphorus load to English Lake (IPS and RMG, 1997). The land drained by Tile A was not part of the historic watershed for English Lake. Plugging or rerouting Tile A so that it no longer outlets to English Lake would eliminate this source of nutrients and suspended solids.

The design concept proposed herein involves plugging or breaking Tile A at the northern site boundary, allowing water to back-up on the site, and restoring/creating between 10 and 20 acres of wetland. A conceptual site plan is presented in Figure 3-2. This design concept is based on a review of the Soil Survey of Calumet and Manitowoc Counties (USDA, 1980), 1985 through 1992 and 1995 aerial photographs obtained from the Manitowoc County office of the Natural Resource Conservation Service (NRCS), NRCS Manitowoc County Wetland Inventory Maps (1985), Wisconsin Wetland Inventory Maps (1989), United States Geologic Survey Clarks Mills Quadrangle 7.5 Minute Topographic Map (1978), and numerous site reconnaissance visits conducted between September, 1996 and April, 1997. A Wetland Restoration Site Evaluation Form which summarizes the results of this review is presented in Appendix A. A brief description of the existing site characteristics, as they relate to the design concept, is presented in the following paragraphs.

Figure 3-1. Location of Drain Tiles and Watershed Boundary

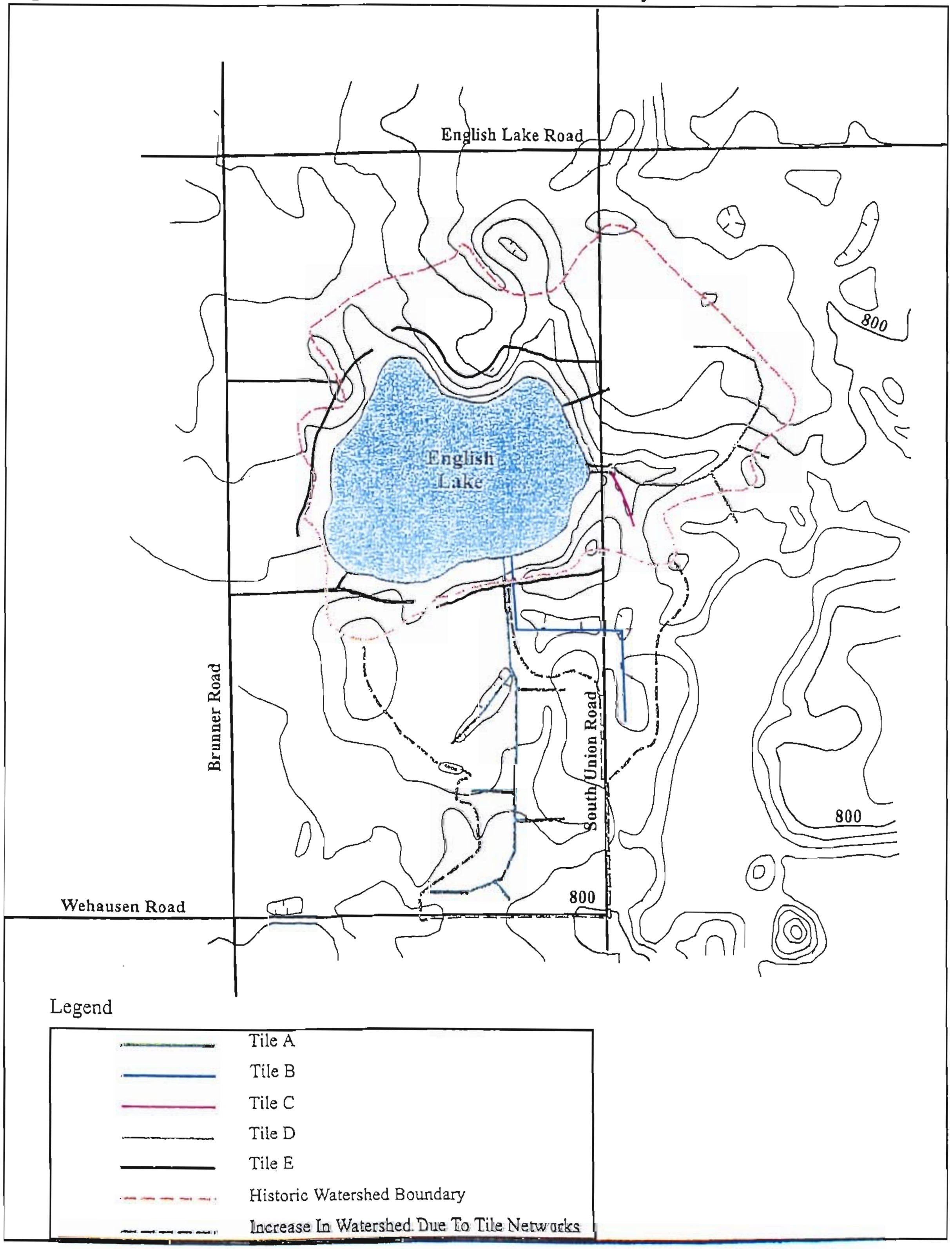
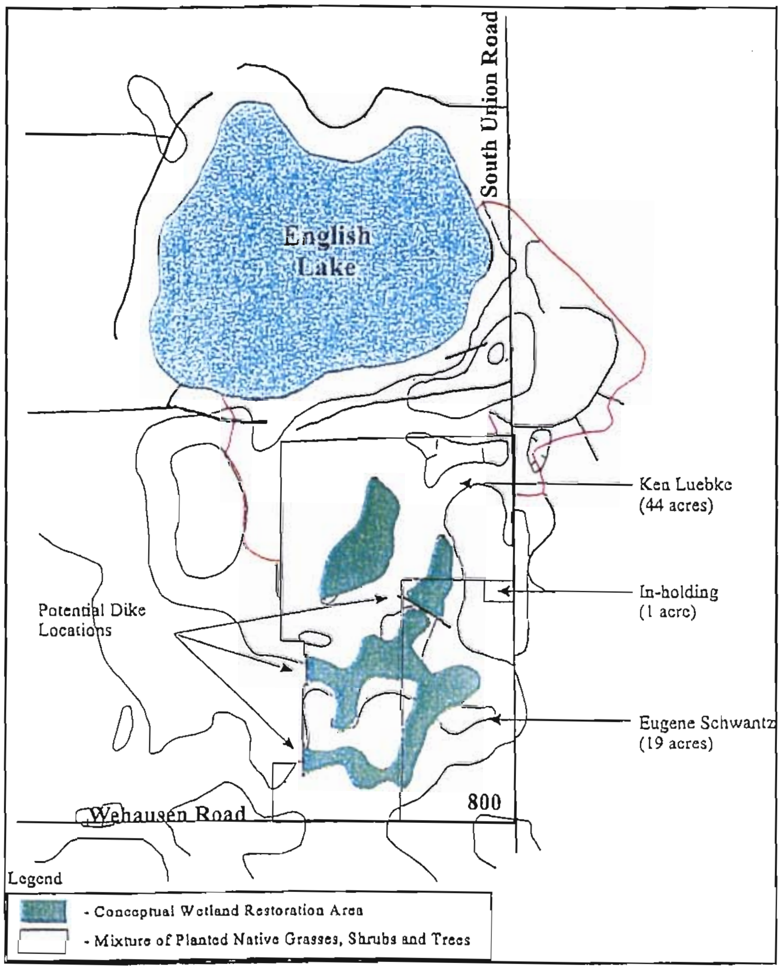


