Lake File Copy

Hey and Associates, Inc.
240 Regency Court, Suite 201
Brookfield, WI 53045-6190
Office 414.796.0440
Fax 414.796.0045

Final Report

SURFACE WATER RUNOFF STUDY

for the

Lauderdale Lakes Lake Management District

In Cooperation with the
Walworth County Land Conservation Department
and Wisconsin Department of Natural Resources

July, 1998

Project No. W97116

TABLE OF CONTENTS

Introduction

The purpose of this study was to develop a surface runoff plan for the reduction of sediment and total phosphorus into Lauderdale Lakes, Walworth County, Wisconsin. The U.S. Geological Survey conducted an intensive hydrology and water quality study of Lauderdale Lakes for the period November 1, 1993, through October 31, 1994, which was published in 1996 (Garn, et. al). The USGS study determined that 51 percent of the phosphorus load entering the lake was from surface runoff. Approximately 75 percent of the surface runoff load was from direct sheet flow into the lake. The remaining 25 percent of the load was derived from five tributary drainage areas, four of which were monitored. This study selected the two tributary areas that contributed the highest phosphorus loading. The first area is on the north side of Green Lake, identified in this study as the "North Watershed", and the second is an area directly south of Don Jean Bay, which will be identified in this study as the "South Watershed" (See Figure 1). These two areas consisted of approximately 18% of the surface runoff load. This project will predict total suspended sediment and total phosphorus loads to the lake and recommends best management practices to reduce this loading.

This study was funded through a Lake Planning Grant from the Wisconsin Department of Natural Resources. The Lauderdale Lake Management District provided local cost share for the grant. The Walworth County Land Conservation Department provided technical assistance.

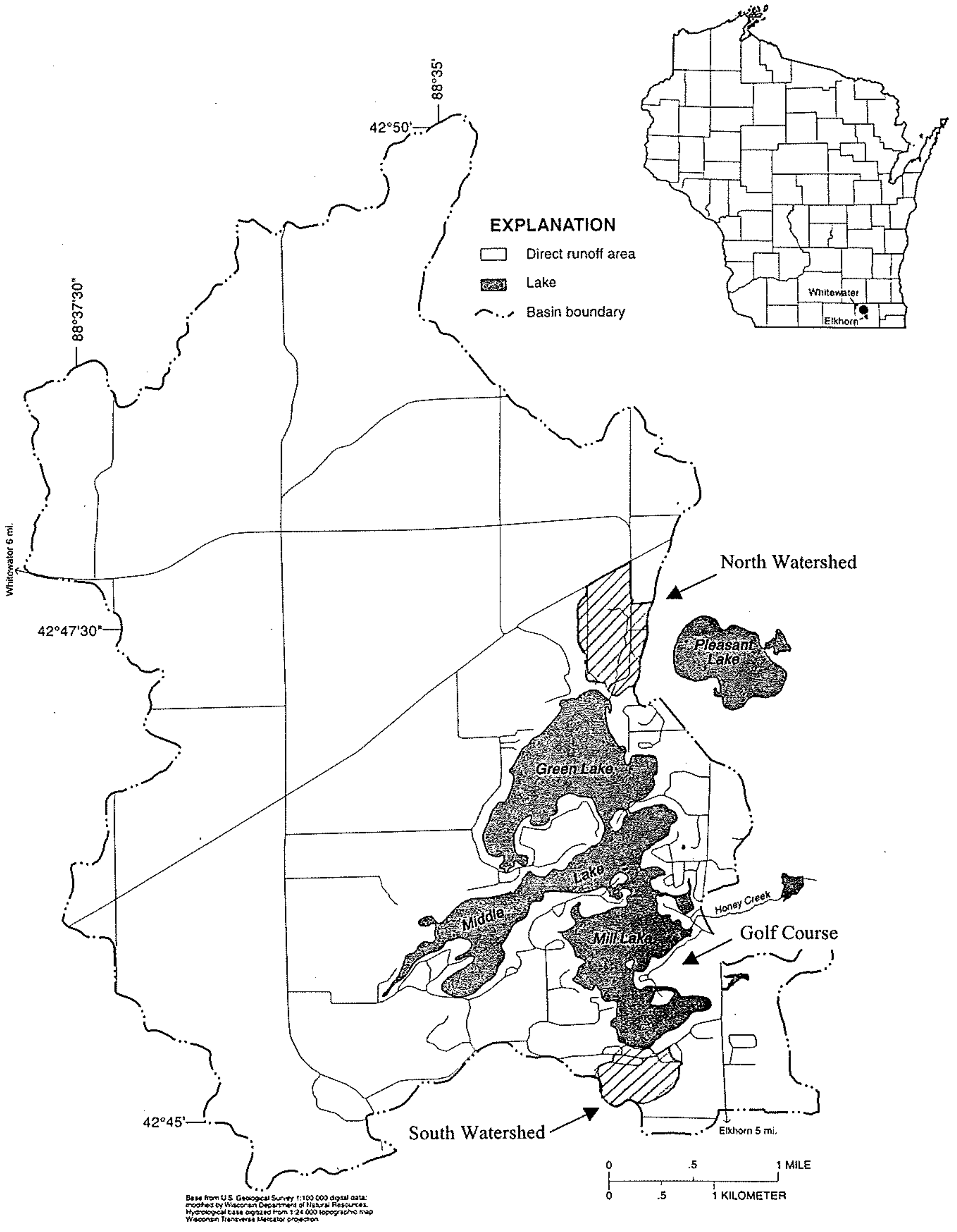
Description of Study Areas

Locations

As previously stated, two tributary areas were selected for study in this project. The first area is on the north side of Green Lake, identified in this study as the "North Watershed", and the second is an area directly south of Don Jean Bay, which will be identified in this study as the "South Watershed" (See Figure 1).

Land Use

Land use in each of the watersheds primarily consists of agricultural and residential land. Table 1 summarizes the particular land uses in each of the watersheds. Figure 2 provides a graphical representation of the land use information.



Source: USGS, WRIR 96-4235

NORTH

Location map of Lauderdale Lakes, Walworth County, Wisconsin

FIGURE NO. 1

Surface Water Runoff Study

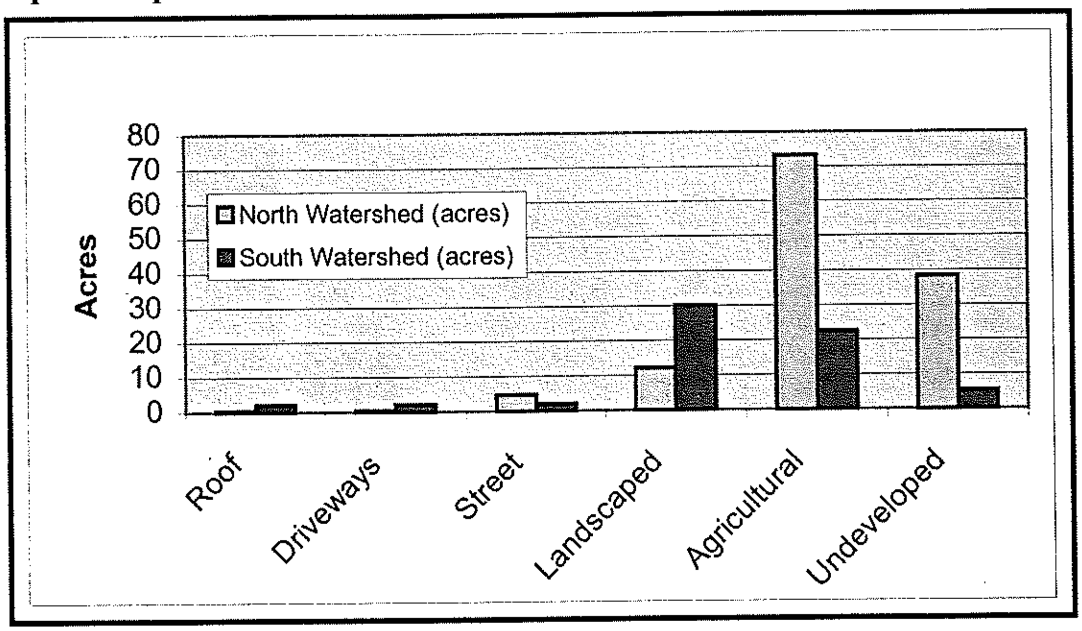
for the Lauderdale Lakes Lake Management District

Hey and Associates, Inc.
240 Regency Court, Suite 201
Brookfield, Wisconsin 53045
Office (414) 796-0440
Fax (414) 796-0445

TABLE 1.
Summary of Land Use in the Lauderdale Lakes Study Watersheds

Land Use	North Watershed (acres)	South Watershed (acres)
Roof	0.42	2.13
Driveways	0.44	1.92
Street	4.78	1.95
Landscaped	12.18	30.12
Agricultural	73.24	22.43
Undeveloped	38.37	5.22
Total	129.43	63.77

FIGURE 2.
Graphical representation of the Land Use in Lauderdale Lakes Study Watersheds



In addition, the North Watershed has 27.5 acres (out of the total of 73.24 acres) of agricultural land that is currently in the federal Conservation Reserve Program and is not farmed.

SOILS

The North and South Watersheds exist on many soil associations. The various soils are summarized in Table 2:

TABLE 2.
Summary of soil types in the North and South Watersheds

Soil Name	Soil Abbrev -iation	Slope %	Hydro-logic Soil Group	Present in North Watershed	Present in South Watershed
Casco Loam	CeB2	2-6, Eroded	B	Res	
Casco Loam	CeD2	12-20, Eroded	B		Res
Casco-Fox Silt Loams	CIC2	6-12, Eroded	B		Ag, Res
Casco-Rodman Complex	CrE2	20-30, Eroded	B		Ag, Res
Fox Silt Loam	FsA	0-2	B	Ag, Res	
Fox Silt Loam	FsB	2-6	B	Ag, Res	Ag, Res
Fox Loam	FoC2	6-12, Eroded	B	Res	
Fox Silt Loam	FsC2	6-12, Eroded	B	Ag	
Juneau Silt Loam	JuA	1-3	B	Res	Ag
McHenry Silt Loam	MpB	2-6	B	Ag	
McHenry Silt Loam	MpC2	6-12, Eroded	B	Ag	
Miami Loam	MwD2	12-20, Eroded	B	Ag	
Miami Loam	MxC2	6-12, Eroded	B	Ag	
Miami Loam	MxD2	12-20, Eroded	B	Ag	
Radford Silt Loam	RaA	0-3	B		Res
Rodman-Casco Complex	RsF	30-45	B	Res	
St. Charles Silt Loam	SeA	0-2	B		Ag, Res
St. Charles Silt Loam	SeB	2-6	B		Ag, Res

All soils in the study area are in the "B" hydrologic soil group. Soils classified in the "B" group, as defined by the Natural Resource Conservation Service (NRCS), have a moderate infiltration rate when thoroughly wet. They consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. In addition, these soils have a moderate rate of water transmission (USDA, 1971).

TOPOGRAPHY

The normal water surface elevation of Lauderdale Lakes is 884 feet MSL, according to the USGS topographic map. Elevations in the North Watershed range from 884 feet to approximately 1020 feet. Elevation in the South Watershed range from 884 feet to approximately 970 feet. A brief description of the geology of the study area can be found in Gain et. al. (1996)

MODELING METHODS

SOURCE LOADING AND MANAGEMENT MODEL (SLAMM)

SLAMM is an urban nonpoint source water quality model. It was strictly developed for modeling urban areas. The model is based on urban runoff monitoring conducted as part of the Nationwide Urban Runoff Project (NURP). SLAMM has been expanded over the years to include a wide variety of source area and outfall control practices. This program can be used to model existing conditions of a drainage area and then add one or more control practices such as; wet detention ponds, infiltration basins, street cleaning, catch basin cleaning, grass swales, and/or porous pavement. Then the results can be compared to see the reduction of pollutants found from the various control practices. As with any modeling efforts is it always recommended to calibrate the modeling results with actual field measured data. However, in this case detailed runoff and pollutant data is not available for use in calibration.

This model calculates pollutants for a specific file of rainfall events. The 1981 rainfall observed at the Milwaukee Nationwide Urban Runoff Project (NURP) sampling locations was used in this modeling. This is considered to be an "average" rainfall year. The program output consisted of total suspended sediment and total phosphorus in pounds for the two watersheds.

The results of the Slamm modeling are summarized in Appendix A of this report.

UNIVERSAL SOIL LOSS EQUATION (USLE)

The USLE was used to calculate total soil loss from all agricultural fields. The USLE was designed to predict the long-term average soil losses in runoff from field areas under specified cropping and management systems (Shen, et. al. 1993). The USLE equation is as follows:

$$A = R\ K\ LS\ C\ P$$

where:
A = total soil loss (tons/acre)
R = rainfall erodibility factor
K = soil erodibility factor (tons/acre)
LS = topographic factor
C = cropping-management factor
P = conservation practice factor

An average annual rainfall erodibility factor of 140 was used for the Lauderdale Lakes area. This number was chosen from a map of rainfall erodibility factors developed by the U.S. Department of Agriculture (Wischmeier and Smith, 1978) for the continental United States.

The soil erodibility factors are published by the Natural Resource Conservation Service for each soil type. A weighted soil erodibility factor was calculated for each agricultural field.

The topographic factor is determined by first chosing a representative slope length and slope of the agricultural field. These numbers were then used in a graph developed by the U.S. Department of Agriculture (Wischmeier and Smith, 1978) to find the topographic factor.

The cropping-management factors and conservation practice factors were chosen from tables published by the U.S. Department of Agriculture and were site specific to the existing and alternative practices on each field. Actual factors chosen can be found in Appendix A.

The USLE calculates the total amount of soil lost from the surface due to erosion. However, it is desired to find the amount of sediment delivered to the watershed outlet. To find this amount a simple relationship between drainage area and sediment delivery ratio was used (Boyce 1975, Frenette et.al. 1987----reprinted in Shen et.al., 1993). The relationship is as follows:

$$SDR = 0.31\ A_t^{-0.3}$$

where:

SDR = sediment delivery ratio
A_t = drainage area (mi^2)

It can be seen in Appendix A that a sediment delivery ratio of 50% was calculated for the North Watershed and 62% for the South Watershed.

