Stormwater Management Plan

City of Amery, Wisconsin

SEH No. A-AMERY0601.00

February 2009

CITY OF AMERY

STORMWATER MANAGEMENT PLAN

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Amery Lakes Protection and Rehabilitation District

Harmony Environmental Inc.

Wisconsin Department of Natural Resources

Polk County Land and Water Resources Department

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Stormwater Management Plan

City of Amery, Wisconsin

Prepared for:
City of Amery, Wisconsin

and

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Executive Summary

SEH Inc. has prepared a Stormwater Management Plan designed to improve the water quality of the lakes and river within the City of Amery and to maintain the Tropic status as mesotrophic for the lakes. The goals have been developed by the City of Amery and the Amery Lakes District (Lakes District), and meet the Wisconsin Department of Natural Resources (WDNR) grant requirements for this project. The plan summarizes the elements required by the City, Lakes District and the WDNR.

The key elements include:

- Water quality and quantity assessment, modeling, and planning, including implementation recommendations to meet the plan goals.
- Development of stormwater related ordinances and policies.
- Provide and document stormwater financing options.
- Address two areas with known stormwater issues.
- Document and describe public outreach and education.

The overriding goal is to improve the water quality of the three lakes in Amery: Pike Lake, North Twin Lake and South Twin Lake, and this will improve the water quality of the Apple River. The lakes are considered mesotrophic and it is the goal to maintain this Trophic State Index.

SLAMM and HydroCAD were used to model the water quality and the water quantity. As anticipated, where pollutant levels were high, so were runoff rates. Using these water quality and water quantity results, areas of interest or hotspots were developed. These were areas of particularly high pollutant loadings and discharge rates as well as other factors.

Recommendations were provided for structural and non-structural practices to reduce the pollutant loading to the lakes. Also developed were ordinance revisions and recommendations to assist in reducing the pollutant loadings.

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Stormwater Management Plan

Prepared for the City of Amery and the Amery Lakes Protection and Rehabilitation District

1.0 Introduction

1.1 Project Background

The City of Amery (Amery) is known as "The City of Lakes." Amery recognizes the importance of water as it is surrounded by water resources. The water resources provide a way of life for Amery residents. The three lakes named, Pike Lake, North Twin Lake, and South Twin Lake, are contained within the city limits.

Amery Sign near North Twin Lake

The three lakes are connected. Pike Lake flows into North Twin Lake, which flows into South Twin Lake. South Twin Lake discharges into a stream that flows into the Apple River.

The entire extents of North Twin and South Twin Lakes' watersheds are contained within the city limits of Amery. The majority of Pike Lake's watershed is contained within the city limits, with the remainder of Pike Lake's watershed located in the Town of Lincoln.

The Amery Lake Protection and Rehabilitation District (Lakes District) completed the Amery Lakes Protection & Rehabilitation District Lake Management Plan (Lake Management Plan) in 2005 with the assistance of Cedar Corporation, Inc. The study's primary recommendation was the need for completion of a Stormwater Management Plan.

As a result of the recommendation made by the Lakes Management Plan, Amery, with the assistance of the Lakes District, applied for and obtained grant funding from the Wisconsin Department of Natural Resources to complete stormwater management planning, which includes:

- A stormwater management plan
- Evaluation of financing mechanisms
- Developing a dedicated revenue source for stormwater management
- Conducting public information and education activities
- Assess ordinances through review and update of current ordinances, as well as, the potential creation of new ordinances.

1.2 Plan Goal

The broad overall goal is to protect the surface water resources of Amery. This is further highlighted in the Purpose and Objectives section below. The minimum goal is, to maintain the water quality of Amery Lakes, and the ultimate goal is to improve the water quality of the lakes. Amery Lakes Management Plan determined that the lakes are mesotrophic on the trophic scale. The mesotrophic status means that the water is moderately clear but may become devoid of oxygen in the deeper parts of the lake during the summer.

A mesotrophic status is very good water quality for lakes that have a high quantity of urban land uses in their watersheds. Because of the urban character of the watersheds, the lakes are very much at risk. With any increased nutrient loading, the next stage is eutrophic, which is indicated by significant algae blooms. Lake Wapogasset is considered eutrophic. It is difficult if not impossible to know how much more phosphorus a lake can have enter its system before it turns eutrophic, but once a lake reaches this stage, it is very difficult to make substantial in-lake water quality improvements.

Although the minimum goal is to maintain the water quality of the Amery Lakes, the Apple River has not been neglected but given equal efforts in all aspects of the study, with a single exception. The recommendations within this document are generally more focused on the Amery lakes than the river. Recommendations are made for the river; however their relative priority is lower than for the Amery lakes. This is for two reasons. First, improved water quality in the lakes will equate to improved water quality that discharges into the river. Therefore, these improvements raise the water quality of the Apple River. Secondly, water quality practices have a greater direct benefit to the lake where the practice is placed, since the lakes have a very small watershed in or in close proximity to Amery; conversely, the Apple River has a very large watershed made up of many thousands of acres before the river flow reaches the outer limits of Amery.

1.3 Purpose and Objectives

The purposes of the stormwater management planning are to:

- Protect the water resources of Amery by identifying existing water quality and quantity problems

  Computer modeling used in the planning process can identify areas where problems with water quality and quantity may be occurring. Problems with quality are known as “hotspots” or areas of high pollutant loadings, for each major water resource. Water quantity was identified through modeling, however, problem areas where flooding occurs were identified by using historical information. Recommendations were developed to improve both water quality and water quantity.

  Water quality is the overriding goal based on the quality of the resources around Amery. There are some flooding issues in Amery but they are generally localized in nature and are often related to natural features of Amery which includes relatively flat topography, low storm sewer depths and slopes, and high surface water elevations comparative to the surrounding land. The main flooding problem in the downtown area has been significantly reduced by work completed by the Amery Department of Public Works in constructing a weir structure at the outlet of South Twin Lake.

- Protect the water resources of Amery by preventing future water quality and water quantity problems

  Unless properly managed, new development or redevelopment will increase stormwater runoff and the potential for higher pollutant loadings. The relatively new WDNR regulations will reduce some of the impacts of the development but will not eliminate them. Recommended future land uses and the passage of new and/or revised Amery ordinances will prevent or reduce the impacts of future land use changes.

- Protect the water resources of Amery by passing and implementing ordinances

  Passing and implementing ordinances that require and enforce erosion control, stormwater management, low impact development, and responsible shoreland management protect the water resources by requiring good stewardship by all. The current WDNR regulations (Wisconsin Administrative Code NR 216) provide a level of protection for water quality that has been in place since 2004 and regulate disturbances of one acre or greater. The passage of ordinances providing regulation of smaller disturbances with more restrictive requirements will further protect the resources of Amery.

- Protect the water resources of Amery by providing public education and understanding

  Public education is critical to the implementation of any plan. Understanding of the importance and need for water quality protection will result in cooperation and greater responsibility in the community. True stewardship occurs out of the understanding and belief in doing what is right. This is much more important and has greater impact than acceptance and following of regulation.

- Protect the water resources of Amery by obtaining stormwater funding

  Plan implementation requires that funding sources are available. There are many potential funding sources, but the source must be reliable, available and fair. Different implementation projects may be better suited to different funding sources. It is important to be aware of the sources already available to Amery and consider developing new sources.

1.4 Scope of Services

The following has been modified slightly from the contractual scope of services. The modifications reflect the change in the approaches to the items. However, the overall scope has not changed.

A. Stormwater Planning

The stormwater planning consists of developing a Stormwater Management Plan that covers Amery, as well as the entire watershed of each lake. The study area includes the land within Amery’s limits as well as the watershed of Pike Lake, which is partly outside of Amery, in the Town of Lincoln. The plan will be comprehensive in nature, including:

- Stormwater conveyance mapping
- Hydrologic and water quality modeling
- Identification of significant impairment areas
- Evaluation of level of impairment and affected resource
- Recommendations on strategy to improve stormwater quality (such as BMPs and ordinance development)
- Financial options for implementation
- Public outreach and education
- Implementation recommendations and strategies.

A.1 Plan Goals and Identified Needs

Amery and Amery Lakes District have a distinct understanding of the plan goals and needs for stormwater management. Amery's location, nestled around significant water resources and subject to continued development pressures, creates the general goal of protecting and improving the water quality of the surface water and groundwater of the region. The task is long-term and on going. The stormwater management plan documents the tasks, and provides a roadmap and detailed steps within the larger goal. The roadmap documents the current and future needs and goals, which must be useful but flexible, as Amery changes and grows. The goals have been developed with the assistance and approval of Amery and the Amery Lakes Protection and Rehabilitation District, under the direction of the Amery Stormwater Committee.

A.2 Resource and Storm Sewer System Information

The initial basis of the project entailed gathering the existing information from Amery, the Amery Lakes District, and consultants. Part of this project was to supplement the work completed as part of the Lake Management Plan. All of Amery's data was available in hard copy format only. Polk County's data was obtained in a digital format useable in both ArcView and AutoCAD. The topographic information that the City has, was obtained in digital form from Cedar Corporation by Amery. On behalf of the City of Amery, Cedar Corporation hired Horizons, Inc. to complete the topographic survey in 1991. Cedar Corporation provided the digital information in an AutoCAD format to Amery. The coordinate system was corrected, to make it useful with the other GIS information.

The AutoCAD files were converted into a GIS format to be utilized in the base map. Amery's digital topographic information is superior to the topographic information available from the County in 2007. Parcel lines or lot lines were obtained from the County. Subwatersheds were delineated. The lakes' drainage areas delineated for the Lake Management Plan were utilized and the remainder of the project area was delineated.

Detailed information about the existing storm sewer system was mapped by Amery's Department of Public Works. These maps were digitized to further assist in delineating watersheds and identifying outfalls. For this planning effort, the stormwater conveyance map was created utilizing existing digital information such as orthophotos and Polk County GIS layers as a base map, as well as the storm sewer map. The City's paper maps were transferred to the GIS base map using the best available information. Coordination with the City's Public Works Department was critical to complete the digitizing of the storm sewer mapping. The Department's valuable storm sewer knowledge was crucial to developing an accurate map of the system.

The Lake Management Plan land use files, obtained by Amery from Cedar Corporation, were first reviewed for accuracy. These are general land cover files provided by the federal government. The land use files did not provide enough detail or accuracy to be utilized. Next, Amery's zoning maps, Amery's Comprehensive Plan and aerial photography were utilized to determine land use. Once a land use map was generated, it was checked for accuracy by the Stormwater Committee at a neighborhood by neighborhood level.

Subdivision record drawings were reviewed for information regarding existing stormwater practices. Minimal information was found in the record drawings or in the construction plans related to stormwater practices. The only information regarding existing practices is related to the construction of the new Amery Regional Medical Center, which information was provided by members of the stormwater committee. The medical center practices were under construction during much of the planning process.

Land use changes are expected to continue in a similar manner with the outer regions of Amery developing and the more centralized areas redeveloping. The northern portion of Amery tends to be developing into single family residential, while the south, especially the southeast, is developing into industrial and commercial uses. The southwest is also developing, but tends to be more commercial and residential uses. The downtown is experiencing small changes with some business redevelopment and some changes from residences along State Trunk Highway 46 into small commercial development. The future land use was discussed with the committee. Enforceable regulation is the only fair and consistent way to manage the new development and redevelopment. All disturbances of an acre or greater are regulated by the WDNR under Wisconsin Administrative Code NR 216/151.

The stormwater map is in a GIS format and conforms to Wisconsin Administrative Code NR 216 standards. The map contains the following information:

- Resources – surface waters, wetlands, and groundwater contour lines (equipotential lines) (groundwater flow data) as available
- Watershed and subwatershed boundaries
- Municipal boundaries
- Soils
- Major stormwater and storm sewer outfalls

- Existing best management practices
- Public lands
- Identified water quality and quantity problems areas
- Land use

Along with the map, quantitative information for watersheds and sub-watersheds is provided; such information includes size in area and land use area quantities.

A.3 Model Pollutant Loading

The mapping results were input for the water quality and quantity models. We used GIS software capabilities to develop the information to enter into the models. The model's output was put back into the GIS software to create maps showing the modeling results.

The Source Loading and Management Model (SLAMM), a water quality based modeling program, was utilized to model the pollutant loading from each sub-watershed. SLAMM provides pollutant loading data for a number of pollutants including Amery's primary concerns; Total Suspended Solids (TSS) and Phosphorus (P). The model information provided information necessary to:

- Prioritize watersheds by loading
- Identify, describe, and rank sources of pollutants
- Describe existing loads and sources of pollutants
- Describe potential load increase
- Identify and evaluate management measures and their effectiveness

SEH developed a SLAMM Model for the following scenarios:

- Existing developed conditions, no BMPs
- Existing developed conditions with existing controls
- Existing developed conditions with proposed controls

All development that disturbs more than one acre is required to meet WDNR NR 151 and reduce pollutant loading by 80% for new development and 40% for redevelopment compared to the no BMPs scenario.

A.4 Model Discharge Quantities

HydroCAD, a water discharge quantity (hydrology) modeling program, was utilized to model stormwater discharge rates and quantities from each sub-watershed. Some of this work was completed as part of the Lake Management Plan. The original intent was to augment the Lake Management Plan work and model only those areas not previously modeled. However, the land use information and the time of concentrations used in the Lake Management Plan were too general. For consistency and accuracy it was necessary to remodel those sub-watersheds.

SEH utilized HydroCAD to determine water quantity (peak flow rates) for the following scenarios:

- Existing developed and undeveloped areas: 1, 2, 5, 10, 25, 50 and 100-year, 24-hour storm events

The modeling information was used to:

- Project stormwater flow increases
- Prioritize current source areas for treatment
- Evaluate regional treatment options for developing areas
- Identify land use planning needs for stormwater management

A.5 Stormwater Management Recommendations

SEH recommended the best alternative(s) to meet current and future stormwater needs within the study area. They are based on:

- Water quality impairment
- Need (timing of future growth and anticipated impacts)
- Cost
- Benefit
- Resource priority

A practice's overall effectiveness must be evaluated by many parameters. SEH utilized the following criterion to establish the best alternative(s).

- Actual effectiveness (quality and/or quantity) – modeled results
- Cost:
  - Actual project cost
  - Cost effectiveness (cost per pound of removal)
- Implementation schedule
- Safety
- Operation and Maintenance
- Site characteristics as they relate to practice:
  - Area available to implement practice
  - Amount of disturbance to install practice
  - How the practice fits surrounding landscape and land use
  - A practice's relation to groundwater

Non-structural recommendations are provided for additional maintenance and good housekeeping practices that can be employed by the City to protect stormwater quality throughout the City.

Items SEH evaluated include:

- Catch basin cleaning
- Street sweeping
- Ditch maintenance
- Roadway maintenance and de-icing program

A.6 Financing Options

Implementation is the true measure of any plan's success. Without an adequate funding plan, project implementation is not possible or a realistic goal. Currently funding for implementation is available, but a long term evaluation of funding mechanisms, including grants, taxes, bonds, and a stormwater utility, is included as part of this project. Details, regarding the extent of review, are in Task B.2. of this scope.

A.7 Stormwater Management/Ordinance for New Development

Recommendations for future stormwater requirements were completed in conjunction with Task B. The results of work completed in Subtask 4, Model Discharge Quantities, might have suggested a site-specific approach to development and stormwater management requirements. But a site specific approach was not considered fair and would be more difficult to enforce. It was found that consistent requirements had significantly more benefits for all areas.

A.8 Public Outreach, Information & Education

The importance of education for the public can never be underestimated. Education directly results in public involvement and action. Often, as a result of education, citizens voluntarily participate in implementation because they are informed and understand the need. Steve Schieffer, Amery Lakes District chair, and Cheryl Clemens, Harmony Environmental, have been instrumental in providing information and educational activities. Also, updates and presentations have been done at the City Council meetings for elected officials, staff and the public that are in the audience and at home through the televising of the City Council meetings.

A.9 Implementation Strategy

Implementation is the true measure of a successful plan. The implementation of the Plan has been an on-going aspect of the project, from the start of the cost share program, the identification of hotspot areas, and the public education and participation. Long term, there is the continued education, and implementation of regulations and facility or Best Management Practice (BMP) implementation.

A.10 Plan Development Coordination

The Stormwater Committee has met regularly over the last 16 months to develop and coordinate a master stormwater management plan. The following have been topics during Stormwater Committee meetings:

- Identify contacts, review scope of work and schedule, discuss potential overall plan goals
- Resource and storm sewer information and modeling
- Management recommendations
- Financing alternative analysis & ordinance review
- Present draft stormwater management plan and review implementation options

The following are the deliverables for this project:

- Preliminary Results: Resource and Storm Sewer Information and Modeling
- Preliminary Results: Management Recommendations
- Digital Storm Sewer Map
- All planning maps and map layers in digital format
- Draft Stormwater Management Plan (10 copies)
- Final Stormwater Management Plan (25 copies)
- Stormwater Management Plan Summary (suitable for printing)

(All documents will be provided in MSWord and the final Stormwater Management Plan will also be provided in .pdf format.)

B. Ordinance Development and Financing

B.1 Ordinance Development

Ordinances provide the authority and the specific directives necessary to require and enforce the practices necessary to meet stormwater objectives. The committee reviewed a number of current ordinances in the area, sample ordinances, and the WDNR model ordinances. Differences, similarities, enforceability, and conformance to WDNR regulations were presented. Discussion of the City's current ordinances also occurred as part of the presentation.

Ultimately, it was decided that the current Polk County Stormwater Management and Erosion Control Ordinance would be the best fit for the City. This is based on the following:

- Consistency with the County ordinance which includes the Town of Lincoln which has regulatory jurisdiction over part of Pike Lake's watershed
- Plan review and enforcement may be able to be completed by contracting with Polk County
- Ordinance meets and exceeds the current WDNR regulations
- Ordinance has water quality and water quantity components that are consistent with the City's goals

As part of the review, it was recognized that the ordinance is cumbersome in how it is written. Polk County recognizes this also and is planning to re-write the ordinance at some point in time. It was decided that a re-write for Amery should occur now so that what is adopted is easy to follow and understandable.

After adoption, all of the current City ordinances will need to be revised so that their stormwater and erosion control sections refer to this new ordinance. This is particularly true for ordinances like the subdivision ordinance.

Low Impact Development was included in the grant. In a community, it is critical to understand the meaning and implementation of low impact development. It means developing responsibly and minimizing all impacts of the development but it should not mean reduced development. Developments that are serviced by municipal infrastructure such as sewer and water services should have smaller lots so that the costs for servicing such areas are cost effective. The developments can be completed in a way that there is low impact to the environment, while having small lots. This can be completed by reducing such things as light pollution, heat island effects, and maximizing on site mitigation of runoff waters generated by impervious surfaces.

The following are the deliverables for this part of the project:

- Suggested changes/draft erosion control and stormwater management and subdivision ordinances in MS Word Format.
- Presentation of draft and final ordinances.

B.2 Financing Mechanisms

The cost of constructing, operating, and maintaining stormwater facilities continues to increase along with other municipal costs, especially as Amery continues to improve their stormwater management. Amery's general funds have typically financed most of the necessary improvements in the past. Grant monies have and will continue to be viable resource options. But, none of these are dedicated funding options which for the long term, is the best way to ensure that improvements in the system can continue to occur.

Methods of financing stormwater improvements have become more complex. Faced with increasing costs, reduced state monies and continuous pressure to minimize property taxes, municipalities are looking for innovative ways to obtain the financial resources to undertake stormwater management programs.

The following are the deliverables for this part of the project:

- Written analysis of potential financing mechanisms for stormwater management, deliverable to City of Amery Public Works Committee in MS Word format.
- Specific, detailed steps necessary to complete chosen financing options for stormwater management.
- Present information to the Committee and/or Council.

C. Engineering Feasibility Analysis

A comprehensive engineering feasibility analysis was completed for both Soldier's Field and Flag Pole Park. Both sites have very high groundwater levels. Due to this, traditional BMP's would not meet the WDNR three feet of separation to groundwater requirements and only minimal treatment would be possible. Therefore, alternative designs needed to be developed.