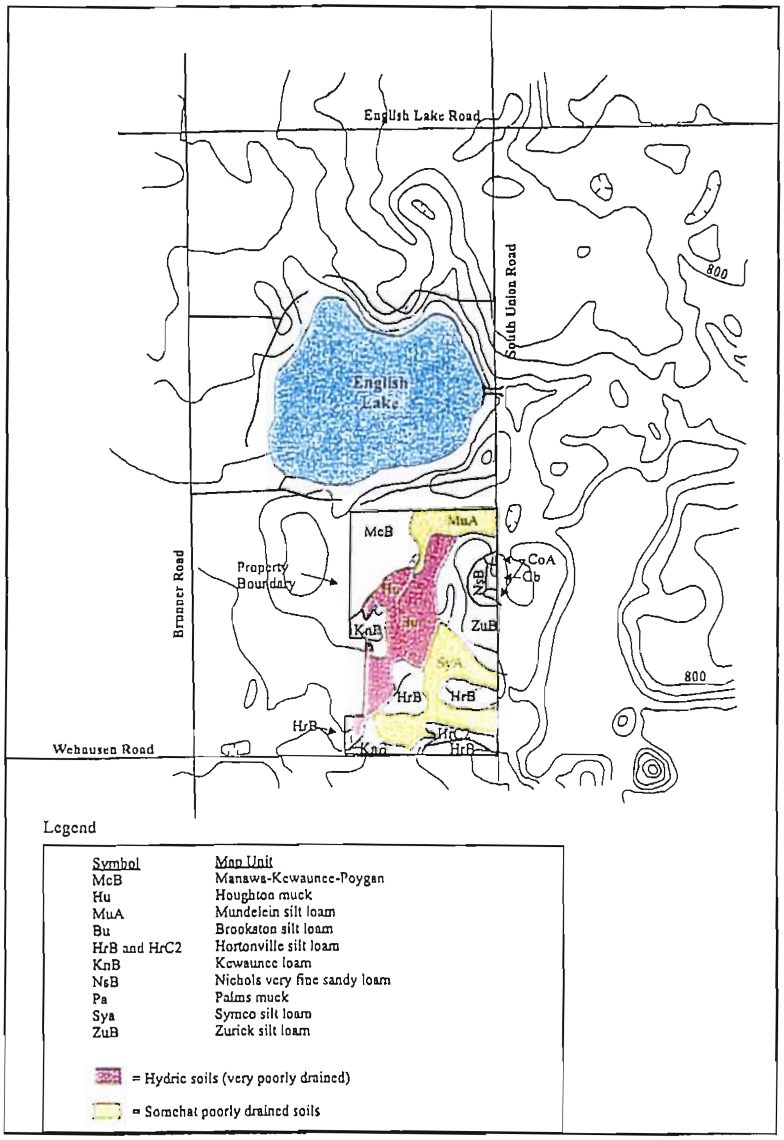
Figure 3-2. Conceptual Natural Area Creation and Wetland Restoration at Tile A Location



The site consists of approximately 63 acres of agricultural land on primarily two privately owned parcels (Figure 3-2). A total of 10 soil types are mapped on the site (Figure 3-3). These include three very poorly drained hydric soils covering approximately 15.2 acres and 15.8 acres of somewhat poorly drained soils (Appendix A). Based on a review of historical aerial photography, these areas generally correspond with the wet, low areas of the site. Although detailed topographic mapping of the site is not available, these areas appear to have a high potential for wetland restoration/creation through the construction of several low-head embankments and/or shallow excavations to intercept groundwater and interconnect the wetland areas (Figure 3-2).

It is anticipated that both groundwater and surface water will be available in sufficient quantities to support wetlands on the site. According to the Soil Survey of Calumet and Manitowoc Counties, the high water table is within 0 to 3 feet of the land surface in the portions of the site to be restored. Standing water was observed throughout most of the proposed wetland restoratin area during field visits in March, 1997. Review of historical aerial photographs further supports the conclusion that these low areas are

Figure 3-3. Soils Present on Conceptual Natural Area Creation and Wetland Restoration Site