The next step was to obtain the amount of total phosphorus in the soil delivered to the watershed outlets. The Walworth County Land conservation office uses a conversion of one pound of total phosphorus per ton of total sediment. This conversion was used in this study.

The results of the USLE modeling are summarized in Appendix B of this report.

WATER QUALITY MODELING SUMMARY

Table 3 summarizes the results of the water quality modeling for the North and South Watersheds under existing land use conditions.

TABLE 3
Summary of Water Quality Modeling Results for Existing Conditions

Watershed	Total Suspend Sediment (lbs/yr)	Total Phosphorus (lbs/yr)
North Watershed	514,257	273
South Watershed	162,993	103
Total	677,250	376

GOALS OF THE SUGAR/HONEY CREEKS PRIORITY WATERSHED PROJECT

Lauderdale Lakes are located in the Sugar/Honey Creek Priority Watershed Project. The watershed project is a state-funded program designed to control nonpoint source pollution. The project, started in 1994, provides technical and financial assistance to landowners in the 167-mile watershed. Lauderdale Lakes are located in the watershed area. A Nonpoint Source Control Plan for the Sugar/Honey Creeks Priority Watershed Project was published in 1997, and outlines specific pollution reduction goals for the Lauderdale Lakes area. The goals are outlined in Table 4.

TABLE 4
Nonpoint Source Pollutant Reduction Goals for Lauderdale Lakes Area

Parameter	Goal
Sediment delivery	34%
Gully erosion	5%
Inlake phosphorus reduction	14%

Source: WDNR, et. al., 1997

The watershed plan recommended, in the Lauderdale Lakes, area that agricultural and riparian residential areas be targeted for controls. The plan also recommended continued inlake monitoring to assess the internal phosphorus loadings in all three lakes.

ALTERNATIVES

Various alternatives were analyzed in this study. Below is a brief summary of each alternative broken down by study area. The results are summarized in Table 5.

NORTH WATERSHED

ALTERNATIVE 1: DO NOTHING

Under the do nothing alternative sediment and nutrient inputs to the lakes will remain the same. Sediment will continue to build up in the lake. Nutrients washed in from runoff will continue to feed algae and rooted aquatic plants. An estimated 514,257 lbs/yr of sediment and 273 lbs/yr of phosphorus would continue to enter the lake from the North Watershed.

ALTERNATIVE 2: DETENTION/WETLAND TREATMENT

This alternative involves construction of a wet detention basin or wetland treatment system to remove sediment and nutrients from the entire upper watershed. An ideal location for the pond is on a vacant lot located in the Gladhurst Subdivision. The location is where two tributaries come together (Figure 2). The detention facility would treat approximately 90-acres of watershed. The pond would need a wet surface area of 1.7 acres to treat the runoff to a 90% suspended solids removal efficiency. This alternative would reduce the suspended solids input to the lake from 514,257 lbs/yr to 56,226 lbs/yr, or a reduction of 458,031 lbs/yr. Phosphorus inputs would be reduced from 273 lbs/yr to 129 lbs/yr, or a 53% reduction. Cost of this alternative is estimated at $65,000 for construction and $40,000 for land acquisition.

A wetland treatment system was evaluated. The system would need a surface area of approximately 3.4-acres, and would not fit on the available land. Therefore, a wetland treatment system would not be feasible for the proposed site.

ALTERNATIVE 3: CONSERVATION COVER

This alternative modeled the watersheds placing all of the agricultural land in conservation cover. This means that the agricultural land is retired from production and a perennial vegetative cover is maintained over the soil (NRCS, NHCP, 1987). A complete description can be found in Appendix C. Implementation of this practice would reduce the sediment inputs by 468,000 lbs/yr to an input of 46,257 lbs/yr, or a 91% reduction. Phosphorus inputs would be reduced from 273 lbs/yr to 39 lbs/yr, or a 86% reduction. Cost of this alternative, following the federal Conservation Reserve Program prototype, is estimated at $75 per acre. The total cost would be $5,475 per year if all the existing agricultural lands in the North Watershed were placed in conservation cover.

ALTERNATIVE 4: RESIDUE MANAGEMENT

This alternative modeled the agricultural land as if farmers were practicing residue management. Residue management is managing the amount, orientation and distribution of crop and other plant residues on the soil surface year-round, while growing crops in narrow slots or tilled strips in previously untilled soil and residue (NRCS, NHCP, 1994). A complete description can be found in Appendix C. Implementation of this practice would reduce the sediment inputs by 304,000 lbs/yr to an input of 210,257 lbs/yr, or a 59% reduction. Phosphorus inputs would be reduced from 273 lbs/yr to 121 lbs/yr, or a 56% reduction. Currently the Sugar/Honey Creek Priority Watershed Project is providing an incentive to eligible farmers of approximately $18.50 per acre to implement residue management. Using this incentive the cost of placing all of the agricultural land in the North Watershed in residue management would be $1,350 per year.

ALTERNATIVE 5: CONTOUR FARMING

This alternative modeled the agricultural land as if farmers were practicing contour farming. Contour farming is sloping the land in such a way that preparing land, planting, and cultivating are done on the contours (NRCS, NHCP, 1980). A complete description can be found in Appendix C. Implementation of this practice would reduce the sediment inputs from 514,257 lbs/yr to an input of 174,257 lbs/yr, or a 66% reduction. Phosphorus inputs would be reduced from 273 lbs/yr to 103 lbs/yr, or a 62% reduction. Currently the Sugar/Honey Creek Priority Watershed Project is providing an incentive to eligible farmers of approximately $9.00 per acre to implement contour farming. Using this incentive the cost of placing all of the agricultural land in the North Watershed in contour farming would be $660.00 per year.

ALTERNATIVE 6: CONTOUR STRIPS

This alternative modeled the agricultural land as if farmers were using contour strips. Contour strips are narrow strips of perennial, herbaceous vegetative cover established across the slope and alternated down the slope with wider cropped strips (NRCS, NHCP, 1997). A complete description can be found in Appendix C. Implementation of this practice would reduce the sediment inputs from 514,257 lbs/yr to an input of 140,257 lbs/yr, or a 73% reduction. Phosphorus inputs would be reduced from 273 lbs/yr to 86 lbs/yr, or a 68% reduction. Currently the Sugar/Honey Creek Priority Watershed Project is providing an incentive to eligible farmers of approximately $13.50 per acre to implement contour strips. Using this incentive the cost of placing all of the agricultural land in the North Watershed in contour strips would be $990.00 per year.

ALTERNATIVE 7: GRASSED WATERWAY

A grassed waterway is a wide, shallow, sod lined channel designed to safely convey water during heavy rainfall. Grassed waterways are used to prevent the formation of gullies. Figure 4 illustrates the typical cross-section of a grassed waterway. Gully erosion is not estimated by the Universal Soil Loss Equation (USLE), therefore, the exact sediment and phosphorus reductions by implementation of this management practice are not known. To protect the grass waterway from high flows during heavy rains, it is recommended that a detention basin be constructed at the upstream area (Figure 2). Cost of a grassed waterway is approximately $2.00 per lineal foot. Approximately 1,000 lineal feet of waterway is needed, for a cost of $2,000. A detention basin would cost approximately $20,000.

ALTERNATIVE 8: CONSERVATION EASEMENTS

Just upstream of the lake, the tributary channel drains through a steep wooded ravine. The ravine is located within a residential development, known as the Gladhurst subdivision (see Figure 2). The tributary runs along several lots. The most important lots are numbers 11, 12, 13, and 14 on the plat. The ravine is a very steep forested area where some erosion has begun. A 20-foot drainage easement currently exists on some of the lots. If these lots were developed and the trees were cut down it may make the banks very unstable and susceptible to erosion. To protect the ravine a conservation easement should acquired on all of the steep slope areas. The following is a list of activities that should be prohibited in the easement:

1. Removal of any vegetation, including trees and shrubs.

2. Runoff from driveways, roofs, and patios should not be drained into the ravine, except through a engineered waterway or pipe to prevent gully erosion.

3. The stream channel should not be relocated. The channel has stabilized itself through years of self-armoring. Disturbance of the channel could damage the natural protection features and cause severe erosion.

The lots along the ravine are currently listed for $26,500 by Remax Realty. The value of a conservation easement would need to be determined by a licensed appraiser. For the purpose of this study a cost of $20,000 for an easement on the four critical lots was assumed.

SOUTH WATERSHED

ALTERNATIVE 1: DO NOTHING

Under the do nothing alternative sediment and nutrient inputs to the lakes will remain the same. Sediment will continue to build up in the lake. Nutrients washed in from runoff will continue to feed algae and rooted aquatic plants. An estimated 162,993 lbs/yr of sediment and 103 lbs/yr of phosphorus would continue to enter the lake from the North Watershed.

ALTERNATIVE 2: DETENTION/WETLAND TREATMENT

The South Watershed was evaluated for installation of a wet detention pond. A pond designed to treat the entire South Watershed would need approximately 0.7 acres in wet surface area with 3 feet of depth. Installation of a wet detention pond would reduce the sediment inputs from 162,993, lbs/yr to an input of 17,198 lbs/yr, or a 89% reduction. Phosphorus inputs would be reduced from 103 lbs/yr to 49 lbs/yr, or a 52% reduction. A pond located at the lower end of the basin on a vacant lot on the corner of Plantation Road and Bay Circle was first evaluated. Based on field visits it was determined that only a portion of the watershed could be diverted into this property. It was concluded that a detention pond designed to treat the entire watershed, including the residential and agricultural areas, was not feasible based on the existing drainage and level of development in the lower watershed.

Construction of a detention pond on the agricultural field was determined to be technically feasible and would need a wet surface area of approximately 0.5 acres. The pond would reduce the sediment loadings to 60,657 lbs/yr or an 88% reduction in total loadings. The estimated cost of wet detention basin in the south watershed is estimated at $50,000.

ALTERNATIVE 3: CONSERVATION COVER

This alternative modeled the watersheds placing all of the agricultural land in conservation cover. This means that the agricultural land is retired from production and a perennial vegetative cover is maintained over the soil (NRCS, NHCP, 1987). A complete description can be found in Appendix C. Implementation of this practice would reduce the sediment inputs from 162,993 lbs/yr to an input of 8,993 lbs/yr, or a 94% reduction. Phosphorus inputs would be reduced from 103 lbs/yr to 26 lbs/yr, or a 75% reduction. Cost of this alternative, following the federal Conservation Reserve Program prototype, is estimated at $75 per acre. The total cost would be $1,682.25 per year if all the existing agricultural lands in the South Watershed were placed in conservation cover.

ALTERNATIVE 4: RESIDUE MANAGEMENT

This alternative modeled the agricultural land as if farmers were practicing residue management. Residue management is managing the amount, orientation and distribution of crop and other plant residues on the soil surface year-round, while growing crops in narrow slots or tilled strips in previously untilled soil and residue (NRCS, NHCP, 1994). A complete description can be found in Appendix C. Implementation of this practice would reduce the sediment inputs from 162,993 lbs/yr to an input of 62,993 lbs/yr, or a 61% reduction. Phosphorus inputs would be reduced from 103 lbs/yr to 53 lbs/yr, or a 49% reduction. Currently the Sugar/Honey Creek Priority Watershed Project is providing an incentive to eligible farmers of approximately $18.50 per acre to implement residue management. Using this incentive the cost of placing all of the agricultural land in the South Watershed in residue management would be $415.00 per year.

ALTERNATIVE 5: CONTOUR FARMING

This alternative modeled the agricultural land as if farmers were practicing contour farming. Contour farming is sloping the land in such a way that preparing land, planting, and cultivating are done on the contours (NRCS, NHCP, 1980). A complete description can be found in Appendix C. Implementation of this practice would reduce the sediment inputs from 162,993 lbs/yr to an input of 58,993 lbs/yr, or a 64% reduction. Phosphorus inputs would be reduced from 103 lbs/yr to 51 lbs/yr, or a 50% reduction. Currently the Sugar Creek Priority Watershed Project is providing an incentive to eligible farmers of approximately $9.00 per acre to implement contour farming. Using this incentive the cost of placing all of the agricultural land in the South Watershed in contour farming would be $200.00 per year.

ALTERNATIVE 6: CONTOUR STRIPS

This alternative modeled the agricultural land as if farmers were using contour strips. Contour strips are narrow strips of perennial, herbaceous vegetative cover established across the slope and alternated down the slope with wider cropped strips (NRCS, NHCP, 1997). A complete description can be found in Appendix C. Implementation of this practice would reduce the sediment inputs from 162,993 lbs/yr to an input of 44,993 lbs/yr, or a 72% reduction. Phosphorus inputs would be reduced from 103 lbs/yr to 44 lbs/yr, or a 57% reduction. Currently the Sugar Creek Priority Watershed Project is providing an incentive to eligible farmers of approximately $13.50 per acre to implement contour strips. Using this incentive the cost of placing all of the agricultural land in the South Watershed in contour strips would be $303.00 per year.

ALTERNATIVE 7: LAKE BUFFER STRIPS

Lake buffer strips are grassed areas along the lake that are allowed to be left un-mowed. The strip of taller grass has the ability to absorb more nutrients than mowed turf and allows the grass to establish a deeper root system, decreasing shore erosion. Riparian properties make up less than 1% of the sediment and phosphorus export from the South Watershed. Therefore lake buffer strips will provide limited water quality benefits. However, lake buffer strips do provide important wildlife habitat benefits that make them worth implementing.

ALTERNATIVE 8: PUBLIC EDUCATION ON LAWN CARE

The South Watershed includes 42 residential lots. Each of these lots is maintained with a turf lawn. Control of fertilizer runoff is important to protecting the lake. While the residential areas contribute only 3% of the sediment load from the South Watershed, they contribute 23% of the phosphorus loading. An education program on fertilizer management could help control a significant source of nutrients to the lake. The following is a list of things local residents can do to reduce the runoff of fertilizers:

1. Have the soil tested for its nutrient needs and follow the recommendations of the test. The University Extension provides soil testing at a nominal fee through the Walworth County Extension Office.