Although both sites have the same limitations, the approaches are different. In the case of Flag Pole Park the intent is to utilize the park to treat stormwater before it is discharged into North Twin Lake. At Soldier's Field, the intent is to discontinue the discharge of one of the subwatersheds into South Twin Lake. The intent is to re-route the storm sewer discharge point to Soldier's Field, treat the stormwater and then discharge the stormwater into the stream, downstream of South Twin Lake.

The following are the deliverables for this part of the project:

- Engineering feasibility study results (10 printed copies and MS Word Format)
- Present results to Stormwater committee

2.0 Project Setting

2.1 Introduction

The area analyzed in this study includes the City of Amery, lands that contribute overland surface runoff to Pike Lake, and lands that contribute overland surface runoff to Amery. To complete the delineation of entire subwatersheds the study area was expanded beyond the original study limits. The project limits including the city limits are shown on Figure 1.

The incorporated area of Amery at the time of the study contributed 2,285 acres, and another 481 acres outside of the city limits was included in the study. The total study area was 2,766 acres. The area does include some depressional areas, wetland areas and some small unnamed water bodies. The watershed area of each of the resources is approximately as follows: Pike Lake 399 acres, North Twin Lake 178 acres, South Twin Lake 124 acres, Apple River 1,131 acres, and 935 acres of internally drained watersheds. Table 1 provides the land use breakdown for each of these drainage basins. There are some basins within the major drainage areas that tend to be internally drained but were included within the other basin due to proximity and potential groundwater connectedness. The major drainage basins are grouped into 5 areas, according to where they drain. The major drainage basins are shown on Figure 2.

This section describes the natural resources and physical features of Amery relevant to this study. Topics presented include: hydrology and subwatershed boundaries, storm sewer system, land use, precipitation, and soil conditions.

2.2 Hydrology/Subwatersheds

The Amery project area was divided into 149 subwatersheds. The subwatersheds were the basic building blocks used in the computer modeling to assess the water quality and quantity leaving each subwatershed. The subwatersheds areas are shown in Figure 3.

The subwatersheds were divided based on topography and major outlets. Where possible, areas were grouped to avoid having an extraordinary number of subwatersheds, which would have made the final results more difficult to work through.

2.3 Storm Sewer System

Much of Amery's downtown area and a portion of its surrounding residential area is drained by curb and gutter to storm sewer. The storm sewer eventually discharges into North Twin Lake, South Twin Lake, the Apple River, the stream connecting South Twin to the Apple River, or to an internally drained water body or depression. Pike Lake does not have any storm sewer discharge locations.

Information on the storm sewer system was obtained from Amery's storm sewer map. The Amery storm sewer system was mapped by Allen "Bones" McCarty, Amery Director of Public Works and his staff. The mapping was completed on a parcel map which identified the pipe locations, flow direction, inlets, manholes, and outlets. The map was digitized into ArcView. The mapping was reviewed for accuracy at the time the land uses were reviewed by the stormwater committee.

Record drawings were reviewed. Their information was limited and they were not utilized for this study.

There were basically no stormwater management practices that were existing at the start of this study. However, the new Amery Regional Medical Center is state of the art with multiple stormwater practices installed. Also, the cost share program has begun and some rain gardens have been installed and some rain barrels have been distributed. More information on the cost share program and public education are in sections 9 and section 6, respectively.

2.4 System Operation and Maintenance

The storm sewer system is operated and maintained by the City of Amery Public Works Department. Besides the operation and maintenance of the storm sewer system the Department is responsible for the entire infrastructure within Amery.

The Department of Public Works operates and maintains Amery's storm sewer system. The Department performs general cleaning of the inlets, mostly on an as needed basis. Street sweeping, with a mechanical sweeper occurs approximately monthly with the most concentrated efforts on the downtown. Street sweeping is completed for the entire city each spring to collect the sand used over the winter. It is also completed in the fall to collect leaves and other debris. This is very significant as these are the times that there is the most debris on the streets. Although vacuum sweepers are more effective at picking up sediment and other debris, the sweeper Amery uses is very effective picking up nearly all of the sand placed each year.

As future development occurs, there will be more storm sewer system installed along with stormwater practices. The overall operation and maintenance of all additional storm sewer installed and accepted by Amery will fall on the Department of Public Works. Stormwater practices accepted by Amery will also be maintained by the Department. Current costs are shown in Table 2.

2.5 Land Use

The type and distribution of land use is an important factor affecting the water quality and water quantity of the project areas. The pollutant loadings, the volume, and rate of stormwater runoff increases as the amount of impervious surfaces (streets, parking lots, roofs, etc.) area increases. As development occurs, the impervious area can increase significantly. Areas with a high percentage of impervious surfaces in Amery include the downtown, high density residential, commercial and industrial areas. The medium density residential makes up a substantial portion of Amery, and contains moderate amount of impervious surfaces, approximately 2 to 6 units per acre. Low density residential has a low percentage of impervious surfaces, which is a density of 0.7 to 2 units per acre. Parks, cemeteries, agricultural lands and other open spaces contain nearly no impervious surfaces.

The existing land use was developed from several sources. As part of the Lakes Management Plan there was a land use map that came from Cedar Corporation for the city. The map was too generalized to be utilized for the study so Amery's zoning map was used as a starting point in developing a new land use map. Recent aerial photos and field inspections were used to make final land use determinations. The determinations were based on the standard land use files contained within the water quality model. Explanations of the standard land use files are contained in Appendix A. Figure 4 shows the existing land uses.

Future land use was not determined directly, although zoning districts exist for Amery and the City is in the process of updating the Comprehensive Land Use Plan. Most of the areas that are already developed will be re-developed into a more commercial land use particularly those areas along Highway 46. The undeveloped areas along Highway 46 will likely be developed into commercial areas. The more industrial areas of Amery will likely continue to expand in the southeast. Medium density developments will likely occur close to the city limits on the northern and western portions of Amery. A majority of the remaining outlying areas will likely develop into low density residential. These areas were not mapped or modeled as they will at a minimum need to meet the existing WDNR regulations if there is greater than an acre of disturbance. Amery ordinances also have the potential to further regulate new development and re-development. The proposed Erosion Control and Stormwater Management Ordinance for Amery will result in consistent regulation for the entire project area, providing protection to all of Pike Lake, North Twin, South Twin Lakes, and the Apple River. Table 1 provides current land use information for each major basin.

2.6 Precipitation

Proper precipitation data is critical for both water quality and water quantity modeling. The precipitation data is dependant on the model used and whether water quality or water quantity modeling is completed. Section 3.0 further documents the models that are utilized and the methodology behind these models.

For water quality modeling, actual precipitation records and five years of consecutive precipitation data is used. These five years are chosen based on how closely they match an average annual precipitation year. Each region has WDNR accepted precipitation data that is to be utilized for modeling. The Minneapolis data for years 1953-1958 is used for the water quality modeling. This data set is used because it follows the requirements of the WDNR MS4 permit requirements. (Although, Amery is not a permitted community, the approach is consistent with the permit requirements, so at such time Amery is under permit requirements the modeling and planning completed can be utilized to meet the requirements of the permit.)

For water quantity modeling, precipitation events are classified according to their recurrence interval, duration, and intensity or total depth.

The recurrence interval of a rainfall (storm) refers to the average amount of time between storms of the particular size. For example, a 2-year storm event will, on average occur every 2 years. This does not mean that a 2-year storm can not occur more than once during a 2-year period. It only means that over a very long period of time that particular storm will occur, statistically, on average once every 2 years.

Duration is the length that the storm event. The duration typically used in designing is a 24-hour duration, and this was also used in the modeling for duration.

A storm is identified by the recurrence interval and duration, such as the 2-year, 24-hour storm. The intensity or total depth of rainfall is determined for the particular storm and geographic location. The intensities were obtained from the U.S. Department of Agricultural Natural Resources Conservation Service (NRCS) for Polk County, Wisconsin, which is based on Technical Paper 40 from the Weather Bureau.

2.7 Soils

The soil properties in the project area directly influence the volume and rates of runoff generated from rainfall events. The soil types as determined by the NRCS are shown in Figure 5. The NRCS classifies soils based on their runoff potential into Hydrologic Soil Groups (HSG) A, B, C, or D. HSG A soils have a high infiltration capacity and low runoff potential, because they are generally sandy or gravelly soils. Conversely, HSG D soils (which are generally soils with high clay contents) have a low infiltration capacity and a high runoff potential. Some soils are classified into two HSG such as A/D. The first letter signifies the soil in its drained state and the second letter refers to it in its undrained state. Most drained soils would be used for agricultural purposes and drained by drainage tile. Generally none of the soils within the project area would be considered drained. Figure 6 shows the modified Hydrologic Soil Groups and the map of the sand, silt and clay soil designations.

For the modeling the soils had to be put into three categories A, B, and C, which for the water quality model was considered sand, silt and clay. For consistency the same approach was used for the water quantity modeling.

3.0 Analysis

Water quality and water quantity was analyzed as part of this study. This analysis was completed by utilizing computer models to assess the water quality and water quantity from each subwatershed.

As part of the Lake Management Plan, the watershed directly adjacent to the lakes was analyzed for water quantity but it was not part of the scope of that study to do any water quality modeling. The analysis completed as part of the Lake Management Plan assumed a time of concentration, the longest time required for precipitation to travel from the farthest most point in the watershed to the watershed outlet, for each of the watersheds being very similar in length, unless it was a large watershed. This approach changes the overall peak rates to be more uniform across each watershed but does not necessarily reflect what is occurring within each watershed. For there to be consistency with the modeling completed for the Lake Management Plan and that completed for this study it was necessary to remodel the subwatersheds that were modeled for the Lake Management Plan.

Each variable in the model, such as land use type and soils impact, impact the results of the modeling. Where more impervious land uses are located, the soil type has less impact on the modeling results. Conversely, the same is true. Where there are less impervious land uses, the soil type has a greater impact on the modeling results. For each subwatershed there are typically multiple soils and multiple corresponding land uses.

3.1 Model Selection

Model selection is critical to the results obtained in the modeling process. In selecting a model it is critical for the results to be widely accepted methodologies, therefore widely accepted models were chosen. There are many models that can assess water quality and water quantity. However, not all models are widely accepted for use. Both of the selected models are widely accepted, and their use is consistent with this type of project. HydroCAD was selected for modeling water quantity. HydroCAD was also the model used in the Lake Management Plan. SLAMM was selected for the water quality modeling.

3.2 Model Methodology

3.2.1 SLAMM – Water Quality Modeling

SLAMM (Source Loading and Management Model) was originally developed to evaluate stormwater control practices. But to evaluate practices, there needed to be a measure of the pollutant load to the practice. To accurately determine the effectiveness of stormwater controls, the program had to be qualitative and quantitative. The program predicts the concentrations and pollutant loading from source areas which are land use based. SLAMM calculates mass balances of pollutants for different land uses and rainfalls. It provides relatively simple results which can be used for planning control or assesses the effectiveness of existing controls.

Special emphasis has been placed on small storm hydrology and particulate transport in SLAMM. Many currently available urban runoff models have their roots in drainage design where the emphasis is with very large and rare rains. Stormwater quality problems are mostly associated with common and relatively small rains. SLAMM is based on the small rainfall events as opposed to large, rare events which some water quality models are based.

All models, including SLAMM, should be used as planning tools only. To expect a true value of actually what is occurring in nature, grossly under estimates the complexity and variability of nature. The results should be considered base line data as well as considered comparative to each other.

SLAMM provides the ability to find problem subwatersheds, which assists with determining the sources of the problem pollutants, and the effectiveness of stormwater management practices that can control the problem pollutants at their sources and at outfalls.

The practices that SLAMM can model include detention ponds, infiltration devices, porous pavements, grass swales, catch basin cleaning, and street cleaning. The practices can be evaluated in many combinations, at multiple source areas, and at the outfall location.

3.2.2 HydroCAD – Water Quality Modeling

HydroCAD is a computer modeling system that models hydrology and hydraulics of stormwater runoff. It is based on the hydrology techniques developed by the Natural Resources Conservation Service (NRCS) combined with other hydrology and hydraulics calculations. For a specific event, of a specific intensity, duration and frequency, the model generates hydrographs for each subwatershed. Typically, this allows the engineer to verify that a given drainage system is adequate for the area under consideration, or to predict where flooding or erosion is likely to occur.

4.0 Results

Modeling of all the subwatersheds within the project area provides insight into where the main source areas are for runoff and pollutants such as total suspended solids and phosphorus. Both pollutants were modeled and used for the comparisons because they are both important. Minimizing the amount of phosphorus in the lakes is critical to the health of the lakes. The total suspended solids are important as they are tied to phosphorus sources and are the current pollutant that is under WDNR regulation.

Pollutants such as total suspended solids and phosphorus are commonly modeled. Total suspended solids, to some degree, can be seen in the water and phosphorus is the main component needed for algae growth. Total suspended solids, known as TSS, are solid materials, including organic and inorganic, that are suspended in the water. TSS includes soil particles (sand, silt, and clay) as well as such things like plankton, grass clippings, and industrial wastes. TSS in a lake will cause the water in the lake to be warmer, less light in the water column, and less oxygen. Phosphorus, known also as P, is a nutrient that is essential for plant growth and is the eleventh most common element. Phosphorus in a lake will cause algae blooms and excessive plant growth. When the plants die, they may give off a foul smell and deplete the oxygen in the water. Phosphorus comes from many sources including fertilizer, animal waste, industrial wastes and naturally occurring phosphorus on soil particles.

4.1 Water Quantity Results

The subwatersheds were modeled for the 1, 2, 5, 10, 25, 50 and 100-year, 24-hour storm events. The modeling provided an exorbitant amount of data. The data is provided in Appendix B. The model results are consistent with the water quality results, and greater focus has been put on the discussion of those results as the main goals of this plan are water quality based. Actual flooding within the City is rather minor overall. The modeling results could be utilized for the planning of regional stormwater ponds if the City decides at some point in time to manage its stormwater in this way. For site specific stormwater management practices, water quantity modeling should be completed at the same time that the water quality modeling is completed.

The general mirroring of the results of the water quantity modeling with the water quality modeling is consistent with a number of studies that have found that the actual pollutant loadings for each land use may be relatively close to each other but the greater quantity of runoff carries more pollutants.

4.2 Water Quality Results

Using SLAMM, each subwatershed was modeled. As a result of the modeling, base line pounds of total suspended solids and phosphorus were determined for each subwatershed. From this information loading rates in pounds per acre were determined for each subwatershed. This was done to more carefully assess the level of pollution within the subwatershed. If only the pounds per subwatershed were considered, all of the large watershed would be considered significant as the size of the subwatershed affects how many pounds it discharges. These results are listed as Tables 3-7, for each major basin.

This information was used to rank each subwatershed individually. Then the rankings were further compared to determine areas of concern or “hotspots.” The hotspots were identified based on level of pollutant discharges per acre for both phosphorus and total suspended solids and the total annual pounds of pollutant discharged to the lakes. These hotspots were further looked at to provide quality assurance on the results. Some subwatersheds within a basin, are partially or completely internally drained. This affects their status as a hotspot but did not necessarily eliminate it from consideration. Also, in regions of very similar land uses, a small area of a different land use can make that subwatershed loading appear very high. Identifying how the transport processes occur provides further insight on how the subwatershed should be ranked. Tables 7-10 include the results with the ranking of the pollutants provided. The rankings are based on all the subwatersheds within each basin. Tables 3-10 do not include the internally drained areas. These are included in Appendix D.

These hotspot determinations are based on modeling not site specific information. There may be areas that are actively eroding or have other site specific characteristic that would make them a much higher priority than those included below. Sites such as these need to be addressed by the landowner, or efforts need to be made to correct these situations immediately. Active erosion or illicit discharges into waters of the state affects all of us.

Hotspots are not provided for the Internally Drained Basin. There are some areas with very significant loads that have the potential of degrading surface waters, which then affect groundwater and further pollute one of the other basins. However, given the number of hotspots in the other four basins it is not realistic to add hotspot areas for subwatersheds that do not have direct drainage to the major resources of Amery.

4.2.1 Pike Lake Hotspots

The Pike Lake Basin has the greatest amount of undeveloped land uses and has the lowest loadings per acre in the entire study area. This is mainly due to the fact that most of the developed lands within the Pike Lake Basin are low density residential.

Subwatersheds A3, A5, A6, and A11 are the hotspot areas. These areas overall had higher pollutant loadings per acre. There are other watersheds that should also be considered for additional controls due to their total watershed pollutant discharges. A12 and A13 also contain a small amount of commercial land uses. As a result, the model showed it to have higher discharges and loadings. A significant amount of the subwatershed is parklands and the commercial use land is far from the lake, so this subwatershed was not considered to be a significant contributor of pollutants.

4.2.2 North Twin Lake Hotspots

The North Twin Lake Basin contains some of the more developed portions of Amery and has a mix of land uses. It does, however, contain some undeveloped lands. It has the second lowest average pollutant loading per acre behind the Pike Lake Basin.

Subwatersheds B1, B2, B10, B11, B12, and B13 are the hotspot areas for the North Twin Lake Basin. This is the developed downtown area of Amery and medium to high residential areas within Amery. Much of this area also tends to be low sloping so once the stormwater is in the storm sewer system it likely discharges directly into North Twin Lake.

4.2.3 South Twin Lake Hotspots

The South Twin Basin contains a significant amount of commercial land uses as well as medium to high density residential. As a result, the South Twin Lake Basin has the second highest average pollutant loadings per acre.

Subwatersheds C1, C3, C5, and W136 are the hotspot subwatersheds for the South Twin Lake Basin. Of these subwatersheds, C3 is by far the most significant. This single subwatershed provides approximately half of the pollutant discharge to South Twin Lake.

4.2.4 Apple River Hotspots

The Apple River Basin contains most of the downtown development but also contains a large portion of low density residential and undeveloped lands. With the overall diversity and large portion of the study area that the Apple

River Basin covers the average pollutant loadings per acre is in the middle, with the South Twin Lake Basin and the Internally Drained Basin being higher.

Subwatersheds W50, W64, W81, W89, W126, W134, W135, and W139 are hotspots for the Apple River Basin. There are other subwatersheds that are close in significance, such as W101 and W107. There is a large variation in subwatershed size in the Apple River Basin which makes it more difficult to assess the rankings and which areas are most meaningful. These areas ranked higher overall.

4.3 Stormwater Plan Modeling Results Vs. Lake Management Plan Modeling Results

The models used in this study and the Lake Management Plan provide relatively similar findings. The SLAMM modeling predicted that there is the potential for 112.7 pounds of phosphorus to enter Pike Lake, while the MNLEAP modeling predicts that the total phosphorus loading is approximately 67 pounds. (This difference in these two values can be explained with the over prediction of SLAMM created with the very general undeveloped land use type which makes up much of the basin drainage.) Both South Twin and North Twin results is matched more closely than the results for Pike Lake. The SLAMM modeling predicted 77 pounds of phosphorus to enter North Twin Lake, and MNLEAP modeling completed for the Lake Management Plan predicted 74 pounds of total phosphorus loading. For South Twin Lake, SLAMM predicted 54 pounds of phosphorus annually and MNLEAP predicted 45 pounds. (The Wisconsin Lake Modeling Suite, WILMS, model would likely be a better predictor than MNLEAP for these lakes. The WILMS model was developed based on MNLEAP but uses specific land use data and was developed specifically for Wisconsin. MNLEAP is based on an ecoregion, and no specific land use information is input into the model. WILMS was used to develop the plan goals as discussed in section 5.4)

5.0 Recommendations

A majority of Amery is nearly flat and the ground surface is close to lake level. A significant amount of Amery is developed. It is difficult to install new practices because of lack of space available and in many cases stormwater would need to be pumped uphill for treatment. Given these limitations, there are few specific areas for practice recommendations. Important opportunities are found at Flagpole Park and Soldiers Field. There are other opportunities for small practices to be placed and monitored for overall effectiveness and maintenance issues. Otherwise, the lakes and rivers can be kept clean by private landowners establishing small projects on their own property to protect the water resources of Amery. Amery can also implement nonstructural good housekeeping practices.