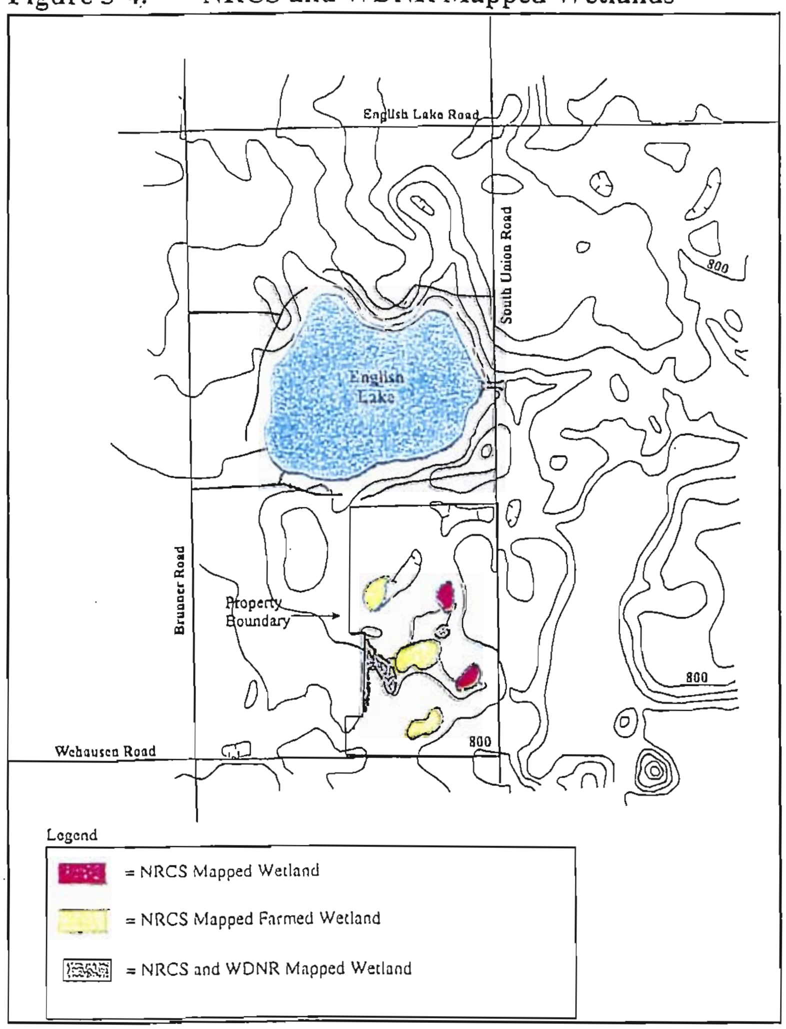
generally moist.

Although no flow monitoring was conducted regarding the tile system, the tile was observed to be flowing during numerous precipitation and snow melt events throughout the Phase I, II and III study periods. On a March 25, 1997 site visit during a period of snow melt, velocity and cross sectional area measurements were recorded and used to calculate an estimated discharge rate of 1.34 acre-feet/day for Tile A. Clearly, this single data point can not be used to estimate average flow rates, but does appear to indicate that a substantial volume of water is drained from the agricultural property as a result of the tile system.

It is important to note that the agricultural land drained by Tile A was not part of the historic English Lake watershed. Removing the Tile A discharge to English Lake would reduce current hydrologic inputs to the lake, but would restore inputs to a level more representative of historic levels.

Existing wetlands on this site may be a factor that will require consideration if this site is to be used for compensatory wetland mitigation in accordance with Section 404 of the Clean Water Act. The NRCS Manitowoc County Wetland Inventory and Wisconsin Wetland Inventory Maps of the site show approximately 3.4 acres of wetland and 3.4 acres of farmed wetland on the site (Figures 3-4). It appears that these areas can easily be incorporated into the design of this wetland restoration/creation. It should be noted, however, that these areas may classify as jurisdictional wetlands and may not be eligible for credit if this site is used for compensatory wetland mitigation. Further, based on the review of historical aerial photographs and site reconnaissance visits, it does not appear that the mapping of these wetland areas is entirely accurate. An on-site field delineation and review of the NRCS designations is recommended if a wetland restoration is pursued in relation to a compensatory mitigation project.

Figure 3-4. NRCS and WDNR Mapped Wetlands



Pollutant Removal Efficiency

Plugging or breaking Tile A to restore/create wetlands would eliminate 100% of the tile's current nutrient and sediment load to English Lake. A wetland restoration project could improve the health of the lake by removing a source of phosphorus, and would also provide wildlife habitat and aesthetic value to the property surrounding the lake.

Estimated Costs and Funding Sources

The estimated costs for a wetland restoration on the agricultural land drained by Tile A is dependent upon many factors. According to recent discussions with land owners, acquisition of the 44 acre parcel would cost approximately $88,000, and the 19 acre parcel would cost approximately $20,000. The cost associated with the actual restoration project is dependent upon factors related to the extent of the earthwork required for construction of low-head embankments and/or shallow excavations, and the desired size of the restoration. Costs for construction of the wetland restoration/creation (e.g., cost of earthwork, dike construction, outlet structures, revegetation, etc.) can range from approximately $1,000 to $10,000 per acre. In this case, it is anticipated that the earthwork requirements would be minimal and the construction costs would be towards the low end of this range. Assuming $2000 per acre for wetland restoration and creation, 20 acres of restored wetland, and the land acquisition costs presented above, the total estimated cost for this project would be approximately $150,000. A more accurate cost estimate would require a site topographic survey and preparation of a final design for the wetland restoration/creation.

A number of potential funding sources are available, but all are dependent upon land owner cooperation. If the land owners are willing to sell, the entire cost of the wetland restoration (including land acquisition) could be borne by the Wisconsin Department of Transportation (WisDOT). This is only an option, however, if WisDOT has a need for compensatory wetland mitigation credit in the area and costs per acre of wetland created are within their established guidelines. The WDNR can also provide funds for land acquisition and wetland restoration through the Lake Protection Grant program. Up to $200,000 is available with a 25 percent match in funds from the Lake Association. There is also the potential, if land owners are willing to sell, for non-profit organizations such as Ducks Unlimited, the Wisconsin Waterfowl Association, or other local organizations or private parties to purchase the property and restore the wetlands.

A number of potential funding sources are also available if landowners are not willing to sell but are interested in converting portions of their property from agricultural uses to wildlife or wetland habitat. The WDNR can fund up to 100 percent of the design and construction for wetland restoration/enhancement projects through the Southeast Wisconsin Coastal Habitat Project. The only obligation to the landowner is signing an agreement stating that the restoration/enhancements will remain on the property for 10 years. A similar program, the Wetland Reserve Program, is administered through the U.S. Fish and Wildlife Service (FWS) and can produce funds for wetland restorations on private lands. In addition, funding for wetland restoration and wildlife habitat creation may also be available through the Conservation Reserve Program (CRP) administered by the Natural Resource Conservation Service (NRCS).