2. Apply fertilizer in several small applications throughout the summer instead of applying the entire dose for the year in one application. Never apply more than is recommended on the manufacturer's label.

3. Leave grass clippings on the lawn. This is equal to one fertilizer application per year.

4. Water the lawn after fertilizing, but do not over water, allowing the water to runoff into the ditch or street.

5. Any fertilizer spilled on roads or sidewalks should be promptly cleaned.

6. Never apply fertilizer to frozen ground.

7. Along ditches, and waterways leave a buffer strip that is not fertilized.

Additional information on safe lawn care can be found in Appendix D of this report. The Lauderdale Lake Management District is planning a public education program on lawn care to begin in the summer of 1998.

ALTERNATIVE 9: DEVELOPMENT CONTROLS

The agricultural area in the South Watershed has recently been sold to a land developer. As of the date of this report the area has not been recorded with Walworth County. The property is currently zoned A-3, agricultural land holding, by the county and township. It is assumed that the property will be developed as residential land use. If the area is converted from tilled field to residential lots it is predicted that the sediment loadings from the agricultural field will drop from the current 150,000 lbs. per year to approxiemntaly 3,000 lbs. per year. Phosphorus loadings will drop from 79 lbs. per year to an estimated 13 lbs. per year, depending on the density of development. The reductions in sediment and phosphorus are caused by conversion of the tilled fields to residential lawns.

While conversion of the agricultural area to residential land use should reduce the amount of sediment and phosphorus entering the lake, other pollutants associated with urban development may increase. Petroleum hydrocarbons, heavy metal, and fecal coliforms are examples of pollutants that may increase without adequate stormwater controls. A stormwater management system that addresses water quality should be installed with any proposed development for the site. If the area is developed as low density residential on large lots, the stormwater system should include grassed waterways and infiltration systems. If a clustered development of higher density lots is developed, wet detention may need to be incorporated into the design. The Lauderdale Lakes Management District should work with Walworth County and the Town of Sugar Creek to assure that adequate stormwater controls are incorporated into the final design of any proposed development.

RESULTS

As previously stated, total suspended sediment and total phosphorus loads were calculated for both the North and the South watersheds. A summary of both watersheds for existing conditions and various alternatives and their respective reductions in loadings are shown in Table 5.

The total phosphorus loadings calculated here are higher than what was calculated in the USGS report. One reason is that the drainage areas are different. The North Watershed is roughly 50 acres larger than in the USGS report and the South Watershed is roughly 15 acres smaller. Watershed delineation's for this study were based on field surveys. Another reason for the difference between the loadings calculated in the USGS report and this study is that the USGS study is for a particular year with precisely measured climatic data (i.e., precipitation, evaporation, etc.), and this study is based on a year with long-term average climatic conditions. In addition, completely different modeling techniques were used to model the watersheds.

RECOMMENDATIONS

FINAL RECOMMENDATION

Modeling results were discussed at a meeting with three representatives from the Lauderdale Lakes Management District; Scott Mason, Jerry Peterson, and WallyYandel, in addition to Bob Wakeman, DNR, and Neal O'Reilly and Tracy Seidel from Hey and Associates, Inc. Our firm also discussed results at a meeting with three representatives from the Walworth County Land Conservation office (WCLC); Brian Semeta, David Duwe, and Faye Anderson. Technical, political, and financial suggestions by all parties were taken into consideration in our final recommendation. Several recommendations will also be made simply based on field observations. Recommendations and the recommended implementation schedule are summarized in Table 6. Figures 2 and 3 show the location of the water quality alternatives, for the North and South Watersheds respectively, and priority listing.

NORTH WATERSHED

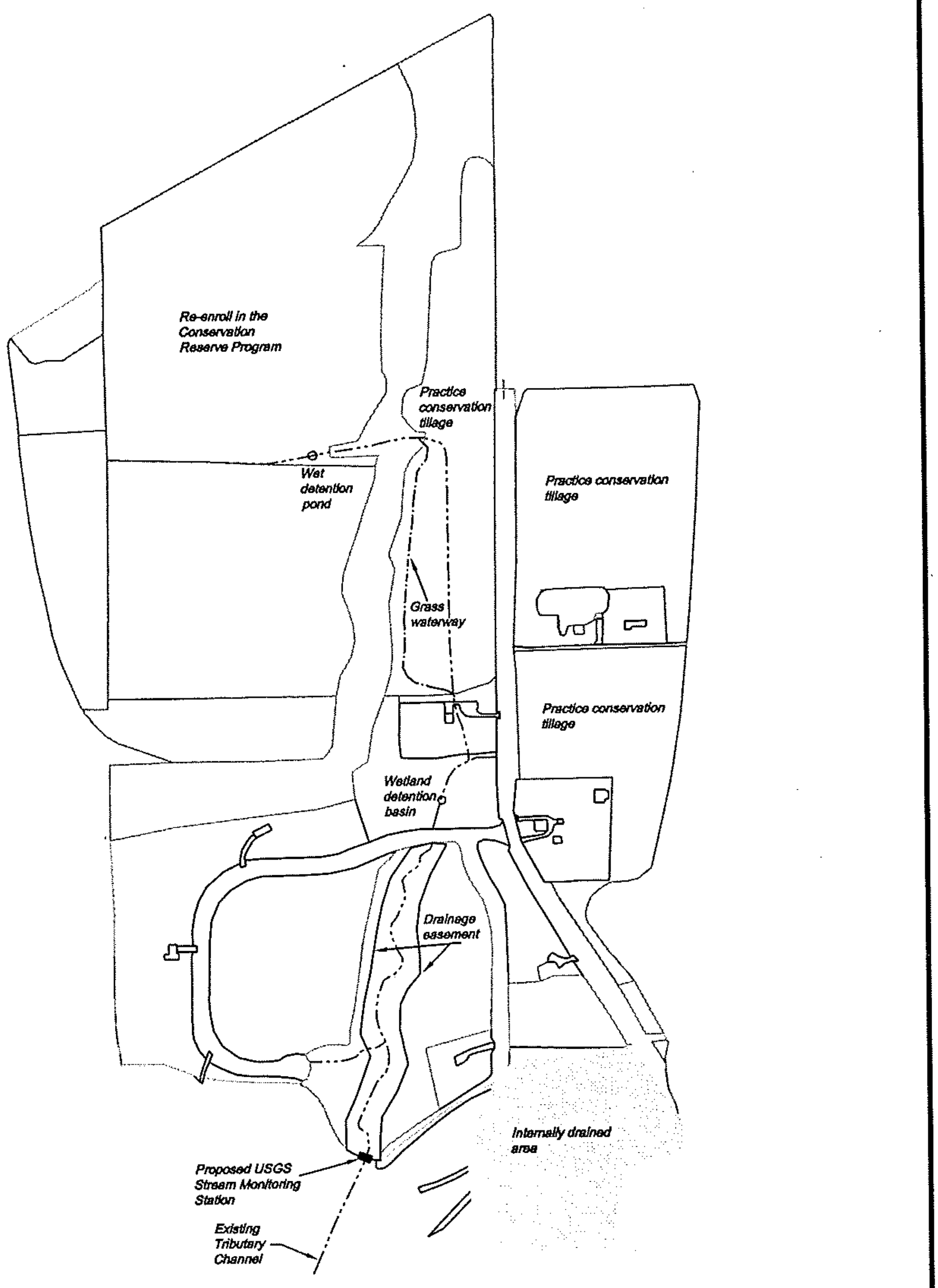
First Priority - The first priority is the construction of a wetland/detention facility on lot 1 in the Gladhurst Subdivision (see Figure 2). A problem with this recommendation is that the lot has recently been sold. Therefore it is recommended that the Lake District identify who the new owner of the lot is and see it they are aware the ephemeral stream runs through the center of the lot. The plat map shows a drainage easement close to the east side of the property, whereas, the actual waterway is further to the west. If the new owners are not aware of the waterway, they may be willing to re-sell the lot. Remax Realty stated that the lot sold for $39,000. The cost of this recommendation, if the land is available, is $65,000 for the construction of the pond, and approximately $42,000 for the land, for a total of $105,000.

Second Priority - The second priority would be to install a grass waterway along the west side of agricultural field west of HWY 12 (see Figure 2). This was a suggestion by Brian Semeta from the WCLC. Additional field survey would be required to identify the exact location of the waterway to fit it into the site's contours. To protect the waterway during heavy rainfall a detention facility should be constructed upstream of a steep section of field to allow the runoff to be safely metered. Cost of this recommendation is $2,000 for 1,000-feet of waterway, and $20,000 for the construction of the detention pond, for a total cost of $22,000.

Table 5 - Summary of Water Quality Management Alternatives

Alternative	Total Suspended Sediment (lbs/yr)											
	North Watershed					South Watershed						
	Residential/ open space	Residential/ open space (treated)	Ag	Total	% Reduction	Residential/ open space	Residential/ open space (treated)	Ag	Total	% Reduction	Total	% Reduction
Existing	10,257	--	504,000	514,257	0	4,993	--	158,000	162,993	0	677,250	0
Wet detention basin in residential area	5,334	492	50,400	56,226	89	999	399	15,800	17,198	89	73,424	89
(North Watershed(1.7 ac) and South Watershed (0.7 ac))												
Wet detention basin on Agricultural field	5,334	492	50,400	56,226	89	4,294	70	15,800	20,164	88	76,390	89
(South Watershed (0.5 ac), and North Watershed as above)												
Conservation cover on ag fields	10,257	--	36,000	46,257	91	4,993	--	4,000	8,993	94	55,250	92
Residue Management on agricultural fields	10,257	--	200,000	210,257	59	4,993	--	58,000	62,993	61	273,250	60
Contour farming on agricultural fields	10,257	--	164,000	174,257	66	4,993	--	54,000	58,993	64	233,250	66
Contour strips on agricultural fields	10,257	--	130,000	140,257	73	4,993	--	40,000	44,993	72	185,250	73

Alternative	Total Phosphorus (lbs/yr)											
	North Watershed					South Watershed						
	Residential/ open space	Residential/ open space (treated)	Ag	Total	% Reduction	Residential/ open space	Residential/ open space (treated)	Ag	Total	% Reduction	Total	% Reduction
Existing	21	--	252	273	0	24	--	79	103	0	376	0
Wet detention basin in residential area	11	5	113	129	53	5	9	36	49	52	178	53
(North Watershed(1.7 ac) and South Watershed (0.7 ac))												
Wet detention basin on Agricultural field	11	5	113	129	53	21	2	36	58	44	187	50
(South Watershed (0.5 ac), and North Watershed as above)												
Conservation cover on ag fields	21	--	18	39	86	24	--	2	26	75	65	83
Residue Management on agricultural fields	21	--	100	121	56	24	--	29	53	49	174	54
Contour farming on agricultural fields	21	--	82	103	62	24	--	27	51	50	154	59
Contour strips on agricultural fields	21	--	65	86	68	24	--	20	44	57	130	65

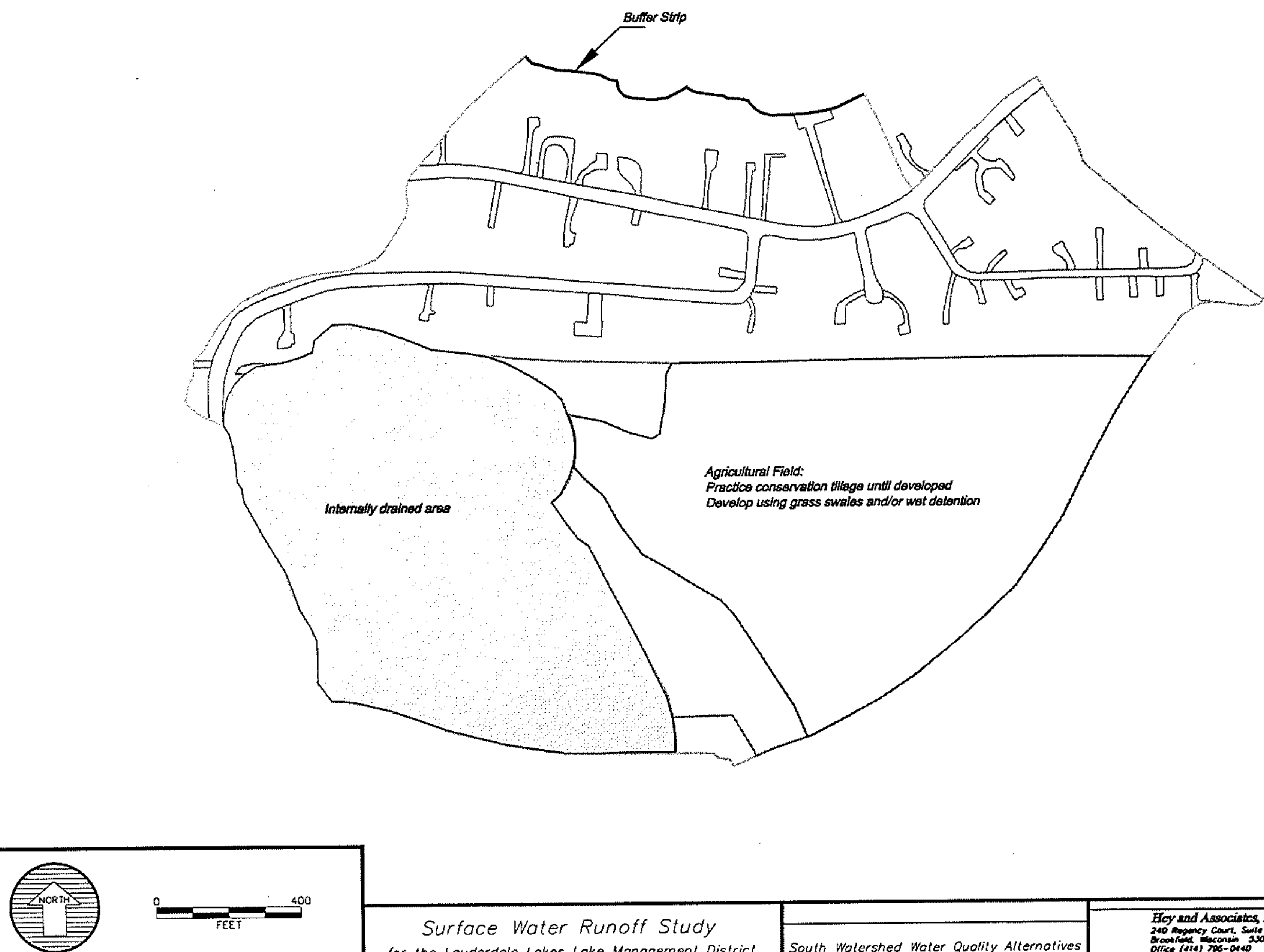


North Watershed Water Quality Alternatives

FIGURE NO. 2

Surface Water Runoff Study
for the Lauderdale Lakes Lake Management District

Hey and Associates, Inc.
240 Regency Court, Suite 201
Brookfield, Wisconsin 53045
Office (414) 796-0440
Fax (414) 796-0445



Surface Water Runoff Study
for the Lauderdale Lakes Lake Management District

South Watershed Water Quality Alternatives

Hey and Associates, Inc.
240 Regency Court, Suite 201
Brookfield, Wisconsin 53045
Office (414) 796-0440
Fax (414) 796-0445

FIGURE NO. 3

Third Priority- The Third priority is to initiate conversation with the landowners of the two agricultural field East of HWY 12 and 8 regarding the use of conservation tillage (Figure 2). A letter has recently been sent by the Walworth County Land Conservation Department asking these landowners if they would be interested in being contacted with more information. Cost share incentives from the priority watershed project may be available for these properties.