5.1 General/Nonstructural Recommendations

The general/nonstructural actions taken can make great impacts on water quality and in some cases water quantity. They tend to be low cost or have their costs extended over a larger time frame. In many ways the nonstructural actions are the good housekeeping approaches of stormwater management, but their impacts can be greater and further reaching than their structural counterparts.

5.1.1 Proper Management of Development and Land Uses

The management of new development allows Amery to have control over lands within the city limits and in the extraterritorial zoning area. This control includes stormwater management. Amery already uses this control over proposed development within the city limits and in the extraterritorial zoning area. Additional ordinances are the only way to legally increase management over development.

In regards to existing development, Amery has a right to notify landowners who need to consider making changes to how they manage their lands. Although, it may not be an enforceable option, as a good neighbor it would be a way to address some situations where changes could be made that could be beneficial to both the landowner as well as for stormwater. An example of this has been the contacting of the golf course by the Polk County Land and Water Resources Department to begin discussions on completing a nutrient management plan. Amery may also desire to take the lead in contacting the golf course as Administrative Code NR 151.14 requires non-municipal owners of more than 5 acres of pervious surface which fertilizer is applied to have a nutrient management plan by March 10, 2008.

Also, geese were discussed in the Stormwater Committee as a potential major contributor of phosphorus to the lakes and river. WDNR has grant funding available for such management that is further described in Section 8. The forest grant may be able to be utilized for the parks with Amery or for an interested landowner in the Pike Lake Basin. Within Section 8 there are a number of grant funding sources that are not directly tied to stormwater but have a direct benefit to stormwater and water quality. It is recommended that these avenues are pursued.

5.1.2 Additional City Ordinances/Policies

Amery has a very complete set of ordinances currently. However, the storm water and erosion control ordinance is not being enforced and is somewhat dated. Revising the ordinance shall be a top priority. With the revised ordinance all references within other ordinances to stormwater and erosion controls shall be modified to direct them to the revised ordinance only.

A shoreland ordinance can also be used to protect water resources in Amery. WDNR is currently rewriting Wisconsin Administrative Code NR 115, which is the frame work for creating a shoreland ordinance. It is recommended that once the new code is adopted, Amery takes action on starting this ordinance.

Amery’s shoreland ordinance, to be valuable, needs to set requirements for the shoreland area that will protect water quality. Regulations need to establish setbacks, impervious surface limitations, and the establishment and/or maintenance of native vegetation along the shore of all Amery Lakes.

The existing ordinance banning phosphorus use could be updated by developing a more realistic enforcement approach. Also, a more significant fine amount is warranted. An annual reminder should be sent out to landscaping and lawn care businesses, reminding them of phosphorus fertilizer restrictions.

5.1.3 Operation and Maintenance Issues

There are many operation and maintenance items for a community to consider for protecting water quality. These include increasing street sweeping, greater vehicle inspections and maintenance to avoid leaks, spill abatement, illicit discharge recognition and enforcement, storm sewer flushing, and sediment removal.

Research has shown that street sweeping is much less effective than originally thought. However, it does remove the mid-sized particles especially with a vacuum sweeper. Even the most recent version of SLAMM shows that if Amery's streets are swept with a mechanical sweeper once per month there is a 4-5% reduction in total suspended solids throughout the community. This is fairly consistent with Amery's sweeping schedule. Also, based on SLAMM modeling, if Amery sweeps once per week with a vacuum sweeper it could achieve nearly 20% reduction in total suspended solids. (Although, these are likely somewhat inflated numbers due to the MS4 regulations and its relation to street sweeping as an approved way to try to meet the regulations.) It should not be over looked as a way to reduce pollutant discharges to the lakes and river, and if a funding source becomes available, increasing sweeping is highly recommended. Also, in the future the purchase of a vacuum sweeper should be considered.

5.1.4 Public Education

Public education is key to the success and acceptance of all plans. The work and discussion that have come out of the Stormwater Committee has been extensive. It is recommended that the committee stay in place after the planning project is complete to continue public education and work to continue to improve the water quality of Amery.

5.1.5 Funding

It is highly recommended that Amery adopts a dedicated funding source for stormwater management. Amery is already funding stormwater management through their Public Works Department. By having a dedicated funding source, Amery will have the revenue to make water quality a priority, while having funds to keep the rest of Amery's infrastructure up and running. This dedicated fund also has the potential to motivate residents to implement stormwater management practices on their own property. Furthermore, these funds could be used to continue the cost sharing program that has been started with this project. This would provide further incentives for the residents to implement projects on their properties.

5.2 Structural Recommendations

5.2.1 Pike Lake

The Pike Lake Basin will benefit the most by extensive management of future development within the basin. Construction of well placed regional ponds would be one way to address both storm water quality and quantity in this basin because it is largely undeveloped. The watershed particularly on the north end has rolling topography that would allow for areas to be drained to a single point, treated in a stormwater management practice such as a regional pond and then eventually discharged into Pike Lake.

Pike Lake

The creation of regional stormwater basins would be most advantageous to do downstream of the high density residential and downstream of the institutional/commercial lands.

Several stormwater ponds were modeled with SLAMM using Amery data files, to see how effective the basins could be for planning purposes. As a general rule for preliminary planning the ponds should have a minimum depth of approximately 5-8 feet, and have a top surface area of approximately 4 percent of the total watershed area to achieve better than 80 percent reduction of total suspended solids. Under current WDNR regulation all new developments disturbing more than an acre would need to provide total suspended solid reduction of a minimum of 80%.

Locations of these regional ponds have not been determined because the lands are all under private ownership. Typically, implementation of best management practices will need to occur at the time of development. Also, much of the lands in the Pike Lake basin are in the Town of Lincoln and it is recommended that the Town is included in any discussions of contacting landowners that are in the Town of Lincoln. This makes this management recommendation more difficult. As such, the main focus in the short term for this basin should be on updating local regulation, as these lands may be annexed into Amery at some time in the future.

The adoption of the revised storm water and erosion control ordinance needs to occur as soon as possible. Also, a shoreland ordinance should immediately follow the adoption of the other ordinance. This will do the most to protect the Pike Lake Basin.

5.2.2 North Twin Lake

North Twin basin is challenging because it is highly developed and it has a number of subwatersheds that are significant contributors. The main contributing subwatersheds are very low sloping and have high groundwater. In many cases the storm sewer discharge pipe is at or below the elevation of the lake and discharges directly into the lake.

North Twin Lake

<u>Private Practices</u>

The land use of watershed B1 is mostly medium density residential. Based on residents' reports there appears to be a substantial amount of gas and oil in the runoff from the subwatershed. Sheen on the water surface has been observed at one of the discharge points. The discharge location is very low and is normally below the lake level. In general, the best solution is to educate this neighborhood and have private practices installed, such as rain gardens and rain barrels. A rain garden in clay soils with commercial use can reduce total suspended solids reduction approximately 50 percent (SLAMM). Following normal rain garden design standards, the residential sites will be able to achieve approximately 80 percent total suspended solids reduction with slightly less phosphorus reduction.

Biofiltration (Public Practice)

A secondary option for subwatershed B1 would be to collect and pump the stormwater to North Park or the north end of Flag Pole Park for treatment in a bioinfiltration basin. This is a significantly more costly option, but has been shown to be more effective on a cost per pound of phosphorus removed.

Inlet Protection (Public Practice)

A less costly but higher maintenance practice is to install inlet protection in all of the storm sewer inlets in this watershed. This should be done as a research/demonstration project. If the product is proven to efficiently trap sediment and maintenance is reasonable for the Public Works Department this practice could be installed in other subwatersheds within Amery. (It should be avoided where soils are predominately clay.) Inlet protection is typically used for construction site erosion control, but it is possible with proper maintenance to use it as a long term practice. It would require significant initial maintenance. Depending on the trap efficiencies of the product selected, it could be significant long term maintenance. There are approximately a dozen storm sewer inlets, with each set up costing a couple hundred dollars initially. The replacement bags are typically under a hundred dollars and may need to be changed approximately every couple of weeks to every couple of months. Product selection is very important and it is recommended that Flexstrom Inlet Filters are considered. One advantage of this system is that there is a frame that sits within the inlet, potentially providing for support to the filter bags. The frame systems cost approximately $150 each and the bags are approximately $50 each. It is highly recommended that an inventory of the inlets in the subwatershed is developed. This inventory is to detail the type and dimension of each inlet. The inventory should be provided to 2-3 manufacturers for bids. With the requested bid each manufacturer/distributor should provide a demonstration/presentation of how their system works. The Director of Public Works should decide which manufacturer to purchase from since they will be responsible for maintenance of this system. Oil and gas booms could be added to the inlets to try to reduce such discharges to the lake. Costs should be obtained from manufacturers with the inlet protection systems.

The manufacturers of the inlet protection devices advertise that their products at a minimum trap 80% of total suspended solids. This may be a gross overstatement of the actual results. Typically, such products have the ability to effectively trap larger sand particles but can not effectively trap silts or clays. Therefore, these should only be used in subwatersheds that are dominated by sandy soils and even in these subwatersheds it is estimated that only approximately 50% of the total suspended solids and 40% of the phosphorus loadings removed. These are estimates based on product knowledge and should be field verified for, at a minimum, the initial subwatershed use. See Appendix E, for monitoring protocol information.

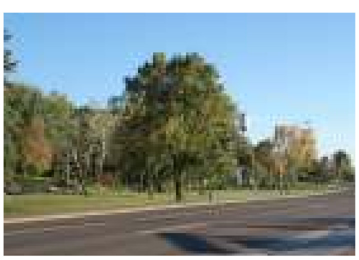
Porous Pavement (Public Practice)

Subwatershed B2, B10, B12 and B13 are generally 100% developed with commercial and medium to high density residential. One of the only options for treatment is the on-site small practices to treat the stormwater runoff prior to it entering the storm sewer system. One practice that is being considered and potentially funded through the cost share program is porous pavement. Porous pavement is designed to significantly increase infiltration, but it needs to be maintained by removing sediment from the voids in the pavement. Also the installation must be done correctly with the base providing stability to the concrete and also providing infiltration. This practice should not be used where groundwater is very high or the potential for the runoff to be very high in petroleum products or industrial waste. Other practices that could be used include bioinfiltration in parking lot islands, rain gardens, rain barrels, and shoreland buffers.

Silt Curtain/Turbidity Barrier (Public Practice)

Another option discussed with WDNR is to install a silt curtain (turbidity barrier) in the lake. The silt curtain is weighted on the bottom and has flotation on the top to create a barrier in the water. Although the aesthetics of the curtain tends to be low and maintenance can be high, it may be an effective way to trap pollutants in the lake and then to mechanically remove them with a backhoe. WDNR water regulations representative for the region felt that the removal of sediment would be part of city maintenance and would not require a permit for such work. An initial plan of where the curtain would be installed would first need to be provided to WDNR and then a determination would be made as to where a permit is needed for installation and for long term maintenance. There are three significant concerns that need to be considered before implementing the silt curtain: removal before winter and installation in spring, need to hold curtain in place with such things as fence post so that the curtain does not float away and the safety/liability of the curtain and fence posts in the lake. Also, the subwatershed should be small where this practice would be installed. Too large of flows will disturb the curtain and it will be ineffective. One possible location would be at subwatershed B12. The curtain can be purchased for approximately $2,000 or less for one hundred feet at 5 feet high.

Flagpole Park Bioinfiltration (Public Practice)



Flagpole Park

Subwatershed B11 was previously identified in the Lakes Management Plan as being a source of high runoff volume and in turn considered to be a high source of pollutants. Flag Pole Park was identified as a potential treatment site for this subwatershed. Originally the Polk County Land and Water Resources Department planned a large rain garden or potentially a series of smaller rain gardens for the stormwater to flow through for treatment. This idea was abandoned due to high groundwater at the site. Also, a majority of the runoff in this area is already in the storm sewer system so there was no way to get the stormwater into the park for treatment by gravity. As a result of these two limitations, a preliminary design was developed to route all of the stormwater to one location and pump the stormwater into a constructed bioinfiltration area. The bioinfiltration area would be constructed on top of the native soils once the topsoil was removed to create the desired three feet of separation for water treatment areas and groundwater.

The main draw back of the preliminary design is cost. This is due to the relatively large pump needed to pump the stormwater into the bioinfiltration area. The anticipated cost of the pump is approximately $20,000 with the total project estimated to be approximately $90,000. The main attribute of the preliminary design is effectiveness. The design was modeled with SLAMM and found to reduce the total suspended solids by more than 80 percent.

The report completed for Amery as part of this plan further described the technical basis of the preliminary design, modeling results, and associated costs. This secondary document is called "Preliminary Stormwater Treatments Alternatives for Amery's Flag Pole Park and Soldiers Field."

5.2.3 South Twin Lake

The South Twin Lake Basin like the North Twin Lake Basin has the same limitation of low slopes and high groundwater. One main advantage for the South Twin Lake Basin is that it has one main subwatershed that is a major contributor, C3. However, subwatersheds C1, C5, and W136 should not be overlooked. These subwatersheds should be the focus for private on-site practices to treat the stormwater prior to it entering the storm sewer system.

South Twin Lake

Soldiers Field Bioinfiltration (Public Practice)

Subwatershed C3 is a hotspot that contributes almost half of the pollutants to the lake. This hotspot was previously identified in the Lakes Management Plan as being a source of high runoff volume and in turn considered to be a high source of pollutants. Soldiers Field was identified as a potential treatment site for this subwatershed. This site has the same limitations as the Flag Pole Park site. As a result of the limitation, a preliminary design was developed to route the stormwater to one location and pump the stormwater into a constructed bioinfiltration area. The bioinfiltration area would be constructed on top of the native soils once the topsoil was removed to create the desired three feet of separation for water treatment areas and groundwater.

Like Flag Pole Park, the main draw back of the preliminary design is cost. This site requires an even larger pump. The main attribute of the preliminary design is effectiveness. The design was modeled with SLAMM and found to reduce the total suspended solids by more than 80-96 percent depending on the size of the bioinfiltration area. Another advantage to South Twin is that discharge out of the basin will be discharged into the creek that outlets into the Apple River. This means that the re-routing will bypass the lake. Care would need to be taking to ensure that the discharge water was treated to a level greater than what would be discharge to the Apple River after this watershed discharges into the lake. Moreover, removing the discharge from that basin should be considered but only if it can be done without causing flooding problems in the creek between South Twin Lake and the Apple River.

Infiltration along Harriman Avenue (Public/Private Practice)

An alternative or additional option for subwatershed C3, is to modify the drainage conditions along Harriman Avenue. Harriman is an excessively wide street that was designed for on-street parking on both sides of the street. It may be possible to modify the street section to increase infiltration in this area and substantially reduce the amount of runoff that ever reaches South

Twin Lake. Due to the street's width and alignment, it is often traveled at a speed in excess of the posted speed. Any modification to the streets section has the potential to create conditions that may cause drivers to reduce speeds.

The actual phosphorus reduced by the infiltration will depend significantly on the amount of area that can be utilized for infiltration compared to the overall amount of runoff. However, it is anticipated that the reduction could be greater than 60 percent if the entire length of Harriman Avenue could be used for infiltration.

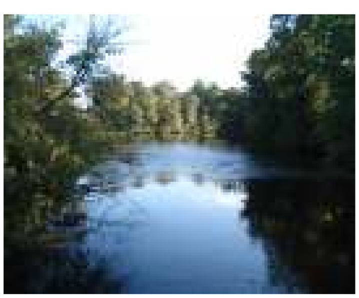
A survey of the street and adjacent street right of way would need to be completed to better assess the options available. Also, a soils investigation would need to be conducted. The potential options are as follows, with the least costly option first and most costly last:

- Modify the curb and boulevard. Direct runoff into the modified boulevard for infiltration and treatment by modifying the curb.
- Modify parking areas. Install infiltration areas in the parking area every couple of hundred of feet to treat runoff from the street.
- Modify the street section, boulevard and curb. Reduce the overall street width so that there is more area for infiltration to occur in the boulevard. Modify the curb so that runoff will be directed into the boulevard.

The report completed for Amery as part of this plan further described the technical basis of the preliminary design, modeling results, and associated costs. This secondary document is called "Preliminary Stormwater Treatments Alternatives for Amery's Flag Pole Park and Soldiers Field."

Property owners along Harriman Avenue should be notified in the early stages of this project. This will allow the owners to be involved in the decision process and will gain public acceptance for the improvements. Landowners should also be asked if they are willing to participate in the project by allowing a portion of their land to be used for infiltration practices.

5.2.4 Apple River



Apple River

Subwatersheds W50, W64, W81, W89, W126, W134, W135, and W139 were identified by the SLAMM modeling as hotspots for the Apple River Basin. Many of the subwatersheds have significant discharges and there are more that could be added to this list. In general, private practices should be the main focus. In general, all of the storm sewer outlets discharge directly into the river making it impossible to treat the stormwater out of the pipe. A possible location for additional treatment would be at the park on State Trunk Highway 46 along the river where runoff from subwatershed W64 and W139 could be treated. This location would likely require a pump to lift the stormwater into the park.

The emphasis on the Amery Lakes directly benefits the river as ultimately the lakes discharge into the river. However, no resource is necessarily more significant than another. The Apple River has relatively low water quality and all efforts to improve the water quality either privately or public are very important. WDNR will increase their emphasis on impaired waters and EPA's 303d listed waters. Amery may be affected by new rules as greater emphasis is placed on these types of waters. It may result in greater consideration of the river watersheds by Amery now and in the future.

It is recommended that the cost share program continues to fund private stormwater practices and that this is extended to both lake and river watersheds. If additional funding sources such as a stormwater utility are adopted by Amery, these monies could be used for private and public practices.

Expansion of Amery's street sweeping to include all larger parking lots would further reduce total suspended solids and phosphorus from entering the Apple River. Discussions should begin with the school district to see if they would be willing to have Amery provide this service. A program could be developed to encourage businesses to contract with Amery to have their parking lots swept. This could become a requirement for new businesses or could be part of the stormwater credit system if a stormwater utility was developed.

If funding is available, Amery should consider upgrading their mechanical street sweeper for a vacuum type of street sweeper. These are considerably more effective. Through the use of SLAMM the mechanical sweeper is able to collect 4-5% of the pollutants while a vacuum sweeper will collect approximately 20% for the same frequency. While part of the difference in effectiveness may be related to the actual SLAMM programming and water quality standards, the vacuum sweeper has been found to be considerably more effective over a mechanical sweeper. The vacuum sweeper is an expensive investment, but it has the potential to positively impact all of the drainage basins.

5.3 Results

Results are provided in Table 11. It details the existing conditions, the existing conditions with controls, and proposed conditions. The proposed conditions include the recommendation detailed above. The proposed conditions assume that each of the basins have about 20 percent of the residential land use to install a private practice and that these provided practices are approximately 50 percent effective.

Table 12, provides a detailed listing of subwatershed considerations and recommendations. The impact each of these practices will have to the water quality of the lakes and river will be dependent on how many and which practices are implemented, as well as where they are implemented. But each practice as long as properly designed, installed and maintained will reduce the pollutants to the lakes. In all cases, the less water that gets to the lake the less pollution will get there, too. Some practices will treat or filter the water but the most effective way to protect the lakes is to keep the runoff that carries the pollutants from getting to the lakes.