Feasibility

This project is very feasible from a technical standpoint. However, due to land ownership considerations, this project does not currently appear feasible. Land owner consultation indicated that both owners are willing to sell, but, based on discussions with WDNR and WisDOT representatives, one of the owners is requesting a sum of money larger than can be provided by state or federal sources. As a result, this project could only move forward if funds were made available from private sources.

3.2 Alternative 2: Rerouting Tiles A and B

Design Concept and Basis

Tiles A and B both outlet into English Lake at nearly the same point along the south central shoreline (Figure 3-1). Combined, Tiles A and B currently contribute approximately 6.9 percent of the annual phosphorus load to English Lake (IPS and RMG, 1997). In this alternative, Tiles A and B would be joined and rerouted through a single 10 inch tile approximately 2,000 feet to a culvert located under the access road to the public boat launch. The culvert discharges into the English Lake outlet, and, therefore, would carry the discharge from Tiles A and B outside of the English Lake watershed. The gradient exists to allow the rerouted tile to drain by gravity flow. It should be noted that this activity will return lake levels back to historic levels present prior to the installation of this tile system. The magnitude of this lake level change is not currently known.

Pollutant Removal Efficiecy

Based on the estimate stated above and modeling results in the Phase III Lake Planning Grant study, relocating the tiles to eliminate their English Lake discharge would remove 6.9% of the current phosphorus load to the lake. While this provides a potential solution for English Lake, this load would be transferred to downstream receiving waters where impacts have not yet been defined.

Estimated Costs and Funding Sources

According to an estimate prepared by Madson Tiling & Excavating, the cost for rerouting Tiles A and B would be $21,221 (Appendix B). Funding for up to 75% of this cost could be provided through the WDNR Lake Protection Grant Program.

Feasibility

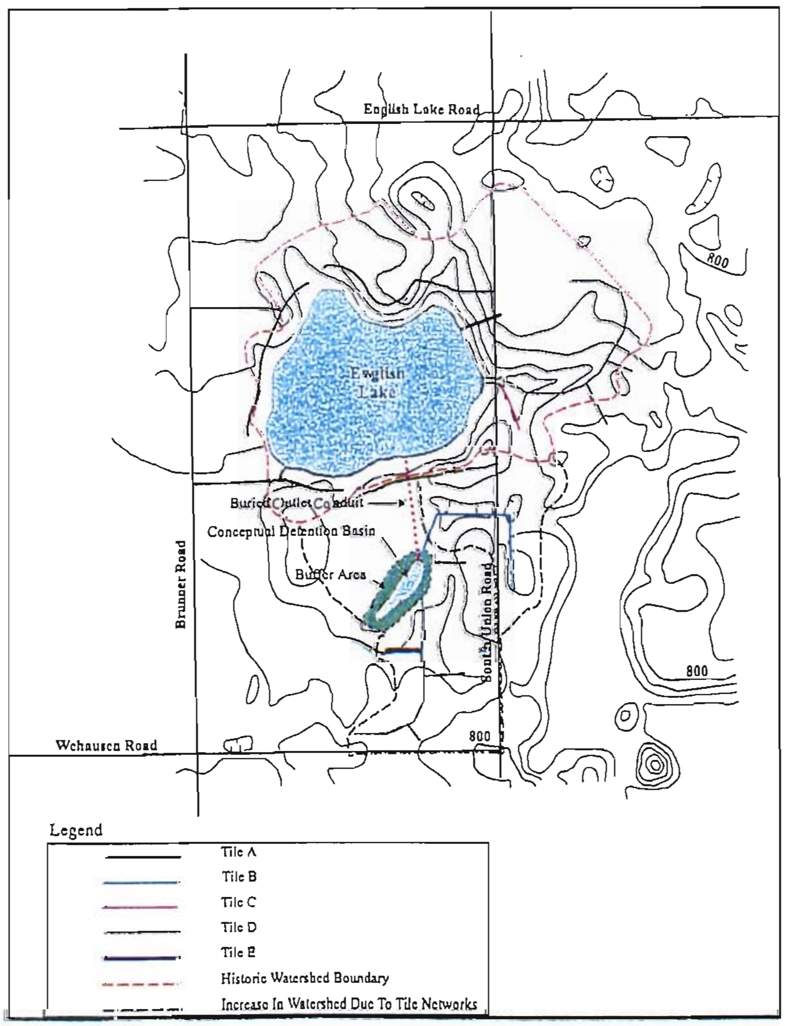
This project is feasible from both a technical and economic standpoint.

3.3 Alternative 3: Detention Basin to Treat Tile A and Tile B Discharges

Design Concept and Basis

As an alternative to purchasing the entire Luebke and Schwantz properties, a portion of the Luebke property could be purchased for the construction of a detention basin. As shown in Figure 3-1, two natural low areas exist in the northern portion of the property and appear to be well suited for the excavation of a detention area. The northernmost area, however, is planned for use as a horse pasture and is unavailable for a detention basin at this time. Therefore, only the low area situated further south will be considered. This project would involve rerouting the existing tile network (Tiles A and B) to inlet into the excavated detention area and providing a buried outlet to the lake (Figure 3-5). Basin discharge rates and water elevations would be controlled to provide both adequate drainage for the upgradient agricultural lands and adequate retention time for nutrient and sediment removal prior to discharge to the lake.

Figure 3-5. Conceptual Detention Basin to Treat Tiles A and B



Based on a preliminary analysis, to contain the 25 year 24 hour storm, the basin would have to be designed to contain an approximate volume of 12 acre-feet. With an average depth of six feet, approximately two acres would be required for the detention basin, plus an approximate three acre buffer area around the basin and an easement for the outlet conduit would be required.