Fourth Priority - The forth priority is to obtain conservation easements on the residential lots along the ravine area.

Fifth Priority - The last priority is to follow through on the re-enrollment of agricultural field located at the north side of the watershed in the conservation reserve program (Figure 2). WCLC stated that this landowner was interested in re-enrollment.

Additional recommendations based on field observations are to rake the leaves out of the downstream end of the tributary. When the site was visited the channel had many leaves in it which would be washed directly into the lake during a large rainfall event. An additional source of sediment is the unpaved road in the Gladhurst subdivision. During large rainfall events sediment may wash directly into the tributary. It may be desirable to pave this roadway.

SOUTH WATERSHED

As discussed above the South Watershed maybe in a period of land use transition. The agricultural field in the watershed has recently been sold for potential development. Therefore, the following recommendations will be prioritized based on the sequencing of the potential land use changes.

First Priority - The first priority is to discuss with the current owner of the agricultural area if they would manage the field in conservation tillage until such time it is developed. Conservation tillage, or residue management, would reduce sediment loadings from the watershed by 61% and phosphorus by 49%. Currently the Sugar/Honey Creek Priority Watershed Project is providing an incentive to eligible farmers of approximately $18.50 per acre to implement residue management. Due to its relatively flat topography, the field would not be eligible for cost share funds from the watershed project. Using the state incentive cost, placement of the watershed's portion of the agricultural field in residue management is estimated at $415.00 per year and would need to be implemented by the lake management district. Contacts with the landowner should be coordinated with the Walworth County Land Conservation Department.

Second Priority – The second priority is to begin discussions with Walworth County, Town of Sugar Creek and the land developer of the proposed new development to identify development standards and stormwater treatment practices that will protect the quality of the lake. The lake management district should contact the county and township stating their concerns and interest in participating in the planning discussions with the developer.

Third Priority – The third priority is to begin a public education program on proper lawn care. Educational materials are available from the WDNR and University of Wisconsin. Additional material is located in Appendix D of this report.

Fourth Priority- The fourth priority is to begin a public education program on the establishment of lake side buffers. An educational brochure on the benefits lake side buffers should be developed and distributed to each lake resident.

TABLE 6
Summary of Recommendations

Recommendation	Cost	Schedule	Implementing Body
North Watershed			
1. Wet detention facility	$105,000	Spring 1999	Lauderdale Lake Management District
2. Grassed waterway/detention basin	$2,000	Spring 1999	WCLD and landowner
3. Conservation easements	$20,000	Fall 1998	Lauderdale Lake Management District
4. Conservation tillage	$1,350/yr	Spring 1999	Lauderdale Lake Management District, WCLD and landowner
South Watershed			
1. Conservation tillage	$415/yr	Spring 1999	Lauderdale Lake Management District, WCLD and landowner
2. Zoning restrictions and stormwater management requirements on new residential development.	$0	When development is proposed	Walworth County and Town of LaGrange.
3. Education program on lawn care	-	Spring 1998	Lauderdale Lake Management District
4. Education program on establishment of lake buffer strips	-	Summer 1998	Lauderdale Lake Management District

FUTURE WATERSHED MONITORING

Success of the watershed nonpoint source program can only truly be determined through runoff monitoring. It is recommended that a monitoring station be established on the North Watershed to document changes over time and to help refine implementation of the watershed project. To establish a monitoring recommendation Bob Wakeman (WDNR) and representatives from the U.S. Geological Survey; Herb Garn and Bill Rose were contacted. From these meetings it was determined that the North tributary could be continuously monitored for flow and pollutants. A monitoring station could be established at a driveway culvert just upstream from Green Lake as shown on Figure 3. The monitoring station should monitor steam flows, and sediment and phosphorus loadings. It was determined that it would not be feasible to monitor the south tributary. The cost of monitoring the North Tributary for a five-year period is estimated at $66,793.

To complement the runoff monitoring it is important to have good rainfall and climatic data. Therefore it is recommended that the Lauderdale Lake Management District install a weather station on the golf course. This station would serve to collect local temperature and precipitation records. This data will be useful while analyzing any flow or water quality data collected on the lake or in the various tributaries to predict trends.

As identified in the introduction to this report, 75% of the surface runoff that enters Lauderdale Lakes comes from sheet flow. Much of the sheet flow is directly off residential lawns adjacent to the lake. To better understand the significance of the lawns as a pollution source it is recommended that a study of lawn runoff be conducted. The study should document typical pollutant export and the impacts of various management activities. The USGS has estimated the cost of a two year lawn study to be $30,204.

FUNDING SOURCES

Potential funding sources for implementation of the above recommendations are available from two state and two federal funding programs, the Lauderdale Lakes Management District, and private landowners. Table 7 summarizes the potentially eligible activities under each of the potential state and federal funding sources.

TABLE 7
Potential State and Federal Funding Sources and Eligible Activities

Program	Cost Share Rate	Eligible Activities in Plan
Wisconsin Nonpoint Source Priority Watershed Program	50 to 100%	Wet detention facility, grassed waterway, conservation tillage, and conservation easements.
Wisconsin Lake Protection Grant Program	75%	Wet detention facility, grassed waterway, conservation tillage, conservation easements, public education, and ordinance development.
USDA Conservation Reserve Program	100%	Conservation Cover
U. S. Geological Survey Cooperative Program Matching Funds	30%	Watershed and lake monitoring

The Wisconsin Nonpoint Source Priority Watershed Program is administered through the Sugar/ Honey Creeks Priority Watershed project. For Calendar year 1998, the priority watershed program is out of money and is not signing up any new landowners to participate in the grant program. Money may be available in calendar year 1999.

Table 8 outlines the recommended funding sources for implementation of this plan.

TABLE 8
Recommended Funding Sources

Recommendation	Cost	Funding Source
North Watershed		
1. Wet detention facility	$105,000.	Wisconsin Lake Protection Grant Program and Lauderdale Lakes Management District
2. Grassed waterway/detention basin	$2,000	Wisconsin Lake Protection Grant Program and Lauderdale Lakes Management District
3. Conservation easements	$20,000	Wisconsin Lake Protection Grant Program and Lauderdale Lakes Management District
4. Conservation tillage	$1,350/yr	Wisconsin Nonpoint Source Priority Watershed Program
5. Watershed Monitoring (5-year period)	$66,793	U. S. Geological Survey Cooperative Program Matching Funds, Wisconsin Lake Protection Grant Program and Lauderdale Lakes Management District
South Watershed		
1. Conservation tillage	$415/yr	Lauderdale Lakes Management District
2. Zoning restrictions and stormwater management requirements on new residential development.	$0	N/A
3. Education program on lawn care	-	Lauderdale Lakes Management District
4. Education program on establishment of lake buffer strips	-	Lauderdale Lakes Management District
Lake Watershed Wide		
1. Lawn runoff study	$30,204	U. S. Geological Survey Cooperative Program Matching Funds, Wisconsin Lake Protection Grant Program and Lauderdale Lakes Management District

watershed program is out of money and is not signing up any new landowners to participate in the grant program. Money may be available in calendar year 1999.

Table 8 outlines the recommended funding sources for implementation of this plan.

TABLE 8
Recommended Funding Sources

Recommendation	Cost	Funding Source
North Watershed		
1. Wet detention facility	$105,000.	Wisconsin Lake Protection Grant Program and Lauderdale Lakes Management District
2. Grassed waterway/detention basin	$2,000	Wisconsin Lake Protection Grant Program and Lauderdale Lakes Management District
3. Conservation easements	$20,000	Wisconsin Lake Protection Grant Program and Lauderdale Lakes Management District
4. Conservation tillage	$1,350/yr	Wisconsin Nonpoint Source Priority Watershed Program
5. Watershed Monitoring (5-year period)	$66,793	U. S. Geological Survey Cooperative Program Matching Funds, Wisconsin Lake Protection Grant Program and Lauderdale Lakes Management District
South Watershed		
1. Conservation tillage	$415/yr	Lauderdale Lakes Management District
2. Zoning restrictions and stormwater management requirements on new residential development.	$0	N/A
3. Education program on lawn care	-	Lauderdale Lakes Management District
4. Education program on establishment of lake buffer strips	-	Lauderdale Lakes Management District
Lake Watershed Wide		
1. Lawn runoff study	$30,204	U. S. Geological Survey Cooperative Program Matching Funds, Wisconsin Lake Protection Grant Program and Lauderdale Lakes Management District

PERMITS

Implementation of the above plan may require the acquisition of regulatory permits. The following is an overview of activities and the associated permit that may be required.

TABLE 9
Activities that May Require Regulatory Permits

Recommendation	Permit	Regulatory Agency
North Watershed		
1. Wet detention facility	Chapter 30	Wisconsin Department of Natural Resources
2. Grassed waterway/detention basin	Erosion Control	Walworth County
South Watershed		
None		

REFERENCES

Garn, H.S. and D.L. Olson, T.L. Seidel, W.J. Rose, 1996, Hydrology and Water Quality of Lauderdale Lakes, Walworth County, Wisconsin, 1993-94. U.S. Geological Survey Water-Resources Investigations Report 96-4235.

Novotony, Vladimir, and Harvey Olem, 1994, Water Quality Prevention, Identification, and Management of Diffuse Pollution, Van Nostrand Reinhold, New York.

Pitt, R. E., and John Vorhees, 1997, Source Loading and Management Model (SLAMM) V 7.0. Wisconsin Department of Natural Resources, Madison, WI.

Roehl, J.W. (1962). *Sediment Source Areas, Delivery Ratios and Influencing Morphological Factors*, Publ. No. 59, Internat. Assoc. Hydrol. Sci., pp. 202-213.

Shen, Hsieh Wen and Julien, Pierre Y., 1993, Handbook of Hydrology, Chapter 12, Erosion and Sediment Transport , McGraw Hill, Inc.

Smith, R.A. & Associates, Inc. (1988). Evaluation of Detention and Stream Buffers to Protect Fox Lake, Dodge County from Uncontrolled Upland Erosion,unpublished.

USDA, Soil Survey of Walworth County, U. S. Department of Agricultural, 1971.

Walworth County, Wisconsin, 1996, Land Atlas & Plat Book, 18th Edition, Rockford Map Publishers, Inc., Rockford, Illinois.

WDNR, WDATCP, and Walworth County Land Conservation Department, 1997. Nonpoint Source Control Plan for the Sugar/Honey Creeks Priority Watershed Project, Wisconsin Department of Natural Resources, Madison, WI.

Wischmeier, W.H., and D.D. Smith, "Predicting Rainfall Erosion Losses – A Guide to Conservation Planning," USDA Agriculture Handbook 537, 1978.

APPENDIX A

Results of SLAMM Modeling

NORTH WATERSHED

Data File: North Watershed
Rain File: RAIN81.RAN
Date: 04-08-1998 Time: 23:01:25
Site description: Lauderdale Lakes Site 1, 120 acres trib. to NE corner of Green Lake

Total Area, with Drainage and Outfall Controls - Runoff Volume (cu. ft)

```
Start       Rain      Total      Total      Catch-     Total       Rv      Total      Calculat
d Peak         Flushing   Detention Basin
Date        Total     Without    With       basin      With                Losses     CN
  Reduction  Ratio       Outlet Structure
            (inches)  Drainage   Drainage   Volume     Outfall             (in) *
  Factor                 Failed (land use #-
                      Controls   Controls   % Full     Controls
                         source area #)
Summary for Runoff Producing Events
Number of Runoff Prod-
   ucing Rains:           76         44         44         44         44
Minimum:      0.03        91         47        0.0         47       0.00       0.03       71.1
Maximum:      1.85     64554      51256        0.0      51256       0.16       1.64       98.5
Average:      0.40      9932      12855        0.0      12855       0.09       0.36
Total:       30.36    754816     565607                565607
```

* Total losses are summarized for all events, not for runoff producing events alon
e.