5.4 Goals

5.4.1 Lake Goals

Each of the lakes is consider to be mesotrophic based on the Wisconsin Tropic State Index. Since the early part of the 20th century, lakes have been classified according to a “trophic” state. "Trophic" means nutrition or growth. A eutrophic (meaning well-nourished) lake has high nutrients and high plant growth. An oligotrophic lake has low nutrient concentrations and low plant growth. A mesotrophic lake is somewhere in between eutrophic and oligotrophic lakes. (The Lake Management Plan is based on the use of MNLEAP which is based on Carlson’s Trophic State Index. In the early 1990’s the WDNR created the Wisconsin Trophic State Index to better tailor the TSI system to mirror what is occurring in Wisconsin Lakes. Therefore, slightly different data is shown with the Lake Management Plan. WILMS was used to model the lakes to compare the results provided by MNLEAP. The results were consistent for the Carlson TSI but MNLEAP does not provide the Wisconsin TSI. The WILMS model provided the same result for the Wisconsin TSI as calculating the Wisconsin TSI based on the equations below.)

The following equations are the Wisconsin Tropic State Index equations:

$$TSI\ (TP) = 28.2 + 7.73 \ln (TP)$$

$$TSI\ (SD) = 60 - 14.4 \ln (SD)$$

$$TSI\ (CHL) = 34.8 + 7.56 \ln (CHL)$$

Where:

TP	=	Total phosphorus (ug/L)
SD	=	Secchi depth (meters)
CHL	=	Chlorophyll *a* (ug/L)
ln	=	Natural log
TSI	=	Wisconsin Trophic State Index

Utilizing the sampling data collected for the Lake Management Plan (average in lake total phosphorus (TP), and the equation for TSI (TP), the following is the TSI (TP) for each of the lakes:

	Average Sampled In-Lake TP (ppb)	TSI (TP)
Pike Lake	16.7	50
North Twin Lake	16.2	50
South Twin Lake	18.6	51

The TSI (CHL) value is considered to be the favored TSI to report as the TSI is intended to predict algal biomass and as a result the TSI (CHL) is considered to be the most accurate measure. However, all of the goals, modeling, and plan are based on phosphorus; therefore TSI (TP) is the measure appropriate for this plan.

Since lakes naturally change toward being eutrophic with time, is not realistic to place a goal for the lakes to have water quality at a level to be classified as oligotrophic. It is however realistic to set a goal for each of the lakes to maintain a total phosphorus TSI of less than 53. This means that the in-lake total phosphorus shall not exceed 25 ug/L (ppb). To accomplish this goal, external phosphorus loading (the phosphorus discharged through runoff from the lake's drainage basin) must be reduced. The total in-lake phosphorus typically comes from three sources, atmospheric, internal (phosphorus release from sediments and groundwater discharge), and external (phosphorus discharges from point and non-point sources).

An in-lake total phosphorus goal of 25 ug/L or less is a long term goal which will require the implementation of practices to reduce the amount of external loading reaching the lakes. Reducing the external loading to a level appropriate to meet the goal will take a significant amount of time. As the external phosphorus is reduced, it is possible that internal loading may remain high for a number of years. Therefore, it will take time to realize the effects of external phosphorus load reductions.

Table 11 provides the anticipated external loading reduction based on the implementation of the recommendations in the plan. Over hundreds of thousands of years a lake natural evolves into an eutrophic state. Man-made activities can cause a lake to be come eutrophic in decades or less. It is critical to the health of the lakes to reduce the external loading to the lakes so that they do not prematurely become eutrophic. To meet the implementation goals and the reductions needed, it will be necessary for a significant amount of private landowners to install practices.

See Appendix E, for monitoring protocol for assessing progress towards plan goals.

5.4.2 River Goals

Establishing a river goal is more difficult as the drainage basin is very large and the external loading caused by Amery is a small portion of the external loading that the river receives by the time it reaches Amery. It is also more difficult as there are not any known additional studies to pull more information on current water quality. It is known however that Apple River Flowage is at a minimum eutrophic (TSI equal to or greater than 50) and is potentially hypereutrophic (TSI equal to or greater than 70).

Considering current permit requirements for stormwater permitted municipalities and what may be feasible for Amery, it reasonable that Amery should look to meeting the requirement of the permitted municipalities but on an extended timeframe. (For a permitted municipality, there are required to reduce total suspended solid discharges by 20% in 5 years and 40% in 10 years.) Given this it is recommended that Amery's goal for the river is to reduce total phosphorus discharge to the river by 20% in 10 years and by 40% in the next 20 years. This is a significant goal and worth investing in for Amery and for the Apple River. One of the main ways to meet this goal would be to invest in a vacuum style street sweeper and to continue to provide incentives for private landowners to install water quality practices.

See Appendix E, for monitoring protocol for assessing progress towards plan goals.

6.0 Public Education

6.1 Introduction

Public education is an important element of the Amery Stormwater Management Plan. The success of the plan is dependent upon residents understanding the importance of protecting the lakes and the methods available for their protection. This background will help motivate residents to follow good housekeeping recommendations and install conservation practices to protect water quality.

Resident education and City Council education will also help to gain support for the implementation of the stormwater management plan. Resources and public acceptance will be needed to install city-level practices and to implement a stormwater and construction site erosion control ordinance.

6.2 Educational Goals and Objectives

Goal: Amery residents and business owners understand the significance of stormwater runoff and the importance of protecting water quality in Amery.

Objective: Residents understand what they can do to protect Amery's lakes.

Objective: Students are involved in Amery storm water activities.

Objective: Residents support implementation of the Amery Stormwater Management Plan.

Implementation of each educational objective is outlined below. A progress report of these activities is included in the following section.

Objective: Encourage residents and business owners to install conservation and infiltration practices on their property.

Action: Install demonstration conservation and other infiltration practices at readily accessible locations within the city limits.

Practices:

Rain gardens, rain barrels, shoreline buffer restoration, tree falls (trees in the lake that provide habit for fish and protect shorelines from wave action erosion), porous pavement, infiltration trenches or pits (rock filled areas to increase the potential for infiltration), etc. Cost share agreements between the City of Amery and each landowner will establish a 70% cost share rate. The City will pay 70% of project costs from a Wisconsin Department of Natural Resources Lake Protection Grant during the duration of the grant. Polk County LWRD staff and qualified consultants will design practices according to accepted standards and inspect completed practices prior to payment.

Action: Distribute information about management practices to residents via newsletter and newspaper articles, brochures, and signage.

Action: Provide written information and sources of technical and financial assistance for residents interested in conservation practices.

Action: Conduct demonstration site tours and open houses.

Action: Highlight completed buffer restoration projects with a special demonstration tour/event.

Action: Sponsor community education classes on rain barrel construction and rain garden installation.

Objective: City residents understand what they can do to protect Amery lakes.

Priority topics: infiltration practices, buffer zones, pet waste clean up, yard maintenance/fertilizing, driveway and sidewalk cleaning, benefits of area wetlands, demonstration projects, Flag Pole Park and Soldiers Field projects, rain barrel distribution, stormwater and erosion control ordinance, etc.

Action:[1]

Articles in city newsletter

Newspaper articles

Action:

Presentations/displays (Amery Art Fair, Nature of Amery, Amery Fall Festival, local clubs such as Community Club, Women's Club, Lions Club)

Door hangers placed on doors to provide event information

Action:

Distribute free rain barrels to residents of Amery watersheds.

Objective: Property owners and contractors understand and follow the requirements of the Amery Stormwater and Erosion Control Ordinance.

Action: Present information to the Amery City Council (televised to the public).

Action: Publish a series of newspaper articles about the ordinance rationale and requirements.

Action: Ensure that the ordinance, application forms, and explanatory materials are concise and easy to understand.

Objective: Students are involved in Amery storm water activities.

Action: Encourage teachers to teach about stormwater runoff and water quality in their classrooms using example materials from Project WET and Adopt-A-Lake that are tailored to Amery water quality concerns.

Action: Involve Amery High School Freshwater Biology and other students in the implementation of stormwater practices such as planting rain gardens,

[1] The Amery Family Lakes Survey (2003) identified newspaper and newsletter articles as the best ways for the Amery Lakes District to communicate with the public.

developing and presenting public information materials, constructing and distributing rain barrels, and taking water quality measurements.

6.3 Stormwater Education Progress to Date

Demonstration projects

A private residence on South Twin Lake is the location for the first Amery Clean Lakes Program demonstration project. Amery High School Freshwater Biology students dug the rain garden and community education rain garden class students planted it.

A landscaper design and installed a second rain garden at a highly visible location that drains to North Twin Lake in the summer of 2008. A porous concrete demonstration will be installed early in 2009. A tour of these sites and other stormwater projects will be arranged in 2009.

Community education classes

Amery Community Education sponsored two rain garden classes in June and September 2007. Eighteen area residents, including master gardeners attended these classes. The master gardeners have volunteered to assist with demonstration gardens in the future.

Rain barrel distribution

Amery Rain Barrel

Amery residents received free rain barrels in June 2007 at the Nature of Amery event and in 2008. Twenty-three barrels were distributed in 2007. Residents signed a pledge to install their barrel at a location in an Amery watershed that they identified. The city crew assembled and distributed another forty barrels in July 2008. A handout with the purpose of the rain barrel and installation instructions was distributed along with the rain barrels.

Logo contest

Amery high school students competed to develop a program logo for the Amery Clean Lakes Program in March of 2007. Molly Tulkki received $100 for her winning design. The logos are used on a sticker affixed to the rain barrels and on the program brochure.

Program brochure

The program brochure offers technical assistance and cost sharing to Amery residents for installation of water quality practices. The brochure identifies high priority areas for assistance and funding and solicits participation. It was distributed to all Amery residents in April 2008. The brochure also describes good outdoor housekeeping practices for clean water.

City Council Meetings

The planning consultant and other members of the stormwater committee presented information to the Amery City Council throughout the planning process. This will continue as the draft and final stormwater plan are developed and the stormwater and erosion control ordinance is proposed. City Council meetings also provide a public education benefit because they are broadcast on cable television. Some of the presentations were called "Why we protect our lakes" and "Where phosphorus comes from."

Presentations

Information about the Amery Clean Lakes program was shared with the Amery Rotary Club in September 2007.

The program will also be featured as part of the Protecting the St. Croix River Basin Conference at UW River Falls in April 2008.

News releases and newsletters

A program status report appeared in the City of Amery newsletter in April 2007. News releases and newsletter articles will continue to keep residents aware of program goals and implementation, as long as publication of continued.

6.4 Educational Tools

The Amery Clean Lakes Program will continue to use a variety of educational tools to reach program objectives. Some of these are listed below.

City of Amery newsletter

City of Amery website

Newspaper articles, through cooperation with the Amery Free Press

High school newsletter

Televised Amery City Council meetings

Special demonstrations, presentations, and meetings

Apple River P&R District meetings and/or District newsletter

Amery Lakes P&R District meetings and/or District newsletter

Northwest Wisconsin Wastewater Engineer's meeting in Turtle Lake

Conference and seminars

Program brochure

Demonstration project on-site visits/technical assistance

Community education classes

6.5 Education Activity Coordinator

Steve Schieffer, Amery Lakes District chair, and project consultant, Cheryl Clemens with Harmony Environmental, will coordinate information and education activities. They will involve students and local volunteer groups in these activities.

6.6 Education Activities Timeline

See Table 13, for Education Activities Timeline

7.0 Ordinance Development

The stormwater committee reviewed a summary of Amery's current ordinances and other communities' ordinances for erosion control and stormwater management as well as low impact development.

From these reviews it was decided that the most appropriate stormwater management and erosion control ordinance for Amery was to adopt a modified version of the current Polk County Storm Water Management and Erosion Control Ordinance. The ordinance has been rewritten and was presented to the City Council in May 2008. As part of the rewrite of the ordinance, low impact development standard of treating the first inch of rainfall for small areas is included. It is anticipated to go for adoption early 2009.

As discussed in Section 5, the adoption of a shoreland ordinance is very important for the overall health of Amery's water resources. Work is recommended to begin with the adoption of the Wisconsin Administrative Code 115.

8.0 Financing Options

There are a number of funding mechanisms that can be used to finance the implementation of best management practices (BMPs). Likely a combination of private and public funds and combinations of sources may be used to fund BMPs.

8.1 Private Funds

Generally private funds are most appropriate for new development stormwater management BMPs; however, there are many options available. Basic forms are discussed below.

- Development Exactions

As a condition of approval for development, Amery requires that the stormwater management facilities and storm sewer systems are constructed and paid for by the developer. In addition, where additional improvements are needed Amery could require developers to donate lands, easements, or other types of partial rights to Amery for stormwater management.

- Private Improvements

Land owners may choose to make stormwater management improvements on their own. In the future, if a stormwater utility was implemented in Amery, discounts could be provided to landowners who installed private stormwater improvements.

8.2 City General Operational Funds

Funds for stormwater management could be provided from the General Operational Funds. This source can be best considered a "bank" into which revenues are placed and from which programs are funded. The major income source for the General Funds is property taxes. This income is based primarily upon the assessed valuation of property within Amery. The revenue source can be used for funding administration, renewal/replacement, construction, maintenance, and water quality monitoring. The negative aspect to this approach is that stormwater management is funded on a year-to-year basis and long term planning is difficult. Also, the stormwater needs must compete with the other City services needs each year during the budget approval process.

8.3 Government Grants Monies

Government grants are available through a variety of organizations of which the WDNR is the most prolific in providing help to local communities. The grant funds allow for planning and implementation of a multitude of water quality and water quantity based programs. The nonpoint source pollution control programs are some of the most common, but there are others that match well with the stormwater management plans recommendations. Below is a general description of some of the grants available at the time of the writing of this report that may assist Amery and the Lakes District. Some of the applicability of these grants and the availability of the funds will need to be verified. Amery and the Lake District with the assistance of Harmony Environmental, on a contractual basis, have obtained WDNR grants to complete planning and implementation work, including grants for this Stormwater Management Plan.

8.3.1 Local Water Quality Management Planning Aids

(s. 604(b), Federal Clean Water Act, s. 281.51, Wis. Stats., and ch. NR 121, Wis. Adm. Code)

Planning entities, government bodies, and tribes with water quality management planning responsibilities can receive funding to assist with the development and implementation of area-wide water quality management planning activities.

- Eligible projects:
  - Sewer service area plans and amendments.
  - Local and regional water resource management and watershed planning activities.
  - Regional wastewater facility planning initiatives.
  - Identification and protection of water quality sensitive environmental corridors.

The eligible fund may be as high as 100 percent but is dependent upon proposed water quality priorities, work plans, cost estimates, fund source, and matching local funds may be required. The funding priorities are as follows. First priority is the funding of water quality implementation in designated management areas of the state as defined by WDNR NR 121, which Amery is not a part of. Second priority is the funding of those areas required to develop sewer service area plans, or long-term plans that identify where public sewer will be placed in the future. Since Amery is under a population of 10,000 it is not required to develop sewer service area plans or long term plans. Third priority is plans and studies that support watershed management, including municipal stormwater analyses for municipalities with populations greater than 10,000, regional wastewater facility planning studies, identification and protection of environmentally sensitive areas ('environmental corridors'), or, for example, special watershed studies in support of pollution trading. Amery has the potential to be considered under the third priority. Being as Amery could only be considered under the lowest of priority areas; additional work with WDNR staff to assess the potential grant success is recommended.

8.3.2 Lake Protection and Classification Grants

(ss. 281.69 and 281.71, Wis. Stats.; ch. NR 191, Wis. Admin. Code)

Eligible entities can apply for funding to protect and improve the water quality of lakes and their ecosystems. Both Amery and the Lakes District are eligible entities.

A WDNR Lake Protection Grant was obtained to complete the Stormwater Management Plan and to implement practices.

The Lake Protection Grant program is funded with a portion of the gas tax on boating fuel. Grant awards may be used for 75 percent of project costs with a maximum grant amount of $200,000.

- Eligible projects include:
  - Purchase of land or conservation easements that will significantly contribute to the protection or improvement of the natural ecosystem and water quality of a lake.
  - Restoration of wetlands and shorelands that will protect a lake's water quality or its natural ecosystem (these grants are limited to $100,000). Special wetland incentive grants of up to $10,000 are eligible for 100 percent state funding if the project is identified in the sponsor's comprehensive land use plan.
  - Development of local regulations or ordinances to protect lakes and the education activities necessary for them to be implemented (these grants are limited to $50,000).

8.3.3 Urban Wildlife Damage Abatement and Control Grant

(ss. 29.887(1), (2), and (3), Wis. Stats.; ss. NR 50.01 through 50.05 and 50.23, Wis. Admin. Code)

Urban Wildlife Damage Abatement and Control (UWDAC) grants are available to any municipality or tribal government as long as they are in an urban area. Grant funding is available to help urban areas develop wildlife plans, implement specific damage abatement, and control measures for white-tailed deer and/or Canada geese. The program will reimburse 50 percent of project costs, a maximum of $5,000. Advancement of up to 50 percent ($2,500) may be available at the beginning of the project.

The geese in Amery have been identified as a potentially significant source of phosphorus entering the water resources of Amery. Although currently their effect is only by observation, so it is unknown to the extent that they play a role in the nutrient loadings to the lakes and river. Overall, it is likely to be minor as opposed to other sources; however, managing each source to the greatest extent possible maximizes the potential for improved water quality to all the water resources.

- Eligible projects include:
  - Developing an urban wildlife population control plan.
  - Monitoring wildlife populations and establishing population estimates.
  - Removing deer using sharpshooters as part of a WDNR approved project.
  - Trapping and translocation of deer and geese.
  - Implementing managed hunts.
  - Removing resident Canadian geese by approved WDNR methods.
  - Performing required health and tissue sampling.
  - Processing, distributing or disposing of geese or deer to a charitable organization.
  - Modifying habitat.
  - Implementing any other wildlife control or damage abatement practices approved by the WDNR.

8.3.4 Lake Management Planning

(s. 281.68, Wis. Stats., and ch. NR 190, Wis. Admin. Code)

Lake Management Planning Grants have already been successfully used to do such projects as the Lake Management Plan for the Amery Lakes District.

Municipalities, tribes, qualified non-profit conservation organizations, qualified lake associations, school districts (in partnership with another eligible party), and other local governmental units as defined in Wisconsin Statues Chapter 66 that are established for the purpose of lake management, are eligible to apply for funding. The purpose of the funding is to collect and analyze information needed to protect and restore lakes and their watersheds.

Like the Lake Protection Grant program, the Lake Management Planning program is funded with a portion of the gas tax on boating fuel. Grant awards may be used for 75 percent of project costs with a maximum grant amount of $10,000.

- Eligible projects include:
  - Gathering and analysis of physical, chemical, and biological information on lakes.

- Describing present and potential land uses within lake watersheds and on shorelines.
- Reviewing jurisdictional boundaries and evaluating ordinances that relate to zoning, sanitation, or pollution control or surface use.
- Assessments of fish, aquatic life, wildlife, and their habitats.
- Gathering and analyzing information from lake property owners, community residents, and lake users.
- Developing, evaluating, publishing, and distributing alternative courses of action and recommendations in a lake management plan.

8.3.5 Clean Sweep Grant

(Ch. ATCP 34, Wis. Admin. Code)

Formerly a WDNR program, Wisconsin Department of Agriculture, Trade, and Consumer Protection (WDATCP) may award a clean sweep grant to a county or municipality for a clean sweep project. The purpose of clean sweep project is to collect wastes. These wastes may include farm chemical wastes and household hazardous wastes.

8.3.6 Forest Stewardship Grant

(U.S. Public Law 101-624, Title XII, and ch. NR 47, Wis. Adm. Code.)

Agencies, organizations, tribes, and private citizens interested in promoting stewardship management of private non-industrial forest lands may be eligible to receive funds for approved projects. Grants cover 50 percent of actual eligible costs, and requests are limited to $15,000 per proposal.

- Projects directed toward one or more of the following are eligible:
  - Providing direct assistance to private forest landowners.
  - Providing information on multi-resource management of forest lands to the general public (especially Wisconsin private forest landowners).
  - Training of resource professionals and service providers who assist private forest landowners in the management of their forest lands.
  - Developing new information and/or training materials on sound forest management.

Eligible projects include landowner workshops, management plan writing, field days, training sessions, direct landowner assistance and research. Applications are available in November and due January 1 each year.