Pollutant Removal Efficiency

Based on personal experience and a literature review (Moshiri, 1993; Urbonas and Stahre, 1993), a wet detention basin of this nature can be expected to provide 35 percent to 50 percent sediment and phosphorus removal. Given that Tiles A and B currently contribute approximately 6.9 percent of the annual phosphorus load to English Lake, this project would reduce the phosphorus load to the lake by 2.4 to 3.5 percent.

Estimated Costs and Funding Sources

Factors considered in this cost estimate include purchase of a minimum of five acres of land (i.e., two for the basin and three for a buffer area and placement of excess soil), excavation and grading activities, rerouting tiles, outlet structure design and construction, and final vegetative cover establishment. Assuming the entire basin would need to be excavated (≈ 19,000 cubic yards) at a cost of $1.50 per cubic yard and an additional $2000 per acre for land acquisition, the cost for this project would be at least $40,000. Additional costs for the outlet structure, rerouting tiles and the establishment of a vegetative cover may add up to $15,000, for a total estimated cost of $55,000.

The most likely funding source for this project would be a WDNR Lake Protection Grant. Up to 75% of the costs for this project could be covered through this source. Monies may also be available through the Southeast Wisconsin Coastal Habitat Project.

Feasibility

This project appears to be technically feasible, but a site topographic survey and detailed hydrologic and hydraulic modeling would be required prior to implementation of this alternative. However, it is currently unlikely that the land owner would be willing to sell a small portion of his property at the proposed location for this detention basin.

3.4 Alternative 4: Relocating a Portion of Tile B

The alternative control measure presented in this section is not applicable if either Alternatives 2 or 3 (which are presented above) are developed.

Design Concept and Basis

Tile B is located southeast of English Lake (Figure 3-1), drains approximately 24 acres of agricultural land, and contributes an estimated 2.1% of the total phosphorus load to English Lake (IPS and RMG, 1997). Tile B drains low agricultural land located east of South Union Road, and currently crosses under South Union Road and outlets to English Lake. Tile B could be broken and the portion east of the road could be discharged to a forested wetland that is located southeast of English Lake, thereby discharging outside of the English Lake watershed.

The tile would need to be plugged at the point where it crosses South Union Road, and rerouted to the forested wetland to the east. Approximately 650 feet of 6 inch tile would be required with a maximum excavation depth of 11 feet. The portion of tile B that is located west of South Union Road would remain intact.

Pollutant Removal Efficiency

Relocating the eastern portion of Tile B to outlet outside of the English Lake watershed would eliminate the nutrient contribution to English Lake from approximately 58% of the Tile B watershed. Based on the formerly stated estimate and modeling results in the Phase III Lake Planning Grant study, relocating the tile would eliminate 1.2% of the current phosphorus load to English Lake.

Estimated Costs and Funding Sources

According to an estimate prepared by Madson Tiling & Excavating, the cost for the project would be $2935 (Appendix B). A WDNR Lake Protection Grant could provide funding for 75% of this cost.

Feasibility

The project is technically feasible, and the land owner has agreed to a tile diversion project if he is not required to provide any funds. It should be noted, however, that it appears that the town may be installing a culvert under South Union Road at this location. The installation of this culvert would limit the effectiveness of this alternative.

3.5 Alternative 5: Moving of Cattle Associated with Barnyard/Feedlot

Design Concept and Basis

There is a barnyard/feedlot located approximately 500 feet east of English Lake on agricultural property owned by Eugene Schwantz. Surface runoff from the barnyard/feedlot enters a grassed waterway which ultimately outlets to English Lake. A single dairy cow produces 6.6 ounces of nitrogen and 1.2 ounces of phosphorus per day, and can be a substantial source of nutrients for surface runoff (Hammer, 1993). The barnyard/feedlot produces an estimated 392 pounds of phosphorus per year, or 77.3 percent of the total phosphorus load to the lake based on Phase III Lake Planning Grant analyses (IPS and RMG, 1997). Given the major phosphorus contribution to the lake from this barnyard/feedlot, an attempt should be made to move the cattle that utilize the barnyard/feedlot to a location out of the watershed. Once the cattle are no longer present, waste remaining on the site should be removed to the extent possible. In addition, the area currently occupied by the barnyard should be seeded with grasses and revegetated to reduce surface runoff and promote nutrient utilization.

Pollutant Removal Efficiency

Based on Phase III Lake Planning Grant analyses, moving the cattle that utilize the barnyard/feedlot, removing remaining waste, and revegetating the barnyard could reduce the phosphorus load to English Lake by 60 to 70 percent.

Estimated Costs and Funding Sources

Costs for moving the cattle would be largely dictated by the land owner. Funds may be available through the Seven Mile Silver Creek Priority Watershed Project to purchase an easement for the farmstead that would prohibit keeping livestock on the property, and funding for costs associated with relocation of the cattle may be available from the Department of Industry, Labor, and Human Relations (DILHR). Grassland restoration on the site could potentially be funded through either the Southeast Wisconsin Coastal Habitat Project or WDNR funds for ring-necked pheasant habitat development.

Feasibility

This project is very feasible and is primarily dependent upon the willingness of the land owner to relocate the cattle. Meetings with the land owner indicate that he is currently considering this option.

3.6 Alternative 6: Wetland Detention Basin East of English Lake

Design Concept and Basis

A wetland detention basin could be constructed east of English Lake on property currently owned by Eugene Schwantz to treat agricultural runoff and discharges from a grassed waterway and Tiles C and D. Tiles C and D drain approximately 37 acres of agricultural land (Figure 3-1), and outlet into a grass waterway bordered by agricultural fields and the barnyard/feedlot discussed in Section 3.5. As mentioned, the barnyard/feedlot produces 77.3 percent of the total English Lake phosphorus load. Monitoring conducted from 1991 to 1997 during or shortly after rain events at eight areas of concern (tile outlets or areas of concentrated surface runoff) around English Lake showed water samples collected in the grassed waterway to have total phosphorus concentrations approximately 400 percent higher than those at other event sites. The implementation of control measures within the watershed tributary to the grassed waterway, therefore, will result in the greatest benefit to the lake. A wetland detention basin could be created to detain and treat water from Tiles C and D and surface runoff from the watershed. The implementation of this measure would be most successful if combined with Alternative 5.