****

Total Area, with Drainage and Outfall Controls - Concentration of PARTICULATE SOLIDS
(mg/L)

```
Start       Rain      Total      Total      Catch-     Total      Flow-wtd
Date        Total     Without    With       basin      With       Min. Part.
            (inches)  Drainage   Drainage   Volume     Outfall    Size
                      Controls   Controls   % Full     Controls   Controlled
Summary for Runoff Producing Events
```

```
Number of Runoff Prod-
   ucing Rains:          76        44        44        44
Minimum:      0.03      261         0       0.0         0
Maximum:      1.85     8720       839       0.0       839
Fl Wt Ave:    0.40      327       291       0.0       291
*****************************************************************

Total Area, with Drainage and Outfall Controls - Yield of PARTICULATE SOLIDS   (lbs)
Start     Rain      Total     Total     Catch-    Total    Flow-wtd
Date      Total     Without   With      basin     With     Min. Part.
          (inches)  Drainage  Drainage  Volume    Outfall  Size
                    Controls  Controls  % Full    Controls Controlled
Summary for Runoff Producing Events
Number of Runoff Prod-
   ucing Rains:          76        44        44        44
Minimum:      0.03       22         2       0.0         2
Maximum:      1.85     1053       833       0.0       833
Fl Wt Ave:    0.40      527       463       0.0       463
Total:       30.36    15397     10257               10257
*****************************************************************
=======================================================================================
===============================================================
=======================================================================================
===============================================================

Total Area, with Drainage and Outfall Controls - Concentration of TOTAL SOLIDS   (mg/L)
Start     Rain      Total     Total     Catch-    Total    Flow-wtd
Date      Total     Without   With      basin     With     Min. Part.
          (inches)  Drainage  Drainage  Volume    Outfall  Size
                    Controls  Controls  % Full    Controls Controlled
Summary for Runoff Producing Events
Number of Runoff Prod-
   ucing Rains:          76        44        44        44
```

Minimum:	0.03	447	0	0.0	0	
Maximum:	1.85	9578	1400	0.0	1400	
Fl Wt Ave:	0.40	841	813	0.0	813	

****

Total Area, with Drainage and Outfall Controls - Yield of TOTAL SOLIDS (lbs)

Start Date	Rain Total (inches)	Total Without Drainage Controls	Total With Drainage Controls	Catch-basin Volume % Full	Total With Outfall Controls	Flow-wtd Min. Part. Size Controlled
Summary for Runoff Producing Events						
Number of Runoff Producing Rains:		76	44	44	44	
Minimum:	0.03	23	3	0.0	3	
Maximum:	1.85	3354	2478	0.0	2478	
Fl Wt Ave:	0.40	1453	1269	0.0	1269	
Total:	30.36	39616	28677		28677	

****

===

Total Area, with Drainage and Outfall Controls - Concentration of PARTICULATE PHOSPHORU
S (micrograms/L)

Start Date	Rain Total (inches)	Total Without Drainage Controls	Total With Drainage Controls	Catch-basin Volume % Full	Total With Outfall Controls	Flow-wtd Min. Part. Size Controlled
Summary for Runoff Producing Events						
Number of Runoff Producing Rains:		76	44	44	44	
Minimum:	0.03	102	0	0.0	0	
Maximum:	1.85	21225	818	0.0	818	
Fl Wt Ave:	0.40	324	297	0.0	297	

****

Total Area, with Drainage and Outfall Controls - Yield of PARTICULATE PHOSPHORUS (lbs)

Start Date	Rain Total (inches)	Total Without Drainage Controls	Total With Drainage Controls	Catch-basin Volume % Full	Total With Outfall Controls	Flow-wtd Min. Part. Size Controlled
Summary for Runoff Producing Events						
Number of Runoff Producing Rains:		76	44	44	44	
Minimum:	0.03	6.95E-03	5.55E-04	0.0	5.55E-04	
Maximum:	1.85	2	1	0.0	1	
Fl Wt Ave:	0.40	6.09E-01	5.10E-01	0.0	5.10E-01	
Total:	30.36	15	10		10	

****

==
==
==
==

Total Area, with Drainage and Outfall Controls - Concentration of TOTAL PHOSPHORUS (micrograms/L)

Start Date	Rain Total (inches)	Total Without Drainage Controls	Total With Drainage Controls	Catch-basin Volume % Full	Total With Outfall Controls	Flow-wtd Min. Part. Size Controlled
Summary for Runoff Producing Events						
Number of Runoff Producing Rains:		76	44	44	44	
Minimum:	0.03	327	0	0.0	0	
Maximum:	1.85	21534	1131	0.0	1131	
Fl Wt Ave:	0.40	641	608	0.0	608	

****

Total Area, with Drainage and Outfall Controls - Yield of TOTAL PHOSPHORUS (lbs)						
Start Date	Rain Total (inches)	Total Without Drainage Controls	Total With Drainage Controls	Catch-basin Volume % Full	Total With Outfall Controls	Flow-wtd Min. Part. Size Controlled
Summary for Runoff Producing Events						
Number of Runoff Producing Rains:		76	44	44	44	
Minimum:	0.03	1.23E-02	1.62E-03	0.0	1.62E-03	
Maximum:	1.85	3	2	0.0	2	
Fl Wt Ave:	0.40	1	1	0.0	1	
Total:	30.36	30	21		21	

****

===

==

SOUTH WATERSHED

Data File: South Watershed
Rain File: RAIN81.RAN
Date: 04-06-1998 Time: 22:24:33
Site description: Lauderdale Lakes Site 2

Residential Areas - Runoff Volume (cu. ft)

Start Date	Rain Total (inches)	Roofs 1	Drive-ways 1	Street Area 1	Small Lndscaped Area 1	Land Use Totals	Rv	Total Losses (in.) *	Calculated CN
Summary for Runoff Producing Events									
Minimum:	0.03	0.00E+00	0.00E+00	42	0.00E+00	42	0.01	0.03	73.7
Maximum:	1.85	1573	1418	10842	22250	36084	0.15	1.57	98.8
Average:	0.40	222	200	1870	3140	5433	0.10	0.36	
Total:	30.36	16878	15214	142140	238674	412906			

Open Space Areas - Runoff Volume (cu. ft)

Start Date	Rain Total (inches)	Undevel-oped Area Area	Land Use Totals	Rv	Total Losses (in.) *	Calculated CN
Summary for Runoff Producing Events						
Minimum:	0.03	0.00E+00	0.00E+00	0.00	0.03	70.8
Maximum:	1.85	3856	3856	0.11	1.65	98.5
Average:	0.40	544	544	0.07	0.37	
Total:	30.36	41364	41364			

Total Area, with Drainage and Outfall Controls - Runoff Volume (cu. ft)

```
Start      Rain       Total      Total      Catch-     Total      Rv       Total      Calculat
d Peak        Flushing  Detention Basin
Date       Total      Without    With       basin      With                Losses     CN
  Reduction  Ratio       Outlet Structure
           (inches)   Drainage   Drainage   Volume     Outfall             (in)  *
  Factor                 Failed (land use #-
                      Controls   Controls   % Full     Controls
                         source area #)
Summary for Runoff Producing Events
Number of Runoff Prod-
   ucing Rains:          76         34         34         34         34
Minimum:     0.03        42         80        0.0         80       0.00       0.03       67.3
Maximum:     1.85     39940      31058        0.0      31058       0.13       1.72       98.5
Average:     0.40      5977       8886        0.0       8886       0.07       0.37
Total:      30.36    454270     302135                302135

    *  Total losses are summarized for all events, not for runoff producing events alon
e.
*****************************************************************

Residential Areas - Concentration of PARTICULATE SOLIDS  (mg/L)
Start      Rain       Roofs 1    Drive-     Street     Small          Land
Date       Total                 ways 1     Area 1     Lndscaped      Use
           (inches)                                    Area 1       Totals
Summary for Runoff Producing Events
Minimum:     0.03          23        120        176        108        124
Maximum:     1.85          23        120      19234        108      19234
Fl Wt Ave:   0.40          23        120        982        108        406

Open Space Areas - Concentration of PARTICULATE SOLIDS  (mg/L)
Start      Rain       Undevel-      Land
Date       Total      oped Area     Use
           (inches)   Area        Totals
```

Summary for Runoff Producing Events

Minimum:	0.03	500	0.00E+00
Maximum:	1.85	500	500
Fl Wt Ave:	0.40	500	500

Total Area, with Drainage and Outfall Controls - Concentration of PARTICULATE SOLIDS (mg/L)

Start Date	Rain Total (inches)	Total Without Drainage Controls	Total With Drainage Controls	Catch-basin Volume % Full	Total With Outfall Controls	Flow-wtd Min. Part. Size Controlled
Summary for Runoff Producing Events						
Number of Runoff Producing Rains:		76	34	34	34	
Minimum:	0.03	161	0	0.0	0	
Maximum:	1.85	19234	2109	0.0	2109	
Fl Wt Ave:	0.40	414	265	0.0	265	

****

Residential Areas - Yield of PARTICULATE SOLIDS (lbs)

Start Date	Rain Total (inches)	Roofs 1	Driveways 1	Street Area 1	Small Lndscaped Area 1	Land Use Totals
Summary for Runoff Producing Events						
Minimum:	0.03	0.00E+00	0.00E+00	47	0.00E+00	47
Maximum:	1.85	2	11	165	150	303
Fl Wt Ave:	0.40	1	5	133	78	213
Total:	30.36	24	114	8705	1608	10451

Open Space Areas - Yield of PARTICULATE SOLIDS (lbs)

Start Date	Rain Total	Undeveloped Area	Land Use

	(inches)	Area	Totals
Summary for Runoff Producing Events			
Minimum:	0.03	0.00E+00	0.00E+00
Maximum:	1.85	120	120
Fl Wt Ave:	0.40	62	62
Total:	30.36	1290	1290

Total Area, with Drainage and Outfall Controls - Yield of PARTICULATE SOLIDS (lbs)

Start Date	Rain Total (inches)	Total Without Drainage Controls	Total With Drainage Controls	Catch-basin Volume % Full	Total With Outfall Controls	Flow-wtd Min. Part. Size Controlled
Summary for Runoff Producing Events						
Number of Runoff Prod-ucing Rains:		76	34	34	34	
Minimum:	0.03	47	10	0.0	10	
Maximum:	1.85	417	375	0.0	375	
Fl Wt Ave:	0.40	273	220	0.0	220	
Total:	30.36	11741	4993		4993	

****

Residential Areas - Source Area Percentage Contribution to Total Runoff Volume

Start Date	Rain Total (inches)	Roofs 1	Drive-ways 1	Street Area 1	Small Lndscaped Area 1	Land Use Totals
Summary for Runoff Producing Events						
Minimum:	0.03	0.00E+00	0.00E+00	26	0.00E+00	90
Maximum:	1.85	4	4	100	57	100
Average:	0.40	2	2	68	25	96

Open Space Areas - Source Area Percentage Contribution to Total Runoff Volume

Start	Rain	Undevel-	Land

Date	Total (inches)	oped Area Area	Use Totals
Summary for Runoff Producing Events			
Minimum:	0.03	0.00E+00	0.00E+00
Maximum:	1.85	10	10
Average:	0.40	4	4

Residential Areas - Source Area Percentage Contribution to PARTICULATE SOLIDS

Start Date	Rain Total (inches)	Roofs 1	Drive- ways 1	Street Area 1	Small Lndscaped Area 1	Land Use Totals
Summary for Runoff Producing Events						
Minimum:	0.03	0.00E+00	0.00E+00	28	0.00E+00	70
Maximum:	1.85	5.71E-01	3	100	38	100
Fl Wt Ave:	0.40	3.86E-01	2	60	26	81

Open Space Areas - Source Area Percentage Contribution to PARTICULATE SOLIDS

Start Date	Rain Total (inches)	Undevel- oped Area Area	Land Use Totals
Summary for Runoff Producing Events			
Minimum:	0.03	0.00E+00	0.00E+00
Maximum:	1.85	30	30
Fl Wt Ave:	0.40	21	21

===
===
===
===

Residential Areas - Concentration of TOTAL SOLIDS (mg/L)

Start Date	Rain Total (inches)	Roofs 1	Drive- ways 1	Street Area 1	Small Lndscaped Area 1	Land Use Totals

Summary for Runoff Producing Events

Minimum:	0.03	26	138	259	214	294
Maximum:	1.85	351	1073	19361	7063	19361
Fl Wt Ave:	0.40	105	304	1114	1051	1007

Open Space Areas - Concentration of TOTAL SOLIDS (mg/L)

Start Date	Rain Total (inches)	Undevel-oped Area Area	Land Use Totals
Summary for Runoff Producing Events			
Minimum:	0.03	579	0.00E+00
Maximum:	1.85	4132	4132
Fl Wt Ave:	0.40	1063	1063

Total Area, with Drainage and Outfall Controls - Concentration of TOTAL SOLIDS (mg/L)

Start Date	Rain Total (inches)	Total Without Drainage Controls	Total With Drainage Controls	Catch-basin Volume % Full	Total With Outfall Controls	Flow-wtd Min. Part. Size Controlled
Summary for Runoff Producing Events						
Number of Runoff Prod-ucing Rains:		76	34	34	34	
Minimum:	0.03	370	0	0.0	0	
Maximum:	1.85	19361	4200	0.0	4200	
Fl Wt Ave:	0.40	1012	819	0.0	819	

****

Residential Areas - Yield of TOTAL SOLIDS (lbs)

Start Date	Rain Total (inches)	Roofs 1	Drive-ways 1	Street Area 1	Small Lndscaped Area 1	Land Use Totals
Summary for Runoff Producing Events						
Minimum:	0.03	0.00E+00	0.00E+00	48	0.00E+00	48

Maximum:	1.85	12	24	251	6785	7031
Fl Wt Ave:	0.40	5	14	170	804	942
Total:	30.36	110	288	9884	15654	25936

Open Space Areas - Yield of TOTAL SOLIDS (lbs)

Start Date	Rain Total (inches)	Undevel-oped Area Area	Land Use Totals
Summary for Runoff Producing Events			
Minimum:	0.03	0.00E+00	0.00E+00
Maximum:	1.85	259	259
Fl Wt Ave:	0.40	124	124
Total:	30.36	2745	2745

Total Area, with Drainage and Outfall Controls - Yield of TOTAL SOLIDS (lbs)

Start Date	Rain Total (inches)	Total Without Drainage Controls	Total With Drainage Controls	Catch-basin Volume % Full	Total With Outfall Controls	Flow-wtd Min. Part. Size Controlled
Summary for Runoff Producing Events						
Number of Runoff Prod-ucing Rains:		76	34	34	34	
Minimum:	0.03	48	12	0.0	12	
Maximum:	1.85	7179	4404	0.0	4404	
Fl Wt Ave:	0.40	1065	750	0.0	750	
Total:	30.36	28681	15443		15443	