8.3.7 Nonpoint Targeted Runoff Management Program (TRM)

(s. 281.65, Wis. Stats., and ch. NR 153, Wis. Adm. Code)

Governmental units and tribes can be reimbursed up to 70 percent of eligible costs associated with installing Best Management Practices (BMP) to limit or end nonpoint source (run-off) water pollution. Grant awards cannot exceed $150,000. Grants are made for specific projects and have a 2-year implementation time frame. Construction and design are eligible for funding as long as design is part of construction.

- Examples of eligible projects include:
  - Detention ponds.
  - Stream bank protection projects.
  - Wetland construction.
- TRM grants may not be used to fund the following:
  - Projects to control pollution regulated under Wisconsin law as a point source. This includes:
    - Municipal or industrial activities to meet permit requirements under ch. NR 216, Wis. Adm. Code.
    - Construction site erosion control and post-construction BMPs for new development.
    - Projects that are not water quality based (such as dredging, or projects to solve drainage or flooding problems).

Efforts are focused in critical watersheds and lakes where nonpoint source-related water quality problems are most severe and control is most feasible. Projects are selected based on a competitive process until all available funds have been allocated.

8.3.8 Urban Nonpoint Source and Stormwater Grants (UNPS and SW)

(s. 281.66, Wis. Stats.; ch. NR 155, Wis. Adm. Code)

Municipalities and tribes are eligible for grants to improve urban water quality by limiting or ending sources of urban nonpoint source (run-off) pollution. Funding of project is site-specific and targeted to address high-priority problems in urbanized areas. Two types of programs available are Planning Grants and Construction Grants.

Eligible Stormwater planning projects must be in an urban area or an area projected to be urbanized within 20 years. Specific criteria must be met for an area to be considered an "urban project area."

Reimbursements are made of up to 70 percent for eligible planning, with awards not exceeding $85,000.

- Eligible activities include:
  - Urban runoff control planning activities including:
    - Stormwater planning for areas of existing development, new development, and re-development.
    - Preparation of local ordinances (such as construction site erosion control, post-construction Stormwater management, pet waste management, and illicit discharge management) affecting Stormwater.

- Evaluating local financing options for Stormwater programs, including Stormwater utilities.
- Urban runoff control implementation activities including:
- Administration costs (in excess of permit revenues) needed to initiate a local ordinance program.
- Administration costs associated with initial establishment of local Stormwater management funding programs (such as Stormwater utilities).
- Illicit discharge detection and elimination.
- Project evaluation activities required by the grant.
- Public participation, education, and outreach activities.

Projects are selected for funding based on a competitive process.

Construction projects designed to control stormwater runoff rates, volumes, and, most importantly, discharge quality from nonpoint sources within existing development are eligible for UNPS & SW Construction grant funding. Governmental units can be reimbursed up to 50 percent to construct Best Management Practices (BMP). The maximum possible grant is $200,000 ($150,000 for construction activities and $50,000 for land acquisition or easements). A project must be located in an urban area to be eligible for BMP cost sharing.

- Eligible activities include:
  - Construction of structural urban BMPs such as detention basins, wet basins, infiltration trenches, infiltration basins, or wetland basins.
  - Engineering design and construction services for BMP installation.
  - Land acquisition and easement purchase, including appraisal costs (only when necessary to install the BMP).
  - Storm sewer rerouting and removal of structures (only when necessary to install the BMP).
  - Streambank and shoreland stabilization projects.
- The following projects are not eligible for funding under this grant:
  - Projects solely focused on new development.
  - Projects designed to solve drainage and flooding problems.
  - Dredging projects.

8.3.9 Aquatic Invasive Species Control Grants

(s. 23.22, Wis. Stats., and ch. 198, Wis. Admin. Code)

Counties, cities, towns, villages, tribes, public inland lake protection and rehabilitation districts, and town sanitary districts and other local governmental units as defined in s. 66.0131 (1)(a), Stats., qualified lake associations as defined in s. 281.68 (1)(b), Stats., qualified school districts, qualified nonprofit conservation organizations, and river management organizations, are eligible to apply for apply for funding for an aquatic invasive species control project for any waters of the state including lakes, rivers, streams and the Great Lakes.

Grant awards may fund up to 75% of the cost of a project up to a maximum grant amount of $75,000, except for Early Detection and Rapid Response projects which are eligible for a maximum grant of 75% of project costs up to a maximum of $10,000.

- Eligible projects include:
  - Education, prevention and planning projects
  - Established infestation control projects
  - Early detection and rapid response projects
- Priorities for funding projects include projects that do any of the following:
  - Involve multiple water bodies
  - Prevent the spread of aquatic invasive species through education and planning
  - Control pioneer infestations of aquatic invasive species
  - Control established infestations of aquatic invasive species and restoring native aquatic species communities
  - Local units of government shall receive first priority for awarding initial $500,000 of cost sharing.

Applications must be received in WDNR regional offices by February 1 (spring grant cycle) and August 1 (fall grant cycle) for education, prevention and planning projects, and for established infestation control projects. Applications are accepted throughout the year for early detection and rapid response projects.

8.3.10 Municipal Flood Control Grant Program

(s. 281.665, Wis Stats., and Ch NR 199, Wis. Adm. Code)

Recognizing that we have a responsibility to protect life, health, and property from flood damages, the Wisconsin Department of Natural Resources, Bureau of Community Financial Assistance and Bureau of Watershed Management offers this grant assistance package to all cities, villages, towns, Indian Tribes, and metropolitan sewerage districts concerned with municipal flood control management in the State of Wisconsin. Assistance is provided with the availability of Acquisition and Development grants to purchase property or vacant land, structure removal, construction or other development costs and with Local Assistance Grants for providing administrative support activities.

8.3.11 Municipal Water Safety Patrols State Assistance

(s. 30.79, Wis. Stats., and s. NR 50.13, Wis. Adm. Code.)

Municipalities, tribes, inland lake protection and rehabilitation districts, and sanitary districts are eligible to receive funds for the cost of operating a Boating Law Enforcement program, and for providing professional enforcement of boating laws at the local level. Applicants are eligible to receive up to 75 percent of the net cost for enforcement of ss.30.50 through 30.80, Wis. Stats., and local regulation adopted under s. 30.77, Wis. Stats.

Program priorities include:

Providing active and productive enforcement of boating laws.

Conducting boating education programs.

Providing search and rescue for live persons.

- Eligible projects include:
  - Reimbursement for salaries, supplies and equipment. (Capital items valued at more than $1,000 will be reimbursed at the rate of 20 percent per year over 5 years).

An applicant must submit an "Intent to Patrol" form to WDNR prior to March 1 of each year. In order to receive reimbursement of expenses, grantees must maintain daily and monthly records and submit an annual claim to the WDNR before January 31 for expenses incurred in the previous calendar year.

8.4 Special Taxing/Assessment Districts

Income from a special taxing district or special assessment district is generally dedicated to that district. That is, the area that is designated as "special," for whatever reason, would pay an additional tax or have an increased assessment. The funds from the additional tax or assessment are returned to that area. For example, if stormwater management facilities are constructed to benefit a particular drainage basin within Amery, then that area could be designated a special taxing district and an additional tax levy could be assigned to the property within the area. The approach requires additional City ordinances and administration.

8.5 Fees/Licenses/Permits

Funding from this source is generally limited to the cost of permit review and the inspection of construction. Other revenue sources must be utilized to finance other aspects of the stormwater management program such as administration, operation and maintenance, and capital improvements.

8.6 Penalties and Fines

Similar to permit fees, penalties and fines are limited in scope. Such income can be placed in the General Fund; however, it may be more reasonable to use the fines to correct the violation or subsequent violations. This type of income could be used to help subsidize a comprehensive stormwater management program but would not support the entire program.

8.7 Bonds

General obligation, revenue, or special assessment bonds are normally used by governments to pay for large capital improvement programs. Repayment of a bond is normally through the General Fund (i.e., property tax income); however, special assessment district income, as well as utility revenues, can be used to pay the debt service. Bonds would allow large-scale capital improvement programs to be initiated when the facilities are needed rather than waiting until the funds are accumulated.

8.8 Pay-As-You-Go Sinking Funds

As an adjunct to revenue bond financing, this type of stormwater funding is most common. Essentially, a separate account is formed to receive revenues from numerous sources such as property taxes or stormwater utility income. The fund accumulates revenues until sufficient money is available for an identified project. Then the total project amount is removed from the fund and the fund "sinks" in size and the growth stage starts over.

8.9 Stormwater Utility

Using revenue from a user charge system to fund stormwater management programs has become a widely accepted utility like a wastewater or water utility. The stormwater utility is user-oriented, with costs allocated according to the level of services received. The objective of the stormwater utility is to develop a procedure which equitably allocates the cost of stormwater management to landowners to whom these services are provided. Another benefit of the utility is that properties which are designated tax exempt from property taxes (schools and churches for example) can be included in the fee structure and assessment for a stormwater utility. Payment for stormwater management with user fees may still be considered unusual by the general public.

Fees are assessed based on the user's relative contribution to stormwater runoff, or the potential for runoff. The greater the runoff and/or potential for runoff from a parcel, the greater the contribution to the stormwater problem, and therefore the higher the associated fee. Thus, each parcel of land within a municipality is assessed a fee based on its runoff contribution.

It is generally accepted to include the fee with water and sewer bills. It could be included with the tax bill. However, the stormwater fee is not tax deductible like property taxes are for single family residences.

8.10 Recommended Options

The options above are a broad description of the sources that are available. It is recommended that as many of these sources as possible are used. The report completed for Amery as part of this plan further lays out the alternatives and recommendations for Amery. This secondary document is called "Alternative Financing Approaches to Financing Amery's Stormwater Management Plan."

9.0 Implementation

9.1 Structural Practice Implementation

A number of municipal practices have been discussed and should be implemented as soon as possible. Cost estimates are included with the practices. These are based on the information currently available and should be considered very preliminary estimates. These are as follows:

1. Stormwater Lift Station and Bioinfiltration Device at Flag Pole Park – Subwatershed B11

   Funding: Lake Protection Grant

   Preliminary Estimated Construction Cost: $90,000; Estimated Annual Maintenance Costs: $4,000

   The following needs to be complete as part of project:

   a. Obtain Council Approval to proceed to design phase.

   b. Obtain practice design.

   c. Bid construction of practice.

   d. City to oversee construction as in-kind services.

   e. Lift station start up.

   f. Public Works Department to operate, monitor and maintain system.

2. Inlet Protection - Subwatershed B1

   Funding: Lake Protection Grant (potentially)

   Preliminary Estimated Installation Cost: $3,000; Estimated Annual Maintenance Costs: $1,700

   a. The following needs to be complete as part of project:

   b. Obtain Council Approval to proceed with project.

   c. Obtain bids from suppliers/manufacturers and hold meeting for product demonstration.

   d. Director of Public Works to pick system.

   e. Purchase inlet protection system.

   f. Public Works Department to install, monitor and maintain system.

3. Porous Concrete – Subwatershed B12

   Funding: Lake Protection Grant

   Preliminary Estimated Construction Cost: $23,000; Estimated Annual Maintenance Costs: $600

The following needs to be complete as part of project:

a. Obtain soil tests to verify groundwater elevations and assess base material requirements.

b. Obtain Council Approval to proceed with project.

c. City to oversee construction and complete construction of base for in-kind services.

d. Public Works Department to monitor and maintain system.

4. Rain Gardens should be considered and are recommended at all of the municipal buildings. Municipal buildings with potential locations for rain gardens are as follows:

- City Hall
- Senior Center (Boulevard)
- City Shop
- Wastewater Treatment Plant

Due to limited pervious surfaces it may be necessary to create smaller rain garden than what would typically be completed if more space was available but it is critical for Amery to lead by example.

Funding: Lake Protection Grant

Preliminary Estimated Construction Cost: $4,000-6,000/each; Estimated Annual Maintenance Costs: $600

a. Obtain soil tests to verify groundwater elevations and assess base material requirements.

b. Obtain Council Approval to proceed with project.

c. Obtain design.

d. Install practice.

e. Public Works Department to monitor and maintain system.

5. Further consideration should be given to the installation of silt curtain within the lake. There are some potential safety concerns as well as aesthetic concerns that should be considered further. If it is decided that this practice should be installed it is recommended that it is placed at the outlet of subwatershed B12. First, a plan needs to be developed that should include planned location, type of silt curtain, anchoring system, and operation and maintenance schedule. This should then be sent to WDNR for review. While review of the plan is occurring, bids for the curtain should be obtained. Once approval is received from WDNR, follow their recommendations and the plan that was developed for installation, removal, operation and maintenance.

Funding: Lake Protection Grant

Preliminary Estimated Curtain and Installation Cost: $4,000; Estimated Annual Maintenance Costs: $1,200

The following practices should plan to be installed in approximately one to two years after the initial municipal practice installation. WDNR TRM, UNPS, and/or SW grant monies may be available for these projects. They are as follows:

1. Stormwater Lift Station and Bio-cell Device and/or Stormwater Basin at Soldiers Field – Subwatershed C3

   Funding: DNR Grant/Stormwater Utility (Possible Options)

   Preliminary Estimated Construction Cost: $120,000-150,000; Estimated Annual Maintenance Costs: $2,000-5,000

   The following needs to be complete as part of project:

   a. Obtain Council Approval to proceed to design phase.

   b. Obtain practice design.

   c. Bid construction of practice.

   d. City to oversee construction as in-kind services.

   e. Lift station start up (if applicable).

   f. Public Works Department to operate, monitor and maintain system.

2. Infiltration Devices along South Harrison Avenue south of West South Street– Subwatershed C3

   Funding: DNR Grant/Stormwater Utility (Possible Options)

   Preliminary Estimated Construction Cost: $120,000-150,000; Estimated Annual Maintenance Costs: $2,000-5,000

   The following needs to be complete as part of project:

   a. Obtain Council Approval to proceed to design phase.

   b. Obtain practice design.

   c. Bid construction of practice.

   d. City to oversee construction as in-kind services.

   e. Lift station start up (if applicable).

   f. Public Works Department to operate, monitor and maintain system.

3. Inlet Protection - Subwatershed B2 – Potential other subwatersheds for inlet protection installation –B11 (B10, B12, B13, and C136 are possible locations but would be less effective as the predominate soil type is silt. C1, C3, and C5 are very marginal sites for inlet protection as the predominate soils types are silt and clay. W89, W98, W129, and W140 are in the Apple River Basin and tend to be predominately sand or sand and silt.)

   Funding: DNR Grant/Stormwater Utility (Possible Options)

   Preliminary Estimated Installation Cost: $3,000-4,000/subwatershed; Estimated Annual Maintenance Costs: $1,700-2,300/subwatershed

   The following needs to be complete as part of project:

   a. Obtain Council Approval to proceed with project.

   b. Purchase inlet protection system.

   c. Public Works Department to install, monitor and maintain system.

4. Porous Concrete in low volume streets is an option specifically for B1, B2 and B11. It is potentially not very cost effective at many other locations for street use due to soil limitations. The effectiveness and level of maintenance needed for the alley in B12 will assist the future decision process on proceeding with additional projects.

   Funding: DNR Grant/Stormwater Utility (Possible Options)

   Preliminary Estimated Installation Cost: $15.00/sq. ft.; Estimated Annual Maintenance Costs: 8-16 man hours per site

5. Increased street sweeping specifically of large parking lots. This effort should begin with the school parking lots and discussion should be started with local businesses for contracted parking lot sweeping.

   Funding: Stormwater Utility/General Fund (Possible Options)

   Estimated Annual Maintenance Costs: 4-16 man hours per site

6. Purchase of Vacuum Street Sweeper which will improve the pollutant collection over the current mechanical street sweeper.

   Funding: DNR Grant/Stormwater Utility (Possible Options)

   Estimated Purchase Price: $300,000

9.2 Non-Structural Practice Implementation

A number of municipal good housekeeping practices can be implemented to minimize the potential for the City to affect water quality.

1. Create and Implement Pollution Prevention Program. The program is specific to the operation of the City to minimize potential pollution in its daily operations.

Funding: DNR Grant/Stormwater Utility (Possible Options)

Estimated Program Development Costs: $5,000; Estimated Annual Costs: $1,000 – 3,000

The following is part of the program and is typically already occurring with in Amery. It is recommend that a more formal approach is taken to educate and remind City staff of their role in protection Amery's water resources.

a. Vehicle maintenance to inspect for leaks, timely procedure for fixing leaking vehicles and protocol to clean up after leaking vehicles.

b. Minimize salt and sand usage where possible, but not at the risk of public safety. Make routine logs of salt and sand usage.

c. Assess mowing operations. Grass clipping should not be removed from sites. Minimize mowing operations close to the Lakes and River.

d. Develop protocol to address spills of any type that could potentially enter storm sewers or the Lakes or River.

e. Review vehicle washing practices.

2. Illicit Discharge Identification and Response

Funding: DNR Grant/Stormwater Utility (Possible Options)

Estimated Program Development Costs: $5,000; Estimated Annual Costs: $1,000 – 3,000

a. Staff needs to understand what an illicit discharge is and what they should do to respond to the discharge.

3. Work with Polk County and host Clean Sweep events in Amery. This will reduce the potential for chemical to be disposed of by other means.

Funding: Grant/Stormwater Utility (Possible Options)

Estimated Annual Costs: $1,200

4. The City should revisit street sweeping schedule and increase sweeping as possible. Prioritize increased sweeping schedules for Pike Lake Basin first, North Twin Lake Basin second and South Twin Basin third, but this should not done to the level that the current sweeping of the rest of the City is reduced.

Funding: Stormwater Utility/General Fund (Possible Options)

Estimated Annual Costs: $2,000

5. Create a permanent Stormwater Committee like the current committee but one that will continue beyond the grant funded projects. The Stormwater Committee should be like the Planning Commission. It would oversee permitting under the erosion control and stormwater management ordinance, project implementation, and work to protect Amery's water resources.

   Funding: Stormwater Utility/General Fund (Possible Options)

   Estimated Annual Costs: $1,000 – 3,000 (These are not new costs but staff time potentially taken from other work. This committee would be made up of volunteers as well as Amery staff members.)

6. Cost share individual stormwater practices. (Currently underway.)

   Funding: Lake Protection Grant/Stormwater Utility

   Estimated Costs: Unknown; Could solely depend on what monies Amery would be will to dedicate to cost sharing of individual practices.

7. Creation of Shoreland Protection Ordinance. (Currently underway.)

   Ordinance Creation: $5,000

A number of non-structural practices can be implemented to improve water quality.

1. The Amery Golf Course should implement a nutrient management plan. The plan would benefit the water resources and has the potential to save the course money. The Golf Course should be encouraged to create there own Pollution Prevention Program as well.

2. Apply for Urban Wildlife Damage Abatement and Control Grant to minimize the number of geese in Amery. The Golf Course may be interested in partnering with the City to work cooperatively to control the geese population.

   Funding: DNR Grant/Stormwater Utility (Possible Options)

   Estimated Annual Cost: $3,500

9.3 Ordinance Implementation

The revised erosion control and stormwater management ordinance has been adopted. The ordinance went before the Council in Fall of 2008 and has been adopted. The main differences between the pervious ordinance and the newly adopted ordinance are the adopted ordinance is consistent with the County ordinance and has a procedure for administration and enforcement.

Minor modification need to be made to existing ordinances such as the subdivision ordinance. The intent of these minor revisions, is to direct any reference within any of the other ordinances to erosion control or stormwater management to the newly adopted ordinance.

Once this is complete, revisions to the phosphorus ban ordinance should be considered and a Shoreland Ordinance should begin to be developed.

9.4 Funding Implementation

It is highly recommended that Amery begins the process to have a dedicated and fair system to finance stormwater management and to protect Amery's Lakes and River. The dedicated fund is a means to protect water quality.

A stormwater utility is highly recommended to finance the operation and maintenance of the entire stormwater management system.

The cost of establishing a utility can be reimbursed to the City with the fees collected initially once the utility is established. This could be through a direct reimbursement of the general fund or the fees incurred may be able to be deferred until the utility has the funds available to pay the fees.