A conceptual design for the wetland detention basin is presented in Figure 3-6. The conceptual design involves construction of an earthen dike that extends 298 linear feet and runs parallel to South Union Road on Eugene Schwantz's property. The dike is estimated to require approximately 2000 cubic yards of fill and have a maximum height of 6.2 feet. Water levels in the basin would be controlled by a rock spillway, with a maximum projected water depth for the basin of 4 to 5 feet. The estimated surface water area that would result from the dike is 1.2 acres.

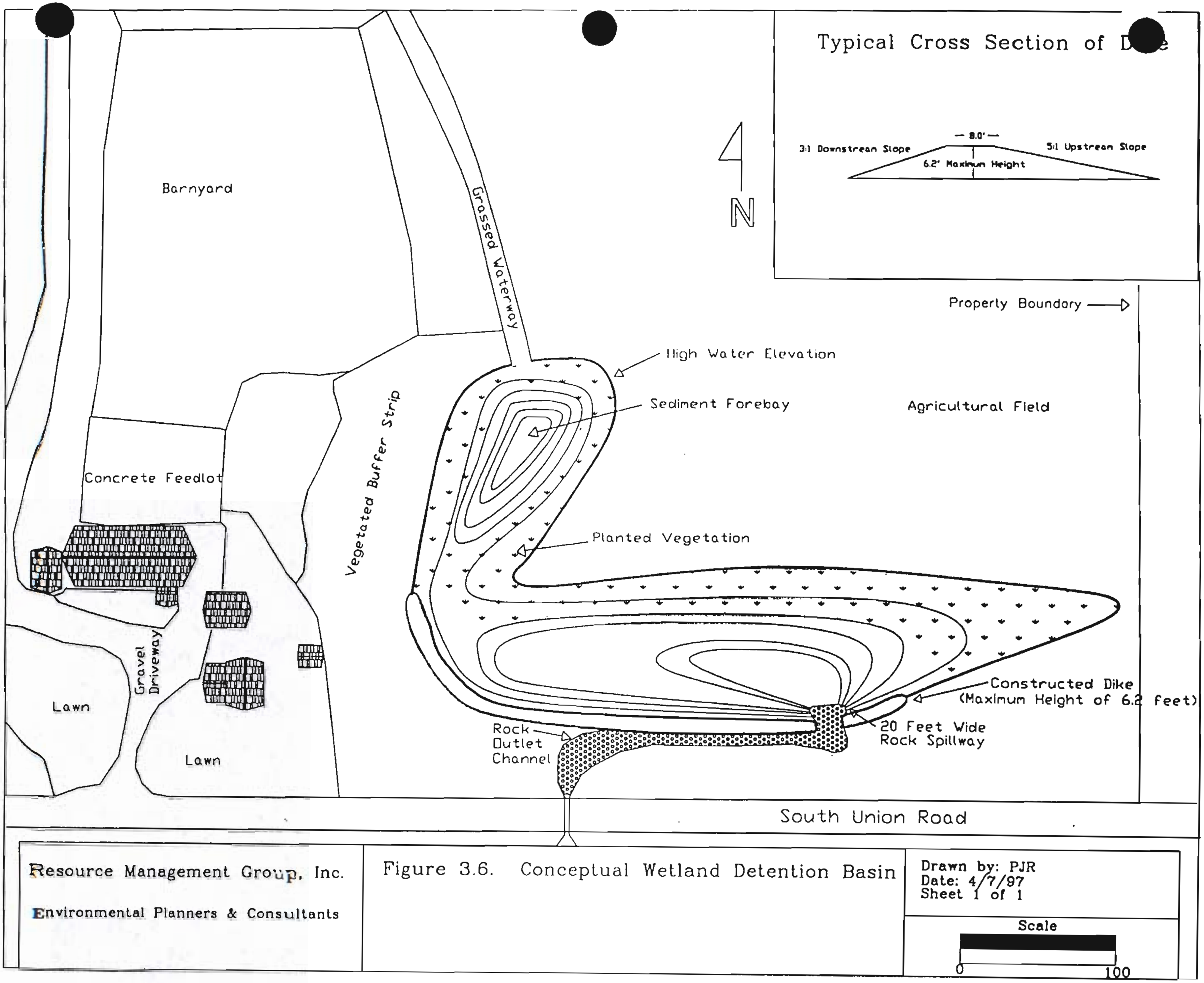


Figure 3.6. Conceptual Wetland Detention Basin

The basin would be designed to maximize sediment and nutrient removal efficiency. Overland runoff would enter the basin primarily through the existing grassed waterway. At the mouth of the waterway, a sediment forebay would be constructed with a maximum depth of approximately 5 feet. The purpose of the sediment forebay would be to allow the larger suspended particles and attached nutrients to settle from the water column, and begin the treatment process. The water would travel from the forebay through a heavily vegetated filter with water depths of 1-2 feet. Vegetated filters can be used to reduce velocities during heavy flow periods, thereby, enhancing sedimentation, and to uptake nutrients (e.g., phosphorus and nitrogen). The water would next pass into a larger siltation basin prior to the spillway outlet. The 1-2 feet deep fringe of the basin would again contain wetland vegetation to enhance pollutant removal. The basin should be designed to maximize distance between the inlet and outlet and, as a result, hydraulic residence time. Residence time should be long enough to allow treatment to occur, but not excessively long because extensive residence periods can reduce biological phosphorus removal by causing anaerobic conditions and stagnation (Harper et al., 1988).

Wetland vegetation should be planted in the basin to ensure timely and desirable vegetation development. Planting aquatic vegetation can establish desirable species, increase the diversity of species compared to relying on natural colonization, and accelerate aquatic vegetation colonization. Species to be planted would be chosen based on their ability to remove pollutants, demonstrated viability in similar wetland treatment projects, and wildlife and aesthetic value. Possible species for planting in areas -0.5 to 0.5 feet deep include *Scirpus atrovirens* (green bulrush), *Carex vulpinoidea* (fox sedge), and *Carex lacustris* (lakebank sedge). *Sparganium eurycarpum* (common bur reed), *Scirpus validus* (soft-stem bulrush), *Pontedaria cordata* (pickerel weed), and *Sagittaria latifolia* (common arrowhead) would be planted in areas of 0.5 to 1.5 feet of water. The total area to be planted in the wetland detention basin would be approximately 0.5 acres. Wetland vegetation would be planted at a spacing of 3 feet on center, or a density of approximately 2500 plants per acre.