****

Residential Areas - Source Area Percentage Contribution to TOTAL SOLIDS

Start Date	Rain Total	Roofs 1	Drive-ways 1	Street Area 1	Small Lndscaped	Land Use

	(inches)				Area 1	Totals
Summary for Runoff Producing Events						
Minimum:	0.03	0.00E+00	0.00E+00	3	0.00E+00	67
Maximum:	1.85	2	5	100	95	100
Fl Wt Ave:	0.40	6.89E-01	2	39	53	85

Open Space Areas - Source Area Percentage Contribution to TOTAL SOLIDS

Start Date	Rain Total (inches)	Undevel-oped Area Area	Land Use Totals
Summary for Runoff Producing Events			
Minimum:	0.03	0.00E+00	0.00E+00
Maximum:	1.85	33	33
Fl Wt Ave:	0.40	16	16

==

==

Residential Areas - Concentration of PARTICULATE PHOSPHORUS (micrograms/L)

Start Date	Rain Total (inches)	Roofs 1	Drive-ways 1	Street Area 1	Small Lndscaped Area 1	Land Use Totals
Summary for Runoff Producing Events						
Minimum:	0.03	13	83	38	112	117
Maximum:	1.85	306	2139	41600	4098	41600
Fl Wt Ave:	0.40	112	423	774	988	858

Open Space Areas - Concentration of PARTICULATE PHOSPHORUS (micrograms/L)

Start Date	Rain Total (inches)	Undevel-oped Area Area	Land Use Totals
Summary for Runoff Producing Events			
Minimum:	0.03	33	0.00E+00
Maximum:	1.85	1073	1073

Fl Wt Ave:	0.40	321	321

Total Area, with Drainage and Outfall Controls - Concentration of PARTICULATE PHOSPHORUS (micrograms/L)

Start Date	Rain Total (inches)	Total Without Drainage Controls	Total With Drainage Controls	Catch-basin Volume % Full	Total With Outfall Controls	Flow-wtd Min. Part. Size Controlled
Summary for Runoff Producing Events						
Number of Runoff Producing Rains:		76	34	34	34	
Minimum:	0.03	136	0	0.0	0	
Maximum:	1.85	41600	2657	0.0	2657	
Fl Wt Ave:	0.40	809	726	0.0	726	

****

Residential Areas - Yield of PARTICULATE PHOSPHORUS (lbs)

Start Date	Rain Total (inches)	Roofs 1	Drive-ways 1	Street Area 1	Small Lndscaped Area 1	Land Use Totals
Summary for Runoff Producing Events						
Minimum:	0.03	0.00E+00	0.00E+00	8.09E-03	0.00E+00	8.09E-03
Maximum:	1.85	1.73E-02	4.96E-02	8.50E-01	3	3
Fl Wt Ave:	0.40	5.21E-03	1.74E-02	9.78E-02	7.16E-01	7.88E-01
Total:	30.36	1.18E-01	4.02E-01	7	15	22

Open Space Areas - Yield of PARTICULATE PHOSPHORUS (lbs)

Start Date	Rain Total (inches)	Undevel-oped Area Area	Land Use Totals
Summary for Runoff Producing Events			
Minimum:	0.03	0.00E+00	0.00E+00

Maximum:	1.85	1.08E-01	1.08E-01
Fl Wt Ave:	0.40	3.37E-02	3.37E-02
Total:	30.36	8.27E-01	8.27E-01

Total Area, with Drainage and Outfall Controls - Yield of PARTICULATE PHOSPHORUS (lbs)

Start Date	Rain Total (inches)	Total Without Drainage Controls	Total With Drainage Controls	Catch-basin Volume % Full	Total With Outfall Controls	Flow-wtd Min. Part. Size Controlled
Summary for Runoff Producing Events						
Number of Runoff Producing Rains:		76	34	34	34	
Minimum:	0.03	8.09E-03	3.49E-03	0.0	3.49E-03	
Maximum:	1.85	3	3	0.0	3	
Fl Wt Ave:	0.40	8.24E-01	6.96E-01	0.0	6.96E-01	
Total:	30.36	23	14		14	

****

Residential Areas - Source Area Percentage Contribution to PARTICULATE PHOSPHORUS

Start Date	Rain Total (inches)	Roofs 1	Drive-ways 1	Street Area 1	Small Lndscaped Area 1	Land Use Totals
Summary for Runoff Producing Events						
Minimum:	0.03	0.00E+00	0.00E+00	2	0.00E+00	77
Maximum:	1.85	3	11	100	96	100
Fl Wt Ave:	0.40	7.79E-01	3	31	70	94

Open Space Areas - Source Area Percentage Contribution to PARTICULATE PHOSPHORUS

Start Date	Rain Total (inches)	Undeveloped Area Area	Land Use Totals

Summary for Runoff Producing Events			
Minimum:	0.03	0.00E+00	0.00E+00
Maximum:	1.85	23	23
Fl Wt Ave:	0.40	6	6

==
==
==
==

Residential Areas - Concentration of TOTAL PHOSPHORUS (micrograms/L)

Start Date	Rain Total (inches)	Roofs 1	Drive-ways 1	Street Area 1	Small Lndscaped Area 1	Land Use Totals
Summary for Runoff Producing Events						
Minimum:	0.03	43	175	157	371	362
Maximum:	1.85	516	2201	41709	4950	41709
Fl Wt Ave:	0.40	171	641	972	1838	1428

Open Space Areas - Concentration of TOTAL PHOSPHORUS (micrograms/L)

Start Date	Rain Total (inches)	Undevel-oped Area Area	Land Use Totals
Summary for Runoff Producing Events			
Minimum:	0.03	117	0.00E+00
Maximum:	1.85	1811	1811
Fl Wt Ave:	0.40	627	627

Total Area, with Drainage and Outfall Controls - Concentration of TOTAL PHOSPHORUS (micrograms/L)

Start Date	Rain Total (inches)	Total Without Drainage Controls	Total With Drainage Controls	Catch-basin Volume % Full	Total With Outfall Controls	Flow-wtd Min. Part. Size Controlled

Summary for Runoff Producing Events

Number of Runoff Producing Rains:		76	34	34	34
Minimum:	0.03	402	0	0.0	0
Maximum:	1.85	41709	3140	0.0	3140
Fl Wt Ave:	0.40	1355	1274	0.0	1274

****

Residential Areas - Yield of TOTAL PHOSPHORUS (lbs)

Start Date	Rain Total (inches)	Roofs 1	Driveways 1	Street Area 1	Small Lndscaped Area 1	Land Use Totals
Summary for Runoff Producing Events						
Minimum:	0.03	0.00E+00	0.00E+00	8.87E-03	0.00E+00	8.87E-03
Maximum:	1.85	1.89E-02	8.74E-02	8.52E-01	4	4
Fl Wt Ave:	0.40	7.77E-03	2.97E-02	1.56E-01	1	1
Total:	30.36	1.80E-01	6.09E-01	9	27	37

Open Space Areas - Yield of TOTAL PHOSPHORUS (lbs)

Start Date	Rain Total (inches)	Undeveloped Area Area	Land Use Totals
Summary for Runoff Producing Events			
Minimum:	0.03	0.00E+00	0.00E+00
Maximum:	1.85	2.40E-01	2.40E-01
Fl Wt Ave:	0.40	7.38E-02	7.38E-02
Total:	30.36	2	2

Total Area, with Drainage and Outfall Controls - Yield of TOTAL PHOSPHORUS (lbs)

Start Date	Rain Total	Total Without	Total With	Catch-basin	Total With	Flow-wtd Min. Part.

	(inches)	Drainage Controls	Drainage Controls	Volume % Full	Outfall Controls	Size Controlled
Summary for Runoff Producing Events						
Number of Runoff Producing Rains:		76	34	34	34	
Minimum:	0.03	8.87E-03	5.09E-03	0.0	5.09E-03	
Maximum:	1.85	4	3	0.0	3	
Fl Wt Ave:	0.40	2	1	0.0	1	
Total:	30.36	38	24		24	

****

Residential Areas - Source Area Percentage Contribution to TOTAL PHOSPHORUS

Start Date	Rain Total (inches)	Roofs 1	Driveways 1	Street Area 1	Small Lndscaped Area 1	Land Use Totals
Summary for Runoff Producing Events						
Minimum:	0.03	0.00E+00	0.00E+00	3	0.00E+00	81
Maximum:	1.85	2	10	100	96	100
Fl Wt Ave:	0.40	5.67E-01	2	27	75	94

Open Space Areas - Source Area Percentage Contribution to TOTAL PHOSPHORUS

Start Date	Rain Total (inches)	Undeveloped Area Area	Land Use Totals
Summary for Runoff Producing Events			
Minimum:	0.03	0.00E+00	0.00E+00
Maximum:	1.85	19	19
Fl Wt Ave:	0.40	6	6

==
==

APPENDIX B

UNIVERSAL SOIL LOSS EQUATION RESULTS

Lauderdale Lakes USLE Computations

A = R K LS C P

A = Annual loss of soil, tons/acre
R = Runoff/rainfall indes, 140 for Lauderdale Lakes
K = Soil erodibility factor
LS = Topographic factor, L for slope length and S for percent slope
C = Cropping-management factor
P = Conservation practice factor

Existing Conditions:

Source	Area (acres)	K	Slope %	Length (ft)	LS	C[1]	P	A (tons/ac/yr)	Total Loss (tons/yr)	Sediment Delivery Ratio (%)	Sediment Delivered (tons/yr)	Total Phosphorus (lbs/yr)
Site 1, Area 1	1.78	0.35	11.0	200	2.25	0.01	1.0	1.1	2	50	1	1
Site 1, Area 2	4.48	0.37	4.0	250	0.57	0.41	1.0	12.1	54	50	27	27
Site 1, Area 3	22.24	0.36	9.0	250	1.85	0.01	1.0	0.9	21	50	10	10
Site 1, Area 4	14.19	0.37	4.0	250	0.57	0.41	1.0	12.0	171	50	85	85
Site 1, Area 5	3.46	0.35	6.0	250	1.1	0.01	1.0	0.5	2	50	1	1
Site 1, Area 6	10.31	0.37	5.0	250	0.85	0.41	1.0	18.1	186	50	93	93
Site 1, Area 7	9.82	0.37	1.0	250	0.14	0.41	1.0	3.0	29	50	15	15
Site 1, Area 8	6.96	0.37	2.0	250	0.27	0.41	1.0	5.7	40	50	20	20
Total Site 1	73.24								505		252	252
Site 2, Area 1	22.43	0.37	2.0	250	0.27	0.41	1.0	5.7	128	62	79	79
Total Site 2	22.43								128		79	79

[1] Fall Moldboard Plow - clean tillage

Site 1 Eight areas totaling 73.24 acres

Area	Soil Type	Acres	K	Acres * K	Average K	Slope (%)	Average Slope (%)	Slope * Acres	Ave Slope	
1	MxD2	0.69	0.32	0.22		12-20	16	11.04		
	MpC2	0.87	0.37	0.32		6-12	9	7.83		
	MpB	0.22	0.37	0.08	0.35	2-6	4	0.88	11.1	
2	MpC2	0.03	0.37	0.01		6-12	9	0.27		
	MpB	4.45	0.37	1.65	0.37	2-6	4	17.8	4.0	
3	MpB	6.89	0.37	2.55		2-6	4	27.56		
	MpC2	11.64	0.37	4.31		6-12	9	104.76		
	MxD2	1.9	0.32	0.61		12-20	16	30.4		
	MwD2	1.81	0.32	0.58	0.36	12-20	16	28.96	8.6	
4	MpB	13.47	0.37	4.98		2-6	4	53.88		
	MxD2	0.35	0.32	0.11		12-20	16	5.6		
	MxC2	0.37	0.32	0.12	0.37	6-12	9	3.33	4.4	
5	MpB	2.2	0.37	0.81		2-6	4	8.8		
	MxC2	1.09	0.32	0.35		6-12	9	9.81		
	MxD2	0.17	0.32	0.05	0.35	12-20	16	2.72	6.2	
6	FsB	7.87	0.37	2.91		2-6	4	31.48		
	FsC2	1.52	0.37	0.56		6-12	9	13.68		
	MpB	0.92	0.37	0.34	0.37	2-6	4	3.68	4.7	
7	FsA	8.94	0.37	3.31		0-2	1	8.94		
	FsB	0.88	0.37	0.33	0.37	2-6	4	3.52	1.3	
8	FsA	3.62	0.37	1.34		0-2	1	3.62		
	FsB	3.34	0.37	1.24	0.37	2-6	4	13.36	2.4	
Total		73.24							Override with above numbers, from field recon.	

Site 2 One area totaling 22.43 acres

Area	Soil Type	Acres	K	Acres * K	Average K	Slope (%)	Average Slope (%)	Slope * Acres	Ave Slope	
1	SeA	15.7	0.37	5.81		0-2	4	62.8		
	SeB	3.6	0.37	1.33		2-6	4	14.4		
	JuA	0.9	0.37	0.33		1-3	2	1.8		
	FsB	1	0.37	0.37		2-6	4	4		
	ClC2	1.23	0.32	0.39	0.37	6-12	9	11.07	4.2	
Total		22.43							Override with 2.0, from field recon.	