It is recommended that the City publish a Request for Services to perform the work necessary to develop the utility.

9.5 Implementation Schedule

Table 14, contains the implementation timeline. The schedule is flexible and is meant to be a guide.

9.6 Cost Share Program

As part of the grants obtained to complete the planning work, monies were obtained to help landowners install water quality practices on their properties. Cost share agreements between the City of Amery and each landowner are set at a 70% cost share rate. The City will pay 70% of project costs from a Wisconsin Department of Natural Resources Lake Protection Grant. Polk County LWRD staff and qualified consultants will design practices according to accepted standards and inspect completed practices prior to payment. **The Planning grant extends through June 30, 2009, and the Lake Protection grant goes through June 30, 2010.**

If a dedicated fund can be established by Amery for stormwater management, Amery should consider continuing the cost share program. Due to the site limitations and the level of development within the City, landowner involvement and practice implementation is necessary to protect the water resources of Amery.

10.0 Conclusion

The implementation of practices both structural and non-structural will reduce the pollutants entering the water resources of Amery. The elimination of some of the runoff to these resources is essential as the pollutants need the stormwater to transport them to the water resources.

Amery has considerable challenges for implementing practices. A majority of Amery has soils with moderate to low infiltration ability. Much of the North Twin and South Twin Basins, as well as other areas in Amery, are very close to groundwater. A significant amount of Amery's storm sewer system discharges directly into water resources. There is also very little land that is held by Amery where practices can be placed. These limitations can be overcome and there are municipal practices for Amery to work on. One key component to protecting Amery's water resources is the landowners' involvement and practice implementation by private residents to treat the water before it enters the pipe. Continuing incentives for practices is critical.

List of Tables

Table 1.
Current Land Use for Major Drainage Basins.

Drainage Basin	Land Use (Acres) Commercial	Residential	Institutional	Industrial	Open Space
Pike Lake Basin	16	166	>1	4	212
North Twin Basin	5	96	1	0	76
South Twin Basin	5	69	4	0	46
Apple River Basin	126	471	38	21	475
Internally Drained Basin	77	109	104	80	565

Table 2.
Estimated Public Works Stormwater Management Costs.

	Annual Estimated Costs
Total Budget	$ 50,000
Street sweeper costs	$ 15,000
Storm sewer, operation and maintenance, and other miscellaneous stormwater needs	$ 35,000

Table 3.
Pike Lake Basin Water Quality – Total Suspended Solids and Phosphorus.

Subwatershed	Subwatershed Area (Acres)	Total Suspended Solids Annual Discharge (Pounds)	Total Suspended Solids Annual Loading (Pounds Per Acre)	Total Phosphorus Annual Discharge (Pounds)	Total Phosphorus Annual Loading (Pounds Per Acre)
A2	42.5	6742.6	158.7	19.7	0.5
A3	27.6	5516.2	199.9	16.3	0.6
A5	13.3	3931.2	295.6	9.6	0.7
A6	17.4	3804.6	219.0	9.6	0.6
A9	21.1	2656.6	126.1	7.0	0.3
A11	24.2	5748.3	237.2	13.4	0.6
A12	22.7	4244.0	187.2	12.8	0.6
A13	27.7	3853.6	139.2	11.9	0.4
W2	13.5	1427.9	106.2	3.5	0.3
W12	0.9	110.4	121.3	0.3	0.3
W13	0.5	58.1	121.1	0.2	0.3
W14	0.4	47.3	121.2	0.1	0.3
W30	24.9	3779.3	152.0	8.1	0.3
TOTAL	236.5	41920.1		112.7	

* Internally drained subwatersheds not included.

Table 4.
North Twin Lake Basin Water Quality– Total Suspended Solids and Phosphorus.

Subwatershed	Subwatershed Area (Acres)	Total Suspended Solids Annual Discharge (Pounds)	Total Suspended Solids Annual Loading (Pounds Per Acre)	Total Phosphorus Annual Discharge (Pounds)	Total Phosphorus Annual Loading (Pounds Per Acre)
B1	35.9	9811.3	273.2	24.1	0.7
B2	11.8	2644.8	224.9	6.2	0.5
B3	7.9	1192.3	151.5	3.1	0.4
B4	7.1	774.4	109.2	2.0	0.3
B5	28.0	3874.2	138.2	10.6	0.4
B8	7.6	1314.4	174.1	3.9	0.5
B9	18.5	3185.5	172.4	8.7	0.5
B10	6.5	1537.9	235.5	4.1	0.6
B11	9.8	3310.9	339.2	6.7	0.7
B12	3.2	1583.1	500.9	2.7	0.9
B13	9.3	1772.3	189.9	4.8	0.5
TOTAL	145.5	31001.1		77.0	

* Internally drained subwatersheds not included.

Table 5.
South Twin Lake Basin Water Quality– Total Suspended Solids and Phosphorus.

Subwatershed	Subwatershed Area (Acres)	Total Suspended Solids Annual Discharge (Pounds)	Total Suspended Solids Annual Loading (Pounds Per Acre)	Total Phosphorus Annual Discharge (Pounds)	Total Phosphorus Annual Loading (Pounds Per Acre)
C1	14.4	4010.4	277.7	10.7	0.7
C3	43.7	13872.5	317.6	34.4	0.8
C5	14.3	2486.8	173.9	7.3	0.5
W136	2.2	575.5	260.4	1.6	0.7
TOTAL	74.6	20945.1		54.0	

* Internally drained subwatersheds not included.

Table 6.
Apple River Basin Water Quality– Total Suspended Solids and Phosphorus.

Subwatershed	Subwatershed Area (Acres)	Total Suspended Solids Annual Discharge (Pounds)	Total Suspended Solids Annual Loading (Pounds Per Acre)	Total Phosphorus Annual Discharge (Pounds)	Total Phosphorus Annual Loading (Pounds Per Acre)
W32	65.3	9769.7	149.7	26.8	0.4
W33	11.8	2295.9	194.2	5.8	0.5
W34	13.1	1704.7	129.9	5.7	0.4
W35	5.2	683.5	131.4	2.3	0.4
W37	4.2	548.9	129.8	1.8	0.4
W38	9.9	2811.8	284.6	6.9	0.7
W39	12.7	1980.5	155.5	6.1	0.5
W41	6.0	1800.3	301.0	4.0	0.7
W42	5.1	1201.3	235.1	3.5	0.7
W43	7.3	1193.5	163.7	4.1	0.6
W44	7.5	1538.9	203.8	4.6	0.6
W45	7.4	1623.9	220.3	4.9	0.7
W46	14.0	3147.0	224.6	9.6	0.7
W47	5.7	1532.6	270.3	4.2	0.7
W48	1.6	464.8	288.6	1.2	0.8
W49	8.3	3563.8	428.3	7.0	0.8
W50	18.2	7933.8	436.6	13.2	0.7
W60	2.7	1196.5	441.5	1.9	0.7
W61	9.6	2734.0	284.8	7.1	0.7
W62	8.6	2224.6	257.2	5.9	0.7
W63	4.3	765.8	176.4	2.3	0.5
W64	10.8	4947.1	456.0	9.6	0.9
W73	34.7	5348.6	154.1	12.1	0.3
W74	4.6	952.8	208.0	2.9	0.6
W76	49.1	10762.0	219.2	22.8	0.5
W79	34.7	5466.0	157.3	12.0	0.3
W80	64.2	23517.6	366.4	38.4	0.6
W81	9.7	5470.2	562.8	9.2	0.9
W83	11.8	1693.7	144.0	4.0	0.3
W84	16.4	6357.2	388.4	9.1	0.6
W85	5.6	3156.7	560.7	5.3	0.9
W86	18.7	1395.1	74.8	3.3	0.2
W87	6.2	840.0	135.7	2.1	0.3
W88	20.3	3610.1	177.6	8.6	0.4
W89	59.7	23494.4	393.9	43.4	0.7
W91	27.7	6648.2	239.9	15.7	0.6
W92	25.7	5917.2	230.4	13.9	0.5
W93	3.4	368.9	109.1	1.0	0.3
W94	30.4	3680.5	120.9	9.7	0.3
W95	9.0	622.7	69.5	1.5	0.2

Table 6. Continued
Apple River Basin Water Quality– Total Suspended Solids and Phosphorus.

Subwatershed	Subwatershed Area (Acres)	Total Suspended Solids Annual Discharge (Pounds)	Total Suspended Solids Annual Loading (Pounds Per Acre)	Total Phosphorus Annual Discharge (Pounds)	Total Phosphorus Annual Loading (Pounds Per Acre)
W96	12.1	4378.4	362.2	9.6	0.8
W97	8.0	2061.9	258.7	5.3	0.7
W98	9.6	1987.9	206.2	5.0	0.5
W99	3.7	761.8	207.0	2.2	0.6
W100	2.6	541.4	204.3	1.5	0.6
W101	25.0	7407.8	296.7	17.6	0.7
W107	24.7	7101.3	288.1	17.7	0.7
W108	8.9	2501.0	279.8	6.7	0.7
W109	6.4	1587.0	247.6	4.5	0.7
W110	38.2	5038.1	132.1	13.9	0.4
W111	3.5	745.1	212.3	2.3	0.6
W112	35.6	4172.0	117.0	10.9	0.3
W113	8.9	1750.3	195.6	5.1	0.6
W114	44.3	5319.6	120.2	14.3	0.3
W115	14.8	1934.5	130.8	5.0	0.3
W116	6.4	719.0	112.3	1.9	0.3
W117	4.6	408.6	89.2	1.0	0.2
W118	28.6	2612.6	91.4	6.7	0.2
W119	8.1	1243.6	153.7	3.6	0.4
W120	18.7	1499.7	80.2	3.6	0.2
W121	7.8	853.0	109.1	2.2	0.3
W122	9.7	5798.2	595.9	7.2	0.7
W124	0.7	171.6	248.5	0.5	0.7
W125	10.9	2597.9	237.9	7.5	0.7
W126	16.0	9059.5	565.5	14.5	0.9
W129	17.7	8431.5	477.4	12.2	0.7
W134	7.0	2567.0	368.8	6.1	0.9
W135	20.8	6934.2	332.7	15.3	0.7
W137	11.1	3359.2	302.9	8.1	0.7
W138	15.4	4273.7	278.1	10.9	0.7
W139	18.3	7422.0	406.7	14.9	0.8
W140	2.5	587.8	232.3	1.3	0.5
TOTAL	1121.8	270792.0		592.6	

* Internally drained subwatersheds not included.

Table 7.
Pike Lake Basin Water Quality – Total Suspended Solids and Phosphorus with Rankings.

Subwatershed	Subwatershed Area (Acres)	Percentage of Overall Size of Watershed	Rank for Overall Watershed Size	Total Suspended Solids Annual Discharge (Pounds)	Percentage of Contributing TSS from Watershed	Rank for Total TSS	Total Suspended Solids Annual Loading (Pounds Per Acre)	Rank for TSS Annual Per Acre	Total Phosphorus Annual Discharge (Pounds)	Percentage of Contributing Phosphorus from Watershed	Rank for Total P	Total Phosphorus Annual Loading (Pounds Per Acre)	Rank for P Annual Per Acre
A2	42	11	2	6743	9	2	159	10	20	11	2	0.5	9
A3	28	7	6	5516	8	6	200	6	16	9	4	0.6	3
A5	13	3	15	3931	5	8	296	2	10	5	11	0.7	1
A6	17	4	13	3805	5	11	219	5	10	5	10	0.6	5
A9	21	5	10	2657	4	13	126	13	7	4	13	0.3	12
A11	24	6	8	5748	8	5	237	3	13	7	5	0.6	6
A12	23	6	9	4244	6	7	187	7	13	7	6	0.6	4
A13	28	7	5	3854	5	10	139	12	12	7	8	0.4	11
W2	13	3	14	1428	2	16	106	19	3	2	16	0.3	19
W12	1	0	17	110	0	17	121	14	0	0	17	0.3	14
W13	0	0	18	58	0	18	121	16	0	0	18	0.3	16
W14	0	0	19	47	0	19	121	15	0	0	19	0.3	15
W30	25	6	7	3779	5	12	152	11	8	4	12	0.3	13
TOTAL	237			41920					113				

* Internally drained subwatersheds not included.

Table 8.
North Twin Lake Basin Water Quality – Total Suspended Solids and Phosphorus with Rankings.

Subwatershed	Subwatershed Area (Acres)	Percentage of Overall Size of Watershed	Rank for Overall Watershed Size	Total Suspended Solids Annual Discharge (Pounds)	Percentage of Contributing TSS from Watershed	Rank for Total TSS	Total Suspended Solids Annual Loading (Pounds Per Acre)	Rank for TSS Annual Per Acre	Total Phosphorus Annual Discharge (Pounds)	Percentage of Contributing Phosphorus from Watershed	Rank for Total P	Total Phosphorus Annual Loading (Pounds Per Acre)	Rank for P Annual Per Acre
B1	36	20	1	9811	27	1	273	3	24	26	1	0.7	3
B2	12	7	6	2645	7	6	225	5	6	7	7	0.5	6
B3	8	4	9	1192	3	12	152	10	3	3	11	0.4	11
B4	7	4	11	774	2	13	109	13	2	2	13	0.3	13
B5	28	16	2	3874	11	2	138	12	11	11	2	0.4	12
B8	8	4	10	1314	4	11	174	8	4	4	10	0.5	7
B9	18	10	3	3186	9	5	172	9	9	9	4	0.5	9
B10	7	4	12	1538	4	10	236	4	4	4	9	0.6	4
B11	10	6	7	3311	9	4	339	2	7	7	5	0.7	2
B12	3	2	13	1583	4	9	501	1	3	3	12	0.9	1
B13	9	5	8	1772	5	8	190	7	5	5	8	0.5	8
TOTAL	145			31001					77				

* Internally drained subwatersheds not included.

Table 9.
South Twin Lake Basin Water Quality – Total Suspended Solids and Phosphorus with Rankings.

Subwatershed	Subwatershed Area (Acres)	Percentage of Overall Size of Watershed	Rank for Overall Watershed Size	Total Suspended Solids Annual Discharge (Pounds)	Percentage of Contributing TSS from Watershed	Rank for Total TSS	Total Suspended Solids Annual Loading (Pounds Per Acre)	Rank for TSS Annual Per Acre	Total Phosphorus Annual Discharge (Pounds)	Percentage of Contributing Phosphorus from Watershed	Rank for Total P	Total Phosphorus Annual Loading (Pounds Per Acre)	Rank for P Annual Per Acre
C1	14	12	3	4010	13	2	278	3	11	13	3	0.7	2
C3	44	35	1	13872	44	1	318	2	34	41	1	0.8	1
C5	14	12	4	2487	8	5	174	8	7	9	5	0.5	8
W136	2	2	8	575	2	8	260	4	2	2	8	0.7	4
TOTAL	75			20945					54				

* Internally drained subwatersheds not included.

Table 10.
Apple River Basin Water Quality – Total Suspended Solids and Phosphorus with Rankings.

Subwatershed	Subwatershed Area (Acres)	Percentage of Overall Size of Watershed	Rank for Overall Watershed Size	Total Suspended Solids Annual Discharge (Pounds)	Percentage of Contributing TSS from Watershed	Rank for Total TSS	Total Suspended Solids Annual Loading (Pounds Per Acre)	Rank for TSS Annual Per Acre	Total Phosphorus Annual Discharge (Pounds)	Percentage of Contributing Phosphorus from Watershed	Rank for Total P	Total Phosphorus Annual Loading (Pounds Per Acre)	Rank for P Annual Per Acre
W32	65	6	1	9770	4	4	150	56	27	5	3	0.4	57
W33	12	1	31	2296	1	37	194	47	6	1	38	0.5	49
W34	13	1	28	1705	1	45	130	62	6	1	39	0.4	54
W35	5	1	59	683	0	65	131	60	2	0	58	0.4	52
W37	4	0	65	549	0	69	130	63	2	0	67	0.4	55
W38	10	1	36	2812	1	31	285	24	7	1	32	0.7	25
W39	13	1	29	1980	1	41	155	52	6	1	35	0.5	50
W41	6	1	56	1800	1	43	301	19	4	1	50	0.7	31
W42	5	1	60	1201	0	55	235	34	3	1	55	0.7	29
W43	7	1	51	1193	0	57	164	50	4	1	49	0.6	41
W44	8	1	49	1539	1	50	204	45	5	1	46	0.6	36
W45	7	1	50	1624	1	48	220	38	5	1	45	0.7	33
W46	14	1	27	3147	1	30	225	37	10	2	22	0.7	28
W47	6	1	57	1533	1	51	270	27	4	1	48	0.7	14
W48	2	0	73	465	0	71	289	21	1	0	71	0.8	10
W49	8	1	45	3564	1	27	428	9	7	1	31	0.8	6
W50	18	2	21	7934	3	7	437	8	13	2	14	0.7	18
W60	3	0	70	1197	0	56	442	7	2	0	65	0.7	19
W61	10	1	40	2734	1	32	285	23	7	1	30	0.7	12
W62	9	1	44	2225	1	38	257	29	6	1	37	0.7	30
W63	4	0	64	766	0	61	176	49	2	0	61	0.5	46
W64	11	1	35	4947	2	21	456	6	10	2	21	0.9	4
W73	35	3	9	5349	2	18	154	54	12	2	16	0.3	59
W74	5	0	63	953	0	58	208	41	3	1	57	0.6	35
W76	49	4	4	10762	4	3	219	39	23	4	4	0.5	51
W79	35	3	8	5466	2	17	157	51	12	2	17	0.3	61
W80	64	6	2	23518	9	1	366	14	38	6	2	0.6	38
W81	10	1	38	5470	2	16	563	3	9	2	24	0.9	2
W83	12	1	32	1694	1	46	144	57	4	1	52	0.3	63
W84	16	1	23	6357	2	13	388	12	9	2	25	0.6	43
W85	6	1	58	3157	1	29	561	4	5	1	40	0.9	1
W86	19	2	19	1395	1	53	75	73	3	1	56	0.2	73
W87	6	1	55	840	0	60	136	58	2	0	64	0.3	60
W88	20	2	17	3610	1	26	178	48	9	1	26	0.4	56

Table 10. Continued.
Apple River Basin Water Quality – Total Suspended Solids and Phosphorus with Rankings.

Subwatershed	Subwatershed Area (Acres)	Percentage of Overall Size of Watershed	Rank for Overall Watershed Size	Total Suspended Solids Annual Discharge (Pounds)	Percentage of Contributing TSS from Watershed	Rank for Total TSS	Total Suspended Solids Annual Loading (Pounds Per Acre)	Rank for TSS Annual Per Acre	Total Phosphorus Annual Discharge (Pounds)	Percentage of Contributing Phosphorus from Watershed	Rank for Total P	Total Phosphorus Annual Loading (Pounds Per Acre)	Rank for P Annual Per Acre
W89	60	5	3	23494	9	2	394	11	43	7	1	0.7	17
W91	28	2	12	6648	2	12	240	32	16	3	7	0.6	42
W92	26	2	13	5917	2	14	230	36	14	2	12	0.5	45
W93	3	0	69	369	0	73	109	68	1	0	73	0.3	68
W94	30	3	10	3680	1	25	121	64	10	2	20	0.3	65
W95	9	1	41	623	0	67	70	74	1	0	69	0.2	74
W96	12	1	30	4378	2	22	362	15	10	2	23	0.8	8
W97	8	1	47	2062	1	39	259	28	5	1	41	0.7	32
W98	10	1	39	1988	1	40	206	43	5	1	44	0.5	47
W99	4	0	67	762	0	62	207	42	2	0	62	0.6	37
W100	3	0	71	541	0	70	204	44	2	0	68	0.6	39
W101	25	2	14	7408	3	9	297	20	18	3	6	0.7	23
W107	25	2	15	7101	3	10	288	22	18	3	5	0.7	20
W108	9	1	43	2501	1	36	280	25	7	1	33	0.7	11
W109	6	1	53	1587	1	49	248	31	5	1	47	0.7	22
W110	38	3	6	5038	2	20	132	59	14	2	13	0.4	58
W111	4	0	68	745	0	63	212	40	2	0	60	0.6	34
W112	36	3	7	4172	2	24	117	66	11	2	19	0.3	66
W113	9	1	42	1750	1	44	196	46	5	1	42	0.6	40
W114	44	4	5	5320	2	19	120	65	14	2	11	0.3	64
W115	15	1	26	1935	1	42	131	61	5	1	43	0.3	62
W116	6	1	54	719	0	64	112	67	2	0	66	0.3	67
W117	5	0	62	409	0	72	89	71	1	0	72	0.2	71
W118	29	3	11	2613	1	33	91	70	7	1	34	0.2	70
W119	8	1	46	1244	1	54	154	55	4	1	54	0.4	53
W120	19	2	18	1500	1	52	80	72	4	1	53	0.2	72
W121	8	1	48	853	0	59	109	69	2	0	63	0.3	69
W122	10	1	37	5798	2	15	596	1	7	1	29	0.7	13
W124	1	0	74	172	0	74	248	30	0	0	74	0.7	24
W125	11	1	34	2598	1	34	238	33	8	1	28	0.7	27
W126	16	1	24	9059	3	5	566	2	14	2	10	0.9	3
W129	18	2	22	8431	3	6	477	5	12	2	15	0.7	26
W134	7	1	52	2567	1	35	369	13	6	1	36	0.9	5

Table 10. Continued.
Apple River Basin Water Quality – Total Suspended Solids and Phosphorus with Rankings.