<u>Pollutant Removal Efficiency</u>

The degree of success of wetland treatment systems in removing phosphorus is variable. A very successful project in Maine that utilized sedimentation basins and a wetland treatment system to treat agricultural runoff resulted in removal of approximately 82 to 91 percent of the total phosphorus. (Higgins et al., 1993). Reported phosphorus removal values, however, have ranged from -4 percent to 90 percent for wetland detention basins. Phosphorus removal ability appears to vary with system design, pollutant loading rates, and site conditions (Urbonas and Stahre, 1993). Based on the conceptual design, literature review, and past monitoring experience for wetland treatment systems, it is expected that the wetland detention basin will remove approximately 40-60 percent of the total phosphorus.

<u>Estimated Costs and Funding Sources</u>

The total estimated cost for construction of the wetland detention basin is $14,400 (Table 3-1). At this time it appears that the most feasible source of funds for this project is a WDNR Lake Protection Grant. The Lake Protection Grant will cover 75% of the costs of the project, but would require the ELMD to provide 25% of associated costs. Based on discussions with Aaron Buchholz, one of the local program coordinators for the Southeast Wisconsin Coastal Habitat Project, they can design the dike and outlet structure for the wetland detention basin, and provide $1500 for construction costs. Because the

Southeast Wisconsin Coastal Habitat Project is a federal program, it appears that the $1500 could apply to the 25% cost share requirement that the ELMD would incur through a Lake Protection Grant. Funds may also be available from the Seven Mile Silver Creek Priority Watershed Project to protect the wetland detention basin and a surrounding buffer area through a conservation easement.

Table 3-1. Costs for Construction of Wetland Detention Basin

Item	Estimated Cost
Earthwork	$7500[1]
Wetland Vegetation	$2900
Planting	$2500
Construction Supervision	$1750
TOTAL	$14,650

[1] Cost estimates for earthwork were solicited from three sources and ranged from $3112.40 to $6200.00 (see Appendix C). To ensure an adequate cost estimate, the $6,200 estimate was used with the addition of an approximate 20% contingency factor.

<u>Feasibility</u>

Development of the wetland detention basin is technically feasible, and it also appears economically feasible. Funding from the Southeast Wisconsin Coastal Habitat Project, however, may be unavailable after March of 1998 due to discontinuation of the program (Buchholz, 1997).

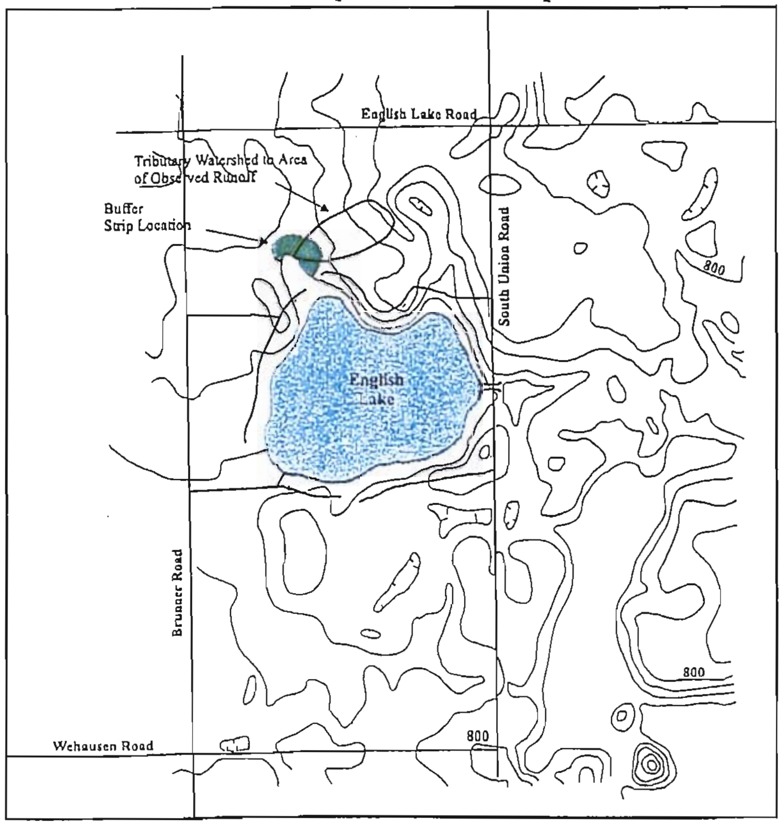
3.7 Alternative 7: Installation of Buffer Strips

<u>Design Concept and Basis</u>

Buffer strips are utilized to trap sediment and nutrients located in surface runoff. It is most practical to construct buffer strips 100 to 125 feet wide because as width increases beyond 125 feet there is a decline in the rate of increase of removal ability (Karr and Schlosser, 1981).

There is an area of agricultural land on the northwest shore of the lake where sheet flow was observed during late winter and early spring site visits (Figure 3-7). Creation of a 100 feet wide buffer strip in the location of the observed surface runoff could reduce water velocities and nutrient and sediment loads prior to the runoff entering the lake. The tributary watershed to the area of runoff observed on the northwest shore consists of primarily agricultural land and is estimated to be 5.8 acres. Based on Wisconsin Lakes Model Spreadsheet phosphorus loading coefficients, the surface runoff contributes 5.17 pounds of phosphorus annually to English Lake, or 1.0 percent of the annual English Lake phosphorus load.