Lauderdale Lakes USLE Computations

A = R K LS C P

A = Annual loss of soil, tons/acre
R = Runoff/rainfall indes, 140 for Lauderdale Lakes
K = Soil erodibility factor
LS = Topographic factor, L for slope length and S for percent slope
C = Cropping-management factor
P = Conservation practice factor

Residue Management (no till and strip till):

Source	Area (acres)	K	Slope %	Length (ft)	LS	C[1]	P	A (tons/ac/yr)	Total Loss (tons/yr)	Sediment Delivery Ratio (%)	Sediment Delivered (tons/yr)	Total Phosphorus (lbs/yr)
Site 1, Area 1	1.78	0.35	11.0	200	2.25	0.01	1.0	1.1	2	50	1	1
Site 1, Area 2	4.48	0.37	4.0	250	0.57	0.15	1.0	4.4	20	50	10	10
Site 1, Area 3	22.24	0.36	9.0	250	1.85	0.01	1.0	0.9	21	50	10	10
Site 1, Area 4	14.19	0.37	4.0	250	0.57	0.15	1.0	4.4	62	50	31	31
Site 1, Area 5	3.46	0.35	6.0	250	1.1	0.01	1.0	0.5	2	50	1	1
Site 1, Area 6	10.31	0.37	5.0	250	0.85	0.15	1.0	6.6	68	50	34	34
Site 1, Area 7	9.82	0.37	1.0	250	0.14	0.15	1.0	1.1	11	50	5	5
Site 1, Area 8	6.96	0.37	2.0	250	0.27	0.15	1.0	2.1	15	50	7	7
Total Site 1	73.24								200		100	100
Site 2, Area 1	22.43	0.37	2.0	250	0.27	0.15	1.0	2.1	47	62	29	29
Total Site 2	22.43								47		29	29

[1] No-till, 35% of ground cover after planting

Site 1 **Eight areas totaling 73.24 acres**

Area	Soil Type	Acres	K	Acres * K	Average K	Slope (%)	Average Slope (%)	Slope * Acres	Ave Slope
1	MxD2	0.69	0.32	0.22		12-20	16	11.04	
	MpC2	0.87	0.37	0.32		6-12	9	7.83	
	MpB	0.22	0.37	0.08	0.35	2-6	4	0.88	11.1
2	MpC2	0.03	0.37	0.01		6-12	9	0.27	
	MpB	4.45	0.37	1.65	0.37	2-6	4	17.8	4.0
3	MpB	6.89	0.37	2.55		2-6	4	27.56	
	MpC2	11.64	0.37	4.31		6-12	9	104.76	
	MxD2	1.9	0.32	0.61		12-20	16	30.4	
	MwD2	1.81	0.32	0.58	0.36	12-20	16	28.96	8.6
4	MpB	13.47	0.37	4.98		2-6	4	53.88	
	MxD2	0.35	0.32	0.11		12-20	16	5.6	
	MxC2	0.37	0.32	0.12	0.37	6-12	9	3.33	4.4
5	MpB	2.2	0.37	0.81		2-6	4	8.8	
	MxC2	1.09	0.32	0.35		6-12	9	9.81	
	MxD2	0.17	0.32	0.05	0.35	12-20	16	2.72	6.2
6	FsB	7.87	0.37	2.91		2-6	4	31.48	
	FsC2	1.52	0.37	0.56		6-12	9	13.68	
	MpB	0.92	0.37	0.34	0.37	2-6	4	3.68	4.7
7	FsA	8.94	0.37	3.31		0-2	1	8.94	
	FsB	0.88	0.37	0.33	0.37	2-6	4	3.52	1.3
8	FsA	3.62	0.37	1.34		0-2	1	3.62	
	FsB	3.34	0.37	1.24	0.37	2-6	4	13.36	2.4
Total		73.24							Override with above numbers, from field recon.

Site 2 **One area totaling 22.43 acres**

Area	Soil Type	Acres	K	Acres * K	Average K	Slope (%)	Average Slope (%)	Slope * Acres	Ave Slope
1	SeA	15.7	0.37	5.81		0-2	4	62.8	
	SeB	3.6	0.37	1.33		2-6	4	14.4	
	JuA	0.9	0.37	0.33		1-3	2	1.8	
	FsB	1	0.37	0.37		2-6	4	4	
	ClC2	1.23	0.32	0.39	0.37	6-12	9	11.07	4.2
Total		22.43							Override with 2.0, from field recon.

Lauderdale Lakes USLE Computations

A = R K LS C P

A = Annual loss of soil, tons/acre
R = Runoff/rainfall indes, 140 for Lauderdale Lakes
K = Soil erodibility factor
LS = Topographic factor, L for slope length and S for percent slope
C = Cropping-management factor
P = Conservation practice factor

Contour Farming:

Source	Area (acres)	K	Slope %	Length (ft)	LS	C[1]	P	A (tons/ac/yr)	Total Loss (tons/yr)	Sediment Delivery Ratio (%)	Sediment Delivered (tons/yr)	Total Phosphorus (lbs/yr)
Site 1, Area 1	1.78	0.35	11.0	200	2.25	0.01	1.0	1.1	2	50	1	1
Site 1, Area 2	4.48	0.37	4.0	250	0.57	0.23	0.5	3.4	15	50	8	8
Site 1, Area 3	22.24	0.36	9.0	250	1.85	0.01	1.0	0.9	21	50	10	10
Site 1, Area 4	14.19	0.37	4.0	250	0.57	0.23	0.5	3.4	48	50	24	24
Site 1, Area 5	3.46	0.35	6.0	250	1.1	0.01	1.0	0.5	2	50	1	1
Site 1, Area 6	10.31	0.37	5.0	250	0.85	0.23	0.5	5.1	52	50	26	26
Site 1, Area 7	9.82	0.37	1.0	250	0.14	0.23	0.6	1.0	10	50	5	5
Site 1, Area 8	6.96	0.37	2.0	250	0.27	0.23	0.6	1.9	13	50	7	7
Total Site 1	73.24								163		82	82
Site 2, Area 1	22.43	0.37	2.0	250	0.27	0.23	0.6	1.9	43	62	27	27
Total Site 2	22.43								43		27	27

[1] Till Plant Contour Rows, 30% of ground cover after planting

Site 1 — Eight areas totaling 73.24 acres

Area	Soil Type	Acres	K	Acres * K	Average K	Slope (%)	Average Slope (%)	Slope * Acres	Ave Slope	
1	MxD2	0.69	0.32	0.22		12-20	16	11.04		
	MpC2	0.87	0.37	0.32		6-12	9	7.83		
	MpB	0.22	0.37	0.08	0.35	2-6	4	0.88	11.1	
2	MpC2	0.03	0.37	0.01		6-12	9	0.27		
	MpB	4.45	0.37	1.65	0.37	2-6	4	17.8	4.0	
3	MpB	6.89	0.37	2.55		2-6	4	27.56		
	MpC2	11.64	0.37	4.31		6-12	9	104.76		
	MxD2	1.9	0.32	0.61		12-20	16	30.4		
	MwD2	1.81	0.32	0.58	0.36	12-20	16	28.96	8.6	
4	MpB	13.47	0.37	4.98		2-6	4	53.88		
	MxD2	0.35	0.32	0.11		12-20	16	5.6		
	MxC2	0.37	0.32	0.12	0.37	6-12	9	3.33	4.4	
5	MpB	2.2	0.37	0.81		2-6	4	8.8		
	MxC2	1.09	0.32	0.35		6-12	9	9.81		
	MxD2	0.17	0.32	0.05	0.35	12-20	16	2.72	6.2	
6	FsB	7.87	0.37	2.91		2-6	4	31.48		
	FsC2	1.52	0.37	0.56		6-12	9	13.68		
	MpB	0.92	0.37	0.34	0.37	2-6	4	3.68	4.7	
7	FsA	8.94	0.37	3.31		0-2	1	8.94		
	FsB	0.88	0.37	0.33	0.37	2-6	4	3.52	1.3	
8	FsA	3.62	0.37	1.34		0-2	1	3.62		
	FsB	3.34	0.37	1.24	0.37	2-6	4	13.36	2.4	
Total		73.24							Override with above numbers, from field recon.	

Site 2 — One area totaling 22.43 acres

Area	Soil Type	Acres	K	Acres * K	Average K	Slope (%)	Average Slope (%)	Slope * Acres	Ave Slope	
1	SeA	15.7	0.37	5.81		0-2	4	62.8		
	SeB	3.6	0.37	1.33		2-6	4	14.4		
	JuA	0.9	0.37	0.33		1-3	2	1.8		
	FsB	1	0.37	0.37		2-6	4	4		
	ClC2	1.23	0.32	0.39	0.37	6-12	9	11.07	4.2	
Total		22.43							Override with 2.0, from field recon.	

Lauderdale Lakes USLE Computations

A = R K LS C P

A = Annual loss of soil, tons/acre
R = Runoff/rainfall indes, 140 for Lauderdale Lakes
K = Soil erodibility factor
LS = Topographic factor, L for slope length and S for percent slope
C = Cropping-management factor
P = Conservation practice factor

Contour Strips:

Source	Area (acres)	K	Slope %	Length (ft)	LS	C[1]	P[2]	A (tons/ac/yr)	Total Loss (tons/yr)	Sediment Delivery Ratio (%)	Sediment Delivered (tons/yr)	Total Phosphorus (lbs/yr)
Site 1, Area 1	1.78	0.35	11.0	200	2.25	0.01	1.00	1.1	2	50	1	1
Site 1, Area 2	4.48	0.37	4.0	250	0.57	0.23	0.38	2.6	12	50	6	6
Site 1, Area 3	22.24	0.36	9.0	250	1.85	0.01	1.00	0.9	21	50	10	10
Site 1, Area 4	14.19	0.37	4.0	250	0.57	0.23	0.38	2.6	36	50	18	18
Site 1, Area 5	3.46	0.35	6.0	250	1.1	0.01	1.00	0.5	2	50	1	1
Site 1, Area 6	10.31	0.37	5.0	250	0.85	0.23	0.38	3.8	40	50	20	20
Site 1, Area 7	9.82	0.37	1.0	250	0.14	0.23	0.45	0.8	7	50	4	4
Site 1, Area 8	6.96	0.37	2.0	250	0.27	0.23	0.45	1.4	10	50	5	5
Total Site 1	73.24								130		65	65
Site 2, Area 1	22.43	0.37	2.0	250	0.27	0.23	0.45	1.4	32	62	20	20
Total Site 2	22.43								32		20	20

[1] Till Plant Contour Rows, 30% of ground cover after planting
[2] Option B, for rotations with 1/2 row crop, 1/4 close grown crop, and 1/4 Meadow.

Site 1 — **Eight areas totaling 73.24 acres**

Area	Soil Type	Acres	K	Acres * K	Average K	Slope (%)	Average Slope (%)	Slope * Acres	Ave Slope
1	MxD2	0.69	0.32	0.22		12-20	16	11.04	
	MpC2	0.87	0.37	0.32		6-12	9	7.83	
	MpB	0.22	0.37	0.08	0.35	2-6	4	0.88	11.1
2	MpC2	0.03	0.37	0.01		6-12	9	0.27	
	MpB	4.45	0.37	1.65	0.37	2-6	4	17.8	4.0
3	MpB	6.89	0.37	2.55		2-6	4	27.56	
	MpC2	11.64	0.37	4.31		6-12	9	104.76	
	MxD2	1.9	0.32	0.61		12-20	16	30.4	
	MwD2	1.81	0.32	0.58	0.36	12-20	16	28.96	8.6
4	MpB	13.47	0.37	4.98		2-6	4	53.88	
	MxD2	0.35	0.32	0.11		12-20	16	5.6	
	MxC2	0.37	0.32	0.12	0.37	6-12	9	3.33	4.4
5	MpB	2.2	0.37	0.81		2-6	4	8.8	
	MxC2	1.09	0.32	0.35		6-12	9	9.81	
	MxD2	0.17	0.32	0.05	0.35	12-20	16	2.72	6.2
6	FsB	7.87	0.37	2.91		2-6	4	31.48	
	FsC2	1.52	0.37	0.56		6-12	9	13.68	
	MpB	0.92	0.37	0.34	0.37	2-6	4	3.68	4.7
7	FsA	8.94	0.37	3.31		0-2	1	8.94	
	FsB	0.88	0.37	0.33	0.37	2-6	4	3.52	1.3
8	FsA	3.62	0.37	1.34		0-2	1	3.62	
	FsB	3.34	0.37	1.24	0.37	2-6	4	13.36	2.4
Total		73.24							Override with above numbers, from field recon.

Site 2 — **One area totaling 22.43 acres**

Area	Soil Type	Acres	K	Acres * K	Average K	Slope (%)	Average Slope (%)	Slope * Acres	Ave Slope
1	SeA	15.7	0.37	5.81		0-2	4	62.8	
	SeB	3.6	0.37	1.33		2-6	4	14.4	
	JuA	0.9	0.37	0.33		1-3	2	1.8	
	FsB	1	0.37	0.37		2-6	4	4	
	CIC2	1.23	0.32	0.39	0.37	6-12	9	11.07	4.2
Total		22.43							Override with 2.0, from field recon.

Lauderdale Lakes USLE Computations

A = R K LS C P

A = Annual loss of soil, tons/acre
R = Runoff/rainfall indes, 140 for Lauderdale Lakes
K = Soil erodibility factor
LS = Topographic factor, L for slope length and S for percent slope
C = Cropping-management factor
P = Conservation practice factor

Conservation Cover:

Source	Area (acres)	K	Slope %	Length (ft)	LS	C[1]	P	A (tons/ac/yr)	Total Loss (tons/yr)	Sediment Delivery Ratio (%)	Sediment Delivered (tons/yr)	Total Phosphorus (lbs/yr)
Site 1, Area 1	1.78	0.35	11.0	200	2.25	0.01	1.0	1.1	2	50	1	1
Site 1, Area 2	4.48	0.37	4.0	250	0.57	0.01	1.0	0.3	1	50	1	1
Site 1, Area 3	22.24	0.36	9.0	250	1.85	0.01	1.0	0.9	21	50	10	10
Site 1, Area 4	14.19	0.37	4.0	250	0.57	0.01	1.0	0.3	4	50	2	2
Site 1, Area 5	3.46	0.35	6.0	250	1.1	0.01	1.0	0.5	2	50	1	1
Site 1, Area 6	10.31	0.37	5.0	250	0.85	0.01	1.0	0.4	5	50	2	2
Site 1, Area 7	9.82	0.37	1.0	250	0.14	0.01	1.0	0.1	1	50	0	0
Site 1, Area 8	6.96	0.37	2.0	250	0.27	0.01	1.0	0.1	1	50	0	0
Total Site 1	73.24								36		18	18
Site 2, Area 1	22.43	0.37	2.0	250	0.27	0.01	1.0	0.1	3	62	2	2
Total Site 2	22.43								3		2	2

Site 1 **Eight areas totaling 73.24 acres**

Area	Soil Type	Acres	K	Acres * K	Average K	Slope (%)	Average Slope (%)	Slope * Acres	Ave Slope
1	MxD2	0.69	0.32	0.22		12-20	16	11.04	
	MpC2	0.87	0.37	0.32		6-12	9	7.83	
	MpB	0.22	0.37	0.08	0.35	2-6	4	0.88	11.1
2	MpC2	0.03	0.37	0.01		6-12	9	0.27	
	MpB	4.45	0.37	1.65	0.37	2-6	4	17.8	4.0
3	MpB	6.89	0.37	2.55		2-6	4	27.56	
	MpC2	11.64	0.37	4.31		6-12	9	104.76	
	MxD2	1.9	0.32	0.61		12-20	16	30.4	
	MwD2	1.81	0.32	0.58	0.36	12-20	16	28.96	8.6
4	MpB	13.47	0.37	4.98		2-6	4	53.88	
	MxD2	0.35	0.32	0.11		12-20	16	5.6	
	MxC2	0.37	0.32	0.12	0.37	6-12	9	3.33	4.4
5	MpB	2.2	0.37	0.81		2-6	4	8.8	
	MxC2	1.09	0.32	0.35		6-12	9	9.81	
	MxD2	0.17	0.32	0.05	0.35	12-20	16	2.72	6.2
6	FsB	7.87	0.37	2.91		2-6	4	31.48	
	FsC2	1.52	0.37	0.56		6-12	9	13.68	
	MpB	0.92	0.37	0.34	0.37	2-6	4	3.68	4.7
7	FsA	8.94	0.37	3.31		0-2	1	8.94	
	FsB	0.88	0.37	0.33	0.37	2-6	4	3.52	1.3
8	FsA	3.62	0.37	1.34		0-2	1	3.62	
	FsB	3.34	0.37	1.24	0.37	2-6	4	13.36	2.4
Total		73.24							Override with above numbers, from field recon.