Subwatershed	Subwatershed Area (Acres)	Percentage of Overall Size of Watershed	Rank for Overall Watershed Size	Total Suspended Solids Annual Discharge (Pounds)	Percentage of Contributing TSS from Watershed	Rank for Total TSS	Total Suspended Solids Annual Loading (Pounds Per Acre)	Rank for TSS Annual Per Acre	Total Phosphorus Annual Discharge (Pounds)	Percentage of Contributing Phosphorus from Watershed	Rank for Total P	Total Phosphorus Annual Loading (Pounds Per Acre)	Rank for P Annual Per Acre
W135	21	2	16	6934	3	11	333	16	15	3	8	0.7	15
W137	11	1	33	3359	1	28	303	18	8	1	27	0.7	16
W138	15	1	25	4274	2	23	278	26	11	2	18	0.7	21
W139	18	2	20	7422	3	8	407	10	15	3	9	0.8	7
W140	3	0	72	588	0	68	232	35	1	0	70	0.5	48
TOTAL	1122			270792					593				

* Internally drained subwatersheds not included.

Table 11.
Summary of Total Suspended Solids and Total Phosphorus – Existing and Proposed Conditions

	Existing Conditions		Existing Conditions with Existing Controls*		Proposed Conditions with Existing and Proposed Controls**		
Basins	Average Total Phosphorus Annual Discharge (Pounds)	Average Total Suspended Solids Annual Discharge (Pounds)	Average Total Phosphorus Annual Discharge (Pounds)	Average Total Suspended Solids Annual Loading (Pounds)	Average Total Phosphorus Annual Discharge (Pounds)	Average Total Suspended Solids Annual Loading (Pounds)	Proposed Percent Reduction of Pounds of Phosphorus Annually
Pike Lake Basin	112.7	41920.1	112.1	41584.7	90.2	33536.8	20%
North Twin Basin	77	31001.1	74.7	29761.1	46	15290.9	38%
South Twin Basin	54	20945.1	52.4	20107.3	15.7	5658.1	70%
Apple River Basin	592.6	270792.1	557	259460.4	452.4	204886.4	19%
*Existing controls include street sweeping and Amery Regional Medical Center							
**Includes Proposed Rain Gardens, Soldier's Field and Flag Pole Park - Bioinfiltration, Harriman Avenue Improvements, and Assumes 20% of Residential Parcels Install On-site Controls such as Buffers or Rain Gardens, etc.							

Table 12.
Subwatershed Considerations and Recommendations

Subwatershed	Predominate Soil Type	Potential Proximity to Groundwater Concerns (Y/N)	Recommended Projects	Priority Ranking (1 being highest priority)	Proposed Installation Timeline (Within the next X years)	Estimated Cost per site	Responsible Parties
CITY WIDE	Variable	N	Increase Street Sweeping	2	5 years	$30,000	Amery
CITY WIDE	Variable	N	Purchase Vacuum Sweeper	2	5 years	$300,000	Amery
PIKE LAKE BASIN	Variable	N/Y	Ordinance Implementation/ Dedicated Funding	1	2 years	$5,000/ $15,000 annually	Amery
PIKE LAKE BASIN	Variable	Y/N	Stormwater Management for New Development	1	2 years	Costs paid by Developer (Project Dependent)	Individuals
PIKE LAKE BASIN	Variable	N	Nutrient Management Plans for Agricultural Lands	1	2 years	Costs paid by Land Owners (Site Dependent)	Individuals
A2	Silt	N	Rain Barrels, Rain Gardens, Infiltration Trench	2	5 years	$200-$10,000 (Site Dependent)	Individuals
A3	Silt/Clay	N	Rain Barrels, Rain Gardens	2	5 years	$200-$10,000 (Site Dependent)	Individuals
A5	Silt	N	Rain Barrels, Rain Gardens, Infiltration Trench	2	5 years	$200-$10,000 (Site Dependent)	Individuals
A6	Silt	N	Rain Barrels, Rain Gardens, Infiltration Trench	2	5 years	$200-$10,000 (Site Dependent)	Individuals
A9	Silt	Y	Rain Barrels, Rain Gardens	2	5 years	$200-$10,000 (Site Dependent)	Individuals
A11	Sand/Silt	N	Rain Barrels, Rain Gardens, Infiltration Trench	2	5 years	$200-$10,000 (Site Dependent)	Individuals
A12	Silt	N	Rain Barrels, Rain Gardens, Infiltration Trench	2	5 years	$200-$10,000 (Site Dependent)	Individuals
A13	Variable	Y	Rain Barrels, Rain Gardens	2	5 years	$200-$10,000 (Site Dependent)	Individuals
W2	Sand	Y	Rain Barrels, Rain Gardens	2	5 years	$200-$10,000 (Site Dependent)	Individuals
W12	Clay	Y	Rain Barrels	2	5 years	$200	Individuals
W13	Clay	Y	Rain Barrels	2	5 years	$200	Individuals
W14	Clay	Y	Rain Barrels	2	5 years	$200	Individuals
W30	Variable	Y	Rain Barrels, Rain Gardens	2	5 years	$400-$10,000 (Site Dependent)	Individuals

Table 12. Continued.
Subwatershed Considerations and Recommendations

Subwatershed	Predominate Soil Type	Potential Proximity to Groundwater Concerns (Y/N)	Recommended Projects	Timing (1-3 Ranking of Priority - 1 being highest priority)	Proposed Year of Installation	Estimated Cost per site	Responsible Parties
NORTH TWIN LAKE BASIN	Variable	N/Y	Ordinance Implementation/ Dedicated Funding	1	2 years	$5,000/ $20,000 annually	Amery
B1	Silt/Sand	Y	Inlet Protection	1	2 years	$3,000-$4,000	Amery
B1	Silt/Sand	Y	Rain Barrels, Rain Gardens, Infiltration Trench	1	2 years	$200-$10,000 (Site Dependent)	Individuals
B2	Sand	Y	Inlet Protection	2	5 years	$3,000-$4,000	Amery
B2	Sand	Y	Rain Barrels, Rain Gardens, Infiltration Trench	1	2 years	$200-$10,000 (Site Dependent)	Individuals
B3	Clay	Y	Rain Barrels	2	5 years	$200	Individuals
B4	Silt	Y	Rain Barrels, Rain Gardens, Infiltration Trench	2	5 years	$200-$10,000 (Site Dependent)	Individuals
B5	Clay	Y	Rain Barrels	1	2 years	$200	Individuals
B9	Silt	Y	Rain Barrels, Rain Gardens	1	2 years	$200-$10,000 (Site Dependent)	Individuals
B10	Silt	Y	Porous Concrete	2		$23,000	Amery
B10	Silt	Y	Rain Barrels, Rain Gardens	1	2 years	$200-$10,000 (Site Dependent)	Individuals
B11	Sand/Silt	Y	Stormwater Lift Station and Bioinfiltration	1	2 years	$90,000	Amery
B11	Sand/Silt	Y	Inlet Protection	2	5 years	$3,000-$4,000	Amery
B11	Sand/Silt	Y	Rain Barrels, Rain Gardens, Infiltration Trench	1	2 years	$200-$10,000 (Site Dependent)	Individuals
B12	Silt	Y	Porous Concrete	2	5 years	$30,000	Amery
B12	Silt	Y	Silt Curtain	3		$4,000-$6,000	Amery
B12	Silt	Y	Rain Barrels/Rain Gardens	1	2 years	$200-$10,000 (Site Dependent)	Individuals
B12	Silt	Y	Inlet Protection	2	5 years	$3,000-$4,000	Amery
B13	Silt	Y	Rain Barrels/Rain Gardens	1	2 years	$200-$10,000 (Site Dependent)	Individuals

Table 12. Continued.
Subwatershed Considerations and Recommendations

Subwatershed	Predominate Soil Type	Potential Proximity to Groundwater Concerns (Y/N)	Recommended Projects	Timing (1-3 Ranking of Priority - 1 being highest priority)	Proposed Year of Installation	Estimated Cost per site	Responsible Parties
SOUTH TWIN LAKE BASIN	Variable	Y	Ordinance Implementation/ Dedicated Funding	1	2 years	$5,000/ $20,000 annually	Amery
C1	Silt/Clay	Y	Rain Barrels/Rain Gardens	1	2 years	$200-$10,000 (Site Dependent)	Individuals
C3	Silt/Clay	Y	Stormwater Lift Station and Bioinfiltration/ Stormwater Basin	1	2 years	$120,000 - $150,000	Amery
C3	Silt/Clay	Y	Harriman Infiltration Areas Adjacent to Street or within Street	1	2 years	$120,000- $150,000	Amery
C3	Silt/Clay	Y	Rain Barrels, Rain Gardens, Infiltration Trench	1	2 years	$200-$10,000 (Site Dependent)	Individuals
C5	Silt/Clay	Y	Rain Barrels/Rain Gardens	1	2 years	$200-$10,000 (Site Dependent)	Individuals
W136	Silt	Y	Rain Barrels/Rain Gardens	1	2 years	$200-$10,000 (Site Dependent)	Individuals
APPLE RIVER BASIN	Variable	Y/N	Ordinance Implementation/ Dedicated Funding	1	2 years	$5,000/$20,000 annually	Amery
W32	Silt/Clay	N	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W33	Sand	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W34	Variable	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W35	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W37	Sand/Silt	N	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W38	Silt	N	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W39	Sand/Silt	N	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals

Table 12. Continued.
Subwatershed Considerations and Recommendations

Subwatershed	Predominate Soil Type	Potential Proximity to Groundwater Concerns (Y/N)	Recommended Projects	Timing (1-3 Ranking of Priority - 1 being highest priority)	Proposed Year of Installation	Estimated Cost per site	Responsible Parties
W41	Silt	N	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W42	Silt	N	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W43	Silt	N	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W44	Silt	N	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W45	Silt	N	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W46	Silt/Clay	N	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W47	Silt	N	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W48	Silt	N	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W49	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W50	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W60	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W61	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W62	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W63	Silt/Clay	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W64	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W73	Variable	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W74	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals

Table 12. Continued.
Subwatershed Considerations and Recommendations

Subwatershed	Predominate Soil Type	Potential Proximity to Groundwater Concerns (Y/N)	Recommended Projects	Timing (1-3 Ranking of Priority - 1 being highest priority)	Proposed Year of Installation	Estimated Cost per site	Responsible Parties
W76	Silt/Clay	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W79	Sand/Clay	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W80	Variable	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W81	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W83	Sand/Clay	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W84	Variable	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W85	Sand/Silt	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W86	Sand	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W87	Sand/Clay	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W88	Sand	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W89	Sand/Silt	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W91	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W92	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W93	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W94	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W95	Sand	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals

Table 12. Continued.
Subwatershed Considerations and Recommendations

Subwatershed	Predominate Soil Type	Potential Proximity to Groundwater Concerns (Y/N)	Recommended Projects	Timing (1-3 Ranking of Priority - 1 being highest priority)	Proposed Year of Installation	Estimated Cost per site	Responsible Parties
W96	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W97	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W98	Sand/Silt	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W99	Variable	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W100	Variable	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W101	Variable	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W107	Silt/Clay	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W108	Silt/Clay	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W109	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W110	Variable	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W111	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W112	Sand/Clay	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W113	Sand/Clay	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W114	Variable	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W115	Sand/Silt	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals

Table 12. Continued.
Subwatershed Considerations and Recommendations

Subwatershed	Predominate Soil Type	Potential Proximity to Groundwater Concerns (Y/N)	Recommended Projects	Timing (1-3 Ranking of Priority - 1 being highest priority)	Proposed Year of Installation	Estimated Cost per site	Responsible Parties
W116	Silt/Clay	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W117	Sand	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W118	Variable	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W119	Sand/Silt	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W120	Sand	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W121	Clay	Y	Rain Barrels	3	10 years	$200	Individuals
W122	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W125	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W125	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W126	Silt	Y	Rain Barrels, Rain Gardens	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W129	Sand/Silt	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W134	Silt/Clay	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W135	Variable	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W137	Variable	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W138	Variable	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals

Table 12. Continued.
Subwatershed Considerations and Recommendations

Subwatershed	Predominate Soil Type	Potential Proximity to Groundwater Concerns (Y/N)	Recommended Projects	Timing (1-3 Ranking of Priority - 1 being highest priority)	Proposed Year of Installation	Estimated Cost per site	Responsible Parties
W139	Variable	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
W140	Sand	Y	Rain Barrels, Rain Gardens, Infiltration Trench	3	10 years	$200-$10,000 (Site Dependent)	Individuals
*Internally drained watersheds not included.							

Table 13.
Education Activities Timeline

Item	April 09	May 09	June 09	July 09	Aug 09	Sept 09	Oct 09	Winter 09/10	April 10	May 10	June 10
Demonstration installation											
Rain barrel distribution	■	■	■	■	■	■			■	■	■
Rain gardens			■	■	■	■			■	■	■
Porous pavement	■	■	■								
Rain garden community education			■			■					
General cost sharing	■	■	■	■	■	■			■	■	■
Amery lakes newsletter	■								■		
News releases		■	■	■	■				■	■	■
Demonstration site tours			■			■				■	

Table 14.
Implementation Timeline

<table>
<tr><th rowspan="2">Implementation</th><th colspan="7">2009</th></tr>
<tr><th>April 2009</th><th>May 2009</th><th>June 2009</th><th>July 2009</th><th>Sept. 2009</th><th>Oct. 2009</th><th>Nov. 2009</th></tr>
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<tr><td>Porous pavement</td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Erosion Control/Stormwater Ordinance</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Flagpole Park</td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Inlet Protection</td><td style="background:#00ccff"></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Silt Curtain</td><td style="background:#00ccff"></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Permanent Stormwater Committee</td><td style="background:#00ccff"></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Pollution Prevention Program</td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Stormwater Utility</td><td></td><td></td><td></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td></td><td></td></tr>
<tr><td>Shoreland Ordinance</td><td></td><td></td><td></td><td></td><td></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td></tr>
<tr><td>Illicit Discharge Education</td><td></td><td></td><td></td><td></td><td></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td></tr>
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<table>
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<tr><th>May 2010</th><th>June 2010</th><th>July 2010</th><th>Aug. 2010</th><th>Sept. 2010</th><th>Oct. 2010</th><th>May 2011</th><th>June 2011</th><th>July 2011</th><th>Aug. 2011</th><th>Sept. 2011</th><th>Oct. 2011</th></tr>
<tr><td>Rain barrel</td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td></td></tr>
<tr><td>Rain gardens</td><td></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td></td><td></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td></td><td></td><td></td></tr>
<tr><td>Soldiers Field</td><td></td><td></td><td></td><td></td><td></td><td></td><td style="background:#00ccff"></td><td style="background:#00ccff"></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Inlet Protection</td><td style="background:#00ccff"></td><td></td><td></td><td></td><td></td><td></td><td style="background:#00ccff"></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

List of Figures

Appendix A

Land Use Descriptions

Appendix B

HydroCadd Modeling Results

Appendix B can be found on the attached disk.

Appendix C

SLAMM Modeling Results

Appendix C can be found on the attached disk.

Appendix D

Modeling Results Including Internally Drained Areas

Table D-1.
Pike Lake Basin Water Quality – Total Suspended Solids and Phosphorus.

Subwatershed	Subwatershed Area (Acres)	Total Suspended Solids Annual Discharge (Pounds)	Total Suspended Solids Annual Loading (Pounds Per Acre)	Total Phosphorus Annual Discharge (Pounds)	Total Phosphorus Annual Loading (Pounds Per Acre)
A1	36.5	6432.9	176.4	18.4	0.5
A2	42.5	6742.6	158.7	19.7	0.5
A3	27.6	5516.2	199.9	16.3	0.6
A4	33.2	3889.2	117.3	10.2	0.3
A5	13.3	3931.2	295.6	9.6	0.7
A6	17.4	3804.6	219.0	9.6	0.6
A7	17.6	1931.6	109.6	5.2	0.3
A9	21.1	2656.6	126.1	7.0	0.3
A10	9.3	1691.4	181.9	5.0	0.5
A11	24.2	5748.3	237.2	13.4	0.6
A12	22.7	4244.0	187.2	12.8	0.6
A13	27.7	3853.6	139.2	11.9	0.4
W2	13.5	1427.9	106.2	3.5	0.3
W12	0.9	110.4	121.3	0.3	0.3
W13	0.5	58.1	121.1	0.2	0.3
W14	0.4	47.3	121.2	0.1	0.3
W30	24.9	3779.3	152.0	8.1	0.3
W31	47.6	10502.1	220.8	21.5	0.5
W40	18.6	6628.7	357.0	11.3	0.6
TOTAL	399.2	72996.0		184.3	

* Shaded subwatershed indicates that some or the entire subwatershed is internally drained.

Table D-2.
North Twin Lake Basin Water Quality– Total Suspended Solids and Phosphorus.

bwatershed	Subwatershed Area (Acres)	Total Suspended Solids Annual Discharge (Pounds)	Total Suspended Solids Annual Loading (Pounds Per Acre)	Total Phosphorus Annual Discharge (Pounds)	Total Phosphorus Annual Loading (Pounds Per Acre)
B1	35.9	9811.3	273.2	24.1	0.7
B2	11.8	2644.8	224.9	6.2	0.5
B3	7.9	1192.3	151.5	3.1	0.4
B4	7.1	774.4	109.2	2.0	0.3
B5	28.0	3874.2	138.2	10.6	0.4
B6	16.1	3332.9	207.4	9.9	0.6
B7	15.4	2285.9	148.5	6.4	0.4
B8	7.6	1314.4	174.1	3.9	0.5
B9	18.5	3185.5	172.4	8.7	0.5
B10	6.5	1537.9	235.5	4.1	0.6
B11	9.8	3310.9	339.2	6.7	0.7
B12	3.2	1583.1	500.9	2.7	0.9
B13	9.3	1772.3	189.9	4.8	0.5
TOTAL	176.9	36619.9		93.4	

* Shaded subwatershed indicates that some or the entire subwatershed is internally drained.

Table D-3.
South Twin Lake Basin Water Quality– Total Suspended Solids and Phosphorus.