Figure 3-7. Tributary Watershed for Observed Runoff and Conceptual Buffer Strip Location



Pollutant Removal Efficiency

The effectiveness of buffer strips in removing phosphorus from surface runoff has been found to be variable with reported ranges of 6% to 80% (Karr and Schlosser, 1977). Given the steep slopes (12-20%) present on the north side of English Lake, it is estimated that buffer strips would eliminate a maximum of 25 percent of the current phosphorus load contained in the surface runoff. This would result in a 0.25 percent reduction in the annual English Lake phosphorus load.

Estimated Costs and Funding Sources

The cost associated with buffer strip installation is variable and depends upon the existing environment, the design used, and the vegetation required. The Conservation Reserve Program (CRP) is a federal program by which agricultural land owners can receive money in exchange for ceasing agricultural activities on their property and/or allowing installation of conservation practices such as buffer strips. If the land owner is willing to place the required property into CRP and allow construction of buffer strips, there will be no cost to the ELMD.

Feasibility

Landowner cooperation is required to make utilization of CRP funds for buffer strip creation possible. To date, attempts to contact the landowner have been unsuccessful.

4.0 COST BENEFIT ANALYSIS

Of the seven alternative control measures evaluated in Section 3.0, all are technically feasible. However, of these, only five are feasible due to current land ownership considerations and/or cost. Given the potential that funding sources may become available in the future and/or land ownership may change, all of the projects have been prioritized herein. Each project is evaluated in Table 4-1 based on its estimated phosphorus removal potential and cost.

Table 4-1. English Lake Watershed Management Cost Benefit Analysis

Alternative	Description	Percent of Reduction in Annual Total Phosphorus	Annual Total Phosphorus Reduction in Pounds	Estimated Project Cost[1]	Cost/lb Total Phosphorus	Cost/ Benefit Rank
1	Natural Area Creation and Wetland Restoration	4.8	24.1	$148,000	$6,141.08	8
2	Rerouting Tiles A and B	6.9	34.8	$21,221	$609.80	5
3	Detention Basin to Treat Tile A and Tile B Discharges	3.5[2]	17.8	$55,000	$3,089.89	7
4	Relocating Portion of Tile B	1.2	6.1	$2,935	$481.15	4
5	Moving of Cattle Associated with Barnyard/Feedlot	77.3	392.0	$1	$0.00	1
6A	Wetland Detention Basin East of English Lake with Alternative 5 (cattle moved)	3.0[2]	16.5	$14,400	$872.73	6
6B	Wetland Detention Basin East of English Lake with[illegible] Alternative 5 (cattle not moved)	41.5[2]	212.0	$14,400	$67.92	3
7	Installation of Buffer Strip	0.25[3]	1.3	$1	$0.77	2

[1] For the purposes of ranking cost-benefit comparisons, $0 values were replaced with $1
[2] Assumes 50% phosphorus removal
[3] Assumes 25% phosphorus removal

Table 4-1 provides a means to compare alternatives on the basis of costs incurred per pound of total phosphorus removed. In other words, which alternative provides the greatest phosphorus reduction for the least cost. From an economic standpoint, Alternatives 5, 6B, and 8 are several orders of magnitude less costly than any of the other alternatives and result in the greatest phosphorus reduction per dollar spent. Alternatives 1 and 3 are not economically efficient as a result of the necessity to purchase land. The remaining alternatives fall somewhere in between in terms of economic efficiency.

5.0 CONCLUSIONS AND RECOMMENDATIONS

To a large extent, the water quality of a lake is a direct result of what enters the lake from its contributing watershed. The first step towards restoration of a lake is to define its physical, chemical, and biological characteristics. Definition of these characteristics for English Lake was accomplished in the previously submitted Phase I, II and III Lake Planning Grant reports (IPS, 1992; IPS, 1995; and IPS and RMG, 1997). The second step is to identify possible sources of pollutants either entering the lake from its contributing watershed or from within the lake itself. Pollutant loading sources to English Lake were identified in the Phase III report. The third stage in the restoration process involves definition and implementation of watershed best management practices to minimize external loading to the greatest extent possible. The definition and selection of watershed best management practices for English Lake was the purpose of this, the Phase IV and V Lake Planning Grant Studies. The final step in the restoration process involves the control of internal sources of pollutants. With reference to English Lake, control of internal sources can be studied in the future if the watershed management measures proposed herein do not adequately address the current water quality issues.

The greatest single source of total phosphorus to English Lake is an approximately two acre cattle barnyard/feedlot located to the east of the lake. This single source produces approximately 77.3 percent of the total annual phosphorus load to the lake. Although other sources of nutrients to the lake have been identified, no other single controllable source contributes greater than 6.9 percent of the total watershed load of phosphorus. Therefore, implementation of measures to control runoff from the cattle barnyard/feedlot will likely result in the greatest benefit to the lake.

Alternative 5 offers the most effective measure for reducing phosphorus loading from the cattle barnyard/feedlot by eliminating the source. The cost benefit analysis also indicated that this was the most cost effective alternative, and implementation may not result in any costs to the ELMD. As a result, it is recommended that the ELMD actively pursue implementation of this alternative. Based on discussions with the Manitowoc County Soil and Water Conservation Department and the Natural Resource Conservation Service, a realistic implementation date, assuming the landowner agrees to participate, is January, 1998.

Since implementation of Alternative 5 is entirely dependent upon the land owners willingness to move his cattle, there is some risk in pursuing only this alternative. Therefore, it is recommended that the ELMD also pursue implementation of Alternative 6 (Wetland Detention Basin East of English Lake). If the cattle cannot be moved, Alternative 6 will still result in a fairly high degree of treatment for the runoff from the barnyard/feedlot as well as treatment for the 37 acre watershed. If the cattle are moved, the wetland detention basin will continue to provide treatment for a 37 acre agricultural watershed. The other factor that needs to be considered regarding the pursuit of this alternative is the availability of funding. The Southeast Wisconsin Coastal Habitat Project may only have funds available for construction in 1997. If this alternative is not pursued now, this source of funding may not be available in the future. Sources of information and assistance for future reference regarding funding and other lake management issues can be found in Appendix D.

Although Alternative 7 (Installation of Buffer Strip) will result in only a 0.25 percent reduction in phosphorus loading to the lake, it is also recommended due to the minimal cost and effort involved in its

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