Site 2 **One area totaling 22.43 acres**

Area	Soil Type	Acres	K	Acres * K	Average K	Slope (%)	Average Slope (%)	Slope * Acres	Ave Slope
1	SeA	15.7	0.37	5.81		0-2	4	62.8	
	SeB	3.6	0.37	1.33		2-6	4	14.4	
	JuA	0.9	0.37	0.33		1-3	2	1.8	
	FsB	1	0.37	0.37		2-6	4	4	
	ClC2	1.23	0.32	0.39	0.37	6-12	9	11.07	4.2
Total		22.43							Override with 2.0, from field recon.

APPENDIX B

WATER QUALITY MODELING RESULTS

APPENDIX D

WATERSHED PROTECTION ACTIVITIES FOR PRIVATE LANDOWNERS

WATERSHED PROTECTION ACTIVITIES FOR PRIVATE LANDOWNERS

As documented in a recent report by the U. S. Geological Survey, Lauderdale Lakes have good water quality. However, the lakes are close to its carrying capacity with regards to nitrogen and phosphorus inputs. To maintain Lauderdale Lakes in their current high quality, management of the watershed is needed. The following is an overview of what you can do as a lake resident to prevent pollution from entering the lake from you property.

PROPERTY MANAGEMENT

Every home and yard requires some maintenance to keep it functioning well and looking good. A lakefront property requires the same maintenance as any other home plus some additional steps to keep the lake in good shape. This section presents ideas for both lakefront property owners and backlot property owners as to what they can do to protect Long Lake.

Septic Maintenance

Maintain your septic system frequently. Check for surface oozing or excessive plant and algae growth in the water at your beach. One sign of a leaking septic system is Cladaphora algae, which grows long, feathery, and green—attaching to rocks and dock posts. The septic tank may need pumping out every year or two to keep it in satisfactory operation. If the system is 20 years old or more, the drain field may need relocation. The Lauderdale Lake Management District has a program that requires landowners to have their septic system pumped every two years. To learn more about the District's program contact them at (414) ____-______ for more information.

Lawn Care/Greenbelts and Buffer Strips

Establish **greenbelts,** or **buffer strips** of shrubs and trees along the water instead of lawns. These trap sediments containing nutrients more effectively than a lawn. The following plants are adapted to lakeside situations:

Shrubs	**Trees**
red-stemmed dogwood	*river birch*
elderberry	tamarack
buttonwood	*sycamore*
Wisconsin Holly (protected)	*red maple*
tag alder	*white cedar*

Plant a few trees. They lock up a large amount of nutrients in the wood. Use shrubs for most of the buffer strip to allow a good view of the water. Evergreen plants loose fewer leaves and twigs and provides less debris to fall into the water and contribute nutrients as the organic matter decomposes.

If the lakefront vegetation has not been cleared, do not remove it and *avoid planting a* lawn. Leave the existing vegetation to act as a buffer. If there is no view of the water, thin the vegetation by removing a few branches or trees. Do not disturb the ground under the trees.

Often, planting a lawn under trees or removing the shrubs or ferns under trees lead to their eventual death.

Fertilizer Application

Get a soil test done before you buy fertilizer for your lawn to determine if you need to fertilize, and with what ingredients. The Cooperative Extension agent in your county, or the Soil Conservation District staff can explain how to test your soil. Most lawns in Wisconsin do not generally need additional phosphorus, one of the typical ingredients in packaged lawn fertilizer.

You may not need to fertilize as much as you have in the past. Nitrogen is the nutrient most responsible for producing a dark green lawn, but darkness of color also depends upon the type of grass in the lawn. A coarse fescue can naturally be a light green compared to some varieties of Kentucky blue grass.

Which is more important, fewer aquatic plants, or a dark green lawn? If maintaining dark green lawns around the lake also provides more nutrient for aquatic plants and algae, the dark green lawn becomes a nuisance. When the lawn slopes *steeply* toward the lake, do not use a fertilizer containing phosphorus. When the lawn slopes gently toward the lake, or is flat, use a fertilizer without phosphorus in the 30 feet of lawn along the water, or do not fertilize this strip at all.

The fertilizer bag label shows the percentage of the fertilizer contents. A 25-10-3 fertilizer is 25% nitrogen, 10% phosphorus, and 3% potassium. If a bag of fertilizer weighs 50 pounds, and is 25% nitrogen, then the bag contains 12.5 pounds of nitrogen. In this bag there is also 5 pounds of phosphorus. Urea is a 45-0-0 fertilizer, with nearly half of it nitrogen. If you applied the fertilizer in three applications from mid-spring to mid-summer, apply it at a rate of three pounds per 1000 square feet of lawn. This will achieve a total application of 4 pounds nitrogen for the season.

Four to six pounds of nitrogen per 1000 square feet of lawn per year is adequate. However, applying that much nitrogen in one application is too much. Nitrogen fertilizer should **not** be applied in the late fall to lawns near a waterbody. The grasses are not taking up the nutrient at that time, and the nitrogen will seep down to the groundwater or wash off the surface.

Lawn fertilizers without phosphorus, other than urea, are available to professional turf managers and may be obtained through some retailers in an order for many homeowners.

Protect Wetlands

If there is a wetland on your property, leave it alone. The wetland filters sediments out of storm water flowing toward the lake, it is habitat for wildlife and food chain animals, and it stores floodwaters during storms. Filling a wetland with soil kills plants and animals and stops the beneficial functions. Do not dump waste paint cans, oil, and other household products because toxic chemicals can enter the groundwater and wash into the lake. Do not dump kitchen garbage, leaves, and lawn clippings into the wetland because these release nutrients when they decompose.

No Dumping in the Lake

Keep organic matter out of the lake. Do not rake leaves or lawn clippings into the lake for disposal. Do not burn leaves along the shore. It may seem safe because the water is near, but the ashes contain nutrients that easily wash into the water. The best disposal of leaves and other organic matter is to compost them away from the lake. Use the compost in flower and vegetable beds, potted plants, or give it to neighbors who garden. As an alternative to allowing organic matter to decompose in a pile on the ground, plans for building and using a simple structure to hold organic matter for composting are available from the Cooperative Extension Service. Gardening catalogues also sell pre-fabricated compost drums and bins.

Do Not Feed Waterfowl

Ducks, geese, and swans can deposit many pounds of nutrient-rich manure on the shore and in the shallow water. Feeding them encourages waterfowl to stay at one location along the shore. The result is a greater plant and algae growth and a beach or shore that is too messy to walk along. It may also result in swimmers' itch.

Aquatic Plant Control

Aquatic Plants are limited on Long Lake, homeowners having a problem with aquatic plants should control them with caution. Plants can be harvested, killed by chemicals, or smothered by special plastic sheets when the proper permits have been obtained from the DNR.

Harvesting aquatic plants can be done by the homeowner to make swimming more pleasant or to clear a path for boats. Special plant cutting rakes are available to do the job by hand. Repeated removal of the stems and leaves deprives the root system of food, and can ultimately reduce the number of plants. Trampling the plants when they are small has a similar effect.

Remove the cut plants from the shore area to reduce the smell so that nutrients do not re-enter the lake from the decomposing weeds and feed more plant growth.

Chemical herbicides can be used to kill aquatic plants in much the same way that lawn plants are killed. The use of herbicides to control aquatic plants is controversial. An advantage to using chemicals is that the process does not involve any backbreaking work or barges with large equipment. Disadvantages include the potential to kill wetland plants, shoreline plants, fish, and beneficial aquatic plants. Herbicides can be dangerous to the person doing the application. Chemical control can also lead to algae blooms when the plants die in the water, releasing nutrients. Herbicide applications in the water requires a permit.

Selection and Protection of a Building Site

If you are about to build on a lakefront property or are going to do a major upgrading of a small or unwinterized lakefront cottage, the following guidelines are important for maintaining water quality. If you are contemplating the purchase of a lakefront lot, try to choose a wide lot. Wide lots allow the most opportunity to employ measures to protect water quality, and there will likely be less impact on the lake from your neighbors if lot widths are large.

Protect Existing Vegetation

Many new lakefront building lots are covered with trees and shrubs. *Keep as much existing vegetation as possible.* This vegetation acts as a sediment filter, it allows less runoff than a lawn, it provides a different visual character than a house in the city, and it is less expensive and time consuming to maintain.

If a flat space is necessary for entertaining or doing some work outside, build a patio or a deck. A small lawn is useful for this purpose, but requires a mower and space to store it.

Protecting existing vegetation involves more effort than simply not cutting it down. The backhoes and bulldozers that dig foundations, drainfields and wells, and grades the driveway must keep off the root area of trees that are intended to be saved. The root area of a tree covers all the ground under the spread of the branches and often out beyond the branch tips for many additional feet. Do not allow any earth to be piled for any length of time on the roots of trees to be saved. Do not store paints, stains, roofing tars, adhesives, mortar, or lumber on the roots of trees or near the water. Inform the contractor of these standards, and fence off the trees and shrubs to be saved. A consulting arborist or a landscape architect can help decide what vegetation is appropriate to save and what protection methods to use. Once trees are damaged, it may be impossible to save them—although the trees may take three to six years to die. Saving vegetation on a 50 foot wide lot can be very difficult because the construction equipment requires some maneuvering space, and building materials need to be stockpiled on the lot. If you highly value natural vegetation, choose a larger lot.

Build Away from the Water's Edge

Build the house and place the driveway as far from the water as is possible. A large setback protects water quality by providing more land surface for sediments to filter out of runoff. If the lot has a ridge that divides drainage toward and away from the water, build on the area that drains away from the water.

Many lakes in Wisconsin have wetlands surrounding much of the shoreline, or in such close proximity that lots are not deep. In these situations it may be impossible to build on the lot without causing harm to the water. Careful thinning of vegetation can provide views of the water. Selecting an appropriate house shape, height, and window placement can also contribute to good views.

Direct Runoff Away from the Lake

When final grading for the driveway is to begin, have the ground surface sloped so that runoff flows away from the lake and away from the septic drain field. Runoff will pick up sediments from the roof and flush them into the eaves and through the downspouts. Sediments from the driveway and the ground are also picked up. It is important to keep these sediments out of the lake and to keep stormwater from flooding the septic system drainfield. A flooded drainfield can cease to bind nutrients to the soil and can supply nutrients and bacteria to the groundwater and surface water. If the lot slopes steeply toward the lake, give the yard some side slope and direct runoff into a vegetation buffer strip at the edge and front of the property.

If extensive grading of the yard is necessary to re-direct runoff, and the result would destroy a large amount of existing vegetation, leave the vegetation intact. Water from the downspout can be directed into a dry well or a vegetation buffer. Slope the driveway toward a vegetation buffer planted alongside.

Protect Wetlands When Building

If there are wetlands on the property, there are three things to do to protect them. First, do not plan to dredge a channel in the wetland to make a deeper access for a boat. This is harmful to wetland functions, and you will probably not get a permit. If you do so without a permit you can be taken to court and be ordered to repair the damage. Second, do not fill the wetland to build a house. This is also harmful to wetland functions. You may see the harm in turbid water, fewer fish, more aquatic plants, and higher spring floods. Third, do not change the amount of runoff that flows into the wetlands. The wetland plant and animal community is balanced and depends upon a certain water supply, although one that probably fluctuates. Blocking surface flow or directing more water into the wetland could kill many of the plants and animals by either drying the wetlands or flooding it more than the amount to which those particular plants are adapted.

Shore Protection

Shoreline erosion is a concern to many lakefront property owners because it can be unsightly. In some severe situations, it represents a loss of property. Concrete and wood bulkheads and revetments out of rock riprap are built in an attempt to prevent the loss. Because these require excavation into the bottomland and the erection of a permanent structure there, a permit from the DNR is required under Wisconsin Statue Chapter 30.

Department of Natural Resources or local Land Conservation Department technicians will be able to give you advice on planning the best type of structure to do the job. These agencies will also advise on the best planting stock and seed to use following construction.

Rock riprap is one of the most effective and permanent erosion control measures available. This material is generally maintenance free, visually acceptable, and provides fisheries' benefits of cover and food production in addition to erosion control. Do not use broken concrete or other unsightly or hazardous material.

Rock riprap is a blanket of various size rocks placed along the edge of an eroding bank. The rock "blanket" should extend the full length of the eroded area and beyond to insure adequate protection of the bank. Although there are other types of bank stabilization structures to do the job, they are more complex than rock riprap.