Subwatershed	Subwatershed Area (Acres)	Total Suspended Solids Annual Discharge (Pounds)	Total Suspended Solids Annual Loading (Pounds Per Acre)	Total Phosphorus Annual Discharge (Pounds)	Total Phosphorus Annual Loading (Pounds Per Acre)
C1	14.4	4010.4	277.7	10.7	0.7
C3	43.7	13872.5	317.6	34.4	0.8
C4	20.1	3987.5	198.7	12.0	0.6
C5	14.3	2486.8	173.9	7.3	0.5
C6	14.1	2986.2	211.8	9.0	0.6
C7	9.4	1771.4	189.4	4.8	0.5
C8	5.4	1752.6	322.2	4.0	0.7
W136	2.2	575.5	260.4	1.6	0.7
TOTAL	123.6	31442.8		83.9	

* Shaded subwatershed indicates that some or the entire subwatershed is internally drained.

Table D-4.
Apple River Basin Water Quality– Total Suspended Solids and Phosphorus.

Subwatershed	Subwatershed Area (Acres)	Total Suspended Solids Annual Discharge (Pounds)	Total Suspended Solids Annual Loading (Pounds Per Acre)	Total Phosphorus Annual Discharge (Pounds)	Total Phosphorus Annual Loading (Pounds Per Acre)
W32	65.3	9769.7	149.7	26.8	0.4
W33	11.8	2295.9	194.2	5.8	0.5
W34	13.1	1704.7	129.9	5.7	0.4
W35	5.2	683.5	131.4	2.3	0.4
W36	4.2	646.7	154.3	2.3	0.5
W37	4.2	548.9	129.8	1.8	0.4
W38	9.9	2811.8	284.6	6.9	0.7
W39	12.7	1980.5	155.5	6.1	0.5
W41	6.0	1800.3	301.0	4.0	0.7
W42	5.1	1201.3	235.1	3.5	0.7
W43	7.3	1193.5	163.7	4.1	0.6
W44	7.5	1538.9	203.8	4.6	0.6
W45	7.4	1623.9	220.3	4.9	0.7
W46	14.0	3147.0	224.6	9.6	0.7
W47	5.7	1532.6	270.3	4.2	0.7
W48	1.6	464.8	288.6	1.2	0.8
W49	8.3	3563.8	428.3	7.0	0.8
W50	18.2	7933.8	436.6	13.2	0.7
W60	2.7	1196.5	441.5	1.9	0.7
W61	9.6	2734.0	284.8	7.1	0.7
W62	8.6	2224.6	257.2	5.9	0.7
W63	4.3	765.8	176.4	2.3	0.5
W64	10.8	4947.1	456.0	9.6	0.9
W73	34.7	5348.6	154.1	12.1	0.3
W74	4.6	952.8	208.0	2.9	0.6
W76	49.1	10762.0	219.2	22.8	0.5
W79	34.7	5466.0	157.3	12.0	0.3
W80	64.2	23517.6	366.4	38.4	0.6
W81	9.7	5470.2	562.8	9.2	0.9
W83	11.8	1693.7	144.0	4.0	0.3
W84	16.4	6357.2	388.4	9.1	0.6
W85	5.6	3156.7	560.7	5.3	0.9
W86	18.7	1395.1	74.8	3.3	0.2
W87	6.2	840.0	135.7	2.1	0.3
W88	20.3	3610.1	177.6	8.6	0.4
W89	59.7	23494.4	393.9	43.4	0.7
W91	27.7	6648.2	239.9	15.7	0.6
W92	25.7	5917.2	230.4	13.9	0.5
W93	3.4	368.9	109.1	1.0	0.3
W94	30.4	3680.5	120.9	9.7	0.3
W95	9.0	622.7	69.5	1.5	0.2

Table D-4. Continued
Apple River Basin Water Quality– Total Suspended Solids and Phosphorus.

Subwatershed	Subwatershed Area (Acres)	Total Suspended Solids Annual Discharge (Pounds)	Total Suspended Solids Annual Loading (Pounds Per Acre)	Total Phosphorus Annual Discharge (Pounds)	Total Phosphorus Annual Loading (Pounds Per Acre)
W96	12.1	4378.4	362.2	9.6	0.8
W97	8.0	2061.9	258.7	5.3	0.7
W98	9.6	1987.9	206.2	5.0	0.5
W99	3.7	761.8	207.0	2.2	0.6
W100	2.6	541.4	204.3	1.5	0.6
W101	25.0	7407.8	296.7	17.6	0.7
W107	24.7	7101.3	288.1	17.7	0.7
W108	8.9	2501.0	279.8	6.7	0.7
W109	6.4	1587.0	247.6	4.5	0.7
W110	38.2	5038.1	132.1	13.9	0.4
W111	3.5	745.1	212.3	2.3	0.6
W112	35.6	4172.0	117.0	10.9	0.3
W113	8.9	1750.3	195.6	5.1	0.6
W114	44.3	5319.6	120.2	14.3	0.3
W115	14.8	1934.5	130.8	5.0	0.3
W116	6.4	719.0	112.3	1.9	0.3
W117	4.6	408.6	89.2	1.0	0.2
W118	28.6	2612.6	91.4	6.7	0.2
W119	8.1	1243.6	153.7	3.6	0.4
W120	18.7	1499.7	80.2	3.6	0.2
W121	7.8	853.0	109.1	2.2	0.3
W122	9.7	5798.2	595.9	7.2	0.7
W124	0.7	171.6	248.5	0.5	0.7
W125	10.9	2597.9	237.9	7.5	0.7
W126	16.0	9059.5	565.5	14.5	0.9
W128	5.1	1648.9	322.7	4.0	0.8
W129	17.7	8431.5	477.4	12.2	0.7
W134	7.0	2567.0	368.8	6.1	0.9
W135	20.8	6934.2	332.7	15.3	0.7
W137	11.1	3359.2	302.9	8.1	0.7
W138	15.4	4273.7	278.1	10.9	0.7
W139	18.3	7422.0	406.7	14.9	0.8
W140	2.5	587.8	232.3	1.3	0.5
TOTAL	1131.1	273087.6		598.9	

* Shaded subwatershed indicates that some or the entire subwatershed is internally drained.

Table D-5.
Internally Drained Basin Water Quality– Total Suspended Solids and Phosphorus.

Subwatershed	Subwatershed Area (Acres)	Total Suspended Solids Annual Discharge (Pounds)	Total Suspended Solids Annual Loading (Pounds Per Acre)	Total Phosphorus Annual Discharge (Pounds)	Total Phosphorus Annual Loading (Pounds Per Acre)
W51	8.1	1723.9	212.3	5.3	0.6
W52	6.0	1515.5	252.1	4.4	0.7
W53	12.2	2970.6	243.1	8.6	0.7
W54	8.5	1833.0	216.4	5.3	0.6
W55	2.0	305.8	152.2	0.8	0.4
W56	6.4	809.1	125.8	2.2	0.3
W57	10.5	2002.6	191.1	6.4	0.6
W58	52.8	7219.3	136.7	20.3	0.4
W59	13.9	6214.2	448.7	11.3	0.8
W65	21.6	5821.7	270.0	12.3	0.6
W66	24.0	5005.2	208.9	12.3	0.5
W67	37.5	23013.4	613.7	27.7	0.7
W68	70.8	10502.1	148.4	25.2	0.4
W69	15.6	2807.6	180.4	6.0	0.4
W70	112.7	25511.9	226.4	48.3	0.4
W71	34.8	6198.7	178.1	13.6	0.4
W72	18.3	3350.8	183.4	7.3	0.4
W75	40.9	11122.7	272.1	20.8	0.5
W77	58.4	19455.6	332.9	35.0	0.6
W78	6.1	740.1	121.5	1.9	0.3
W82	18.6	7039.1	377.6	11.0	0.6
W90	87.9	29895.7	340.3	46.6	0.5
W102	45.7	18020.2	394.1	32.0	0.7
W103	4.5	559.5	123.0	1.2	0.3
W104	66.1	19689.7	297.9	33.9	0.5
W105	11.9	1900.0	160.2	5.4	0.5
W106	8.8	3944.9	446.8	6.2	0.7
W123	2.2	669.5	304.3	1.6	0.7
W141	25.3	4566.1	180.3	15.0	0.6
W142	10.4	2030.2	196.2	6.8	0.7
W143	4.6	1247.7	268.9	3.6	0.8
W144	4.8	896.2	188.7	3.0	0.6
W145	14.4	2822.1	196.0	9.1	0.6
W146	25.9	4843.4	187.3	15.6	0.6
W150	43.1	14599.1	338.7	18.8	0.4
TOTAL	935.1	250847.2		484.9	

* Shaded subwatershed indicates that some or the entire subwatershed is internally drained.

Table D-6.
Pike Lake Basin Water Quality – Total Suspended Solids and Phosphorus with Rankings.

Subwatershed	Subwatershed Area (Acres)	Percentage of Overall Size of Watershed	Rank for Overall Watershed Size	Total Suspended Solids Annual Discharge (Pounds)	Percentage of Contributing TSS from Watershed	Rank for Total TSS	Total Suspended Solids Annual Loading (Pounds Per Acre)	Rank for TSS Annual Per Acre	Total Phosphorus Annual Discharge (Pounds)	Percentage of Contributing Phosphorus from Watershed	Rank for Total P	Total Phosphorus Annual Loading (Pounds Per Acre)	Rank for P Annual Per Acre
A1	36	9	3	6433	9	4	176	9	18	10	3	0.5	8
A2	42	11	2	6743	9	2	159	10	20	11	2	0.5	9
A3	28	7	6	5516	8	6	200	6	16	9	4	0.6	3
A4	33	8	4	3889	5	9	117	17	10	6	9	0.3	17
A5	13	3	15	3931	5	8	296	2	10	5	11	0.7	1
A6	17	4	13	3805	5	11	219	5	10	5	10	0.6	5
A7	18	4	12	1932	3	14	110	18	5	3	14	0.3	18
A9	21	5	10	2657	4	13	126	13	7	4	13	0.3	12
A10	9	2	16	1691	2	15	182	8	5	3	15	0.5	7
A11	24	6	8	5748	8	5	237	3	13	7	5	0.6	6
A12	23	6	9	4244	6	7	187	7	13	7	6	0.6	4
A13	28	7	5	3854	5	10	139	12	12	7	8	0.4	11
W2	13	3	14	1428	2	16	106	19	3	2	16	0.3	19
W12	1	0	17	110	0	17	121	14	0	0	17	0.3	14
W13	0	0	18	58	0	18	121	16	0	0	18	0.3	16
W14	0	0	19	47	0	19	121	15	0	0	19	0.3	15
W30	25	6	7	3779	5	12	152	11	8	4	12	0.3	13
W31	48	12	1	10502	14	1	221	4	22	12	1	0.5	10
W40	19	5	11	6629	9	3	357	1	11	6	7	0.6	2
TOTAL	399			72996					184				

* Shaded subwatersheds indicate that there is some or the entire subwatershed is internally drained.

Table D-7.
North Twin Lake Basin Water Quality – Total Suspended Solids and Phosphorus with Rankings.

Subwatershed	Subwatershed Area (Acres)	Percentage of Overall Size of Watershed	Rank for Overall Watershed Size	Total Suspended Solids Annual Discharge (Pounds)	Percentage of Contributing TSS from Watershed	Rank for Total TSS	Total Suspended Solids Annual Loading (Pounds Per Acre)	Rank for TSS Annual Per Acre	Total Phosphorus Annual Discharge (Pounds)	Percentage of Contributing Phosphorus from Watershed	Rank for Total P	Total Phosphorus Annual Loading (Pounds Per Acre)	Rank for P Annual Per Acre
B1	36	20	1	9811	27	1	273	3	24	26	1	0.7	3
B2	12	7	6	2645	7	6	225	5	6	7	7	0.5	6
B3	8	4	9	1192	3	12	152	10	3	3	11	0.4	11
B4	7	4	11	774	2	13	109	13	2	2	13	0.3	13
B5	28	16	2	3874	11	2	138	12	11	11	2	0.4	12
B6	16	9	4	3333	9	3	207	6	10	11	3	0.6	5
B7	15	9	5	2286	6	7	149	11	6	7	6	0.4	10
B8	8	4	10	1314	4	11	174	8	4	4	10	0.5	7
B9	18	10	3	3186	9	5	172	9	9	9	4	0.5	9
B10	7	4	12	1538	4	10	236	4	4	4	9	0.6	4
B11	10	6	7	3311	9	4	339	2	7	7	5	0.7	2
B12	3	2	13	1583	4	9	501	1	3	3	12	0.9	1
B13	9	5	8	1772	5	8	190	7	5	5	8	0.5	8
TOTAL	177			36620					93				

* Shaded subwatershed indicates that some or the entire subwatershed is internally drained.

Table D-8.
South Twin Lake Basin Water Quality – Total Suspended Solids and Phosphorus with Rankings.

Subwatershed	Subwatershed Area (Acres)	Percentage of Overall Size of Watershed	Rank for Overall Watershed Size	Total Suspended Solids Annual Discharge (Pounds)	Percentage of Contributing TSS from Watershed	Rank for Total TSS	Total Suspended Solids Annual Loading (Pounds Per Acre)	Rank for TSS Annual Per Acre	Total Phosphorus Annual Discharge (Pounds)	Percentage of Contributing Phosphorus from Watershed	Rank for Total P	Total Phosphorus Annual Loading (Pounds Per Acre)	Rank for P Annual Per Acre
C1	14	12	3	4010	13	2	278	3	11	13	3	0.7	2
C3	44	35	1	13872	44	1	318	2	34	41	1	0.8	1
C4	20	16	2	3987	13	3	199	6	12	14	2	0.6	6
C5	14	12	4	2487	8	5	174	8	7	9	5	0.5	8
C6	14	11	5	2986	10	4	212	5	9	11	4	0.6	5
C7	9	8	6	1771	6	6	189	7	5	6	6	0.5	7
C8	5	4	7	1753	6	7	322	1	4	5	7	0.7	3
W136	2	2	8	575	2	8	260	4	2	2	8	0.7	4
TOTAL	124			31443					84				

* Shaded subwatershed indicates that some or the entire subwatershed is internally drained.

Table D-9.
Apple River Basin Water Quality – Total Suspended Solids and Phosphorus with Rankings.

Subwatershed	Subwatershed Area (Acres)	Percentage of Overall Size of Watershed	Rank for Overall Watershed Size	Total Suspended Solids Annual Discharge (Pounds)	Percentage of Contributing TSS from Watershed	Rank for Total TSS	Total Suspended Solids Annual Loading (Pounds Per Acre)	Rank for TSS Annual Per Acre	Total Phosphorus Annual Discharge (Pounds)	Percentage of Contributing Phosphorus from Watershed	Rank for Total P	Total Phosphorus Annual Loading (Pounds Per Acre)	Rank for P Annual Per Acre
W32	65	6	1	9770	4	4	150	56	27	5	3	0.4	57
W33	12	1	31	2296	1	37	194	47	6	1	38	0.5	49
W34	13	1	28	1705	1	45	130	62	6	1	39	0.4	54
W35	5	1	59	683	0	65	131	60	2	0	58	0.4	52
W36	4	0	66	647	0	66	154	53	2	0	59	0.5	44
W37	4	0	65	549	0	69	130	63	2	0	67	0.4	55
W38	10	1	36	2812	1	31	285	24	7	1	32	0.7	25
W39	13	1	29	1980	1	41	155	52	6	1	35	0.5	50
W41	6	1	56	1800	1	43	301	19	4	1	50	0.7	31
W42	5	1	60	1201	0	55	235	34	3	1	55	0.7	29
W43	7	1	51	1193	0	57	164	50	4	1	49	0.6	41
W44	8	1	49	1539	1	50	204	45	5	1	46	0.6	36
W45	7	1	50	1624	1	48	220	38	5	1	45	0.7	33
W46	14	1	27	3147	1	30	225	37	10	2	22	0.7	28
W47	6	1	57	1533	1	51	270	27	4	1	48	0.7	14
W48	2	0	73	465	0	71	289	21	1	0	71	0.8	10
W49	8	1	45	3564	1	27	428	9	7	1	31	0.8	6
W50	18	2	21	7934	3	7	437	8	13	2	14	0.7	18
W60	3	0	70	1197	0	56	442	7	2	0	65	0.7	19
W61	10	1	40	2734	1	32	285	23	7	1	30	0.7	12
W62	9	1	44	2225	1	38	257	29	6	1	37	0.7	30
W63	4	0	64	766	0	61	176	49	2	0	61	0.5	46
W64	11	1	35	4947	2	21	456	6	10	2	21	0.9	4
W73	35	3	9	5349	2	18	154	54	12	2	16	0.3	59
W74	5	0	63	953	0	58	208	41	3	1	57	0.6	35
W76	49	4	4	10762	4	3	219	39	23	4	4	0.5	51
W79	35	3	8	5466	2	17	157	51	12	2	17	0.3	61
W80	64	6	2	23518	9	1	366	14	38	6	2	0.6	38
W81	10	1	38	5470	2	16	563	3	9	2	24	0.9	2
W83	12	1	32	1694	1	46	144	57	4	1	52	0.3	63
W84	16	1	23	6357	2	13	388	12	9	2	25	0.6	43
W85	6	1	58	3157	1	29	561	4	5	1	40	0.9	1
W86	19	2	19	1395	1	53	75	73	3	1	56	0.2	73
W87	6	1	55	840	0	60	136	58	2	0	64	0.3	60
W88	20	2	17	3610	1	26	178	48	9	1	26	0.4	56

Table D-9. Continued.
Apple River Basin Water Quality – Total Suspended Solids and Phosphorus with Rankings.

Subwatershed	Subwatershed Area (Acres)	Percentage of Overall Size of Watershed	Rank for Overall Watershed Size	Total Suspended Solids Annual Discharge (Pounds)	Percentage of Contributing TSS from Watershed	Rank for Total TSS	Total Suspended Solids Annual Loading (Pounds Per Acre)	Rank for TSS Annual Per Acre	Total Phosphorus Annual Discharge (Pounds)	Percentage of Contributing Phosphorus from Watershed	Rank for Total P	Total Phosphorus Annual Loading (Pounds Per Acre)	Rank for P Annual Per Acre
W89	60	5	3	23494	9	2	394	11	43	7	1	0.7	17
W91	28	2	12	6648	2	12	240	32	16	3	7	0.6	42
W92	26	2	13	5917	2	14	230	36	14	2	12	0.5	45
W93	3	0	69	369	0	73	109	68	1	0	73	0.3	68
W94	30	3	10	3680	1	25	121	64	10	2	20	0.3	65
W95	9	1	41	623	0	67	70	74	1	0	69	0.2	74
W96	12	1	30	4378	2	22	362	15	10	2	23	0.8	8
W97	8	1	47	2062	1	39	259	28	5	1	41	0.7	32
W98	10	1	39	1988	1	40	206	43	5	1	44	0.5	47
W99	4	0	67	762	0	62	207	42	2	0	62	0.6	37
W100	3	0	71	541	0	70	204	44	2	0	68	0.6	39
W101	25	2	14	7408	3	9	297	20	18	3	6	0.7	23
W107	25	2	15	7101	3	10	288	22	18	3	5	0.7	20
W108	9	1	43	2501	1	36	280	25	7	1	33	0.7	11
W109	6	1	53	1587	1	49	248	31	5	1	47	0.7	22
W110	38	3	6	5038	2	20	132	59	14	2	13	0.4	58
W111	4	0	68	745	0	63	212	40	2	0	60	0.6	34
W112	36	3	7	4172	2	24	117	66	11	2	19	0.3	66
W113	9	1	42	1750	1	44	196	46	5	1	42	0.6	40
W114	44	4	5	5320	2	19	120	65	14	2	11	0.3	64
W115	15	1	26	1935	1	42	131	61	5	1	43	0.3	62
W116	6	1	54	719	0	64	112	67	2	0	66	0.3	67
W117	5	0	62	409	0	72	89	71	1	0	72	0.2	71
W118	29	3	11	2613	1	33	91	70	7	1	34	0.2	70
W119	8	1	46	1244	1	54	154	55	4	1	54	0.4	53
W120	19	2	18	1500	1	52	80	72	4	1	53	0.2	72
W121	8	1	48	853	0	59	109	69	2	0	63	0.3	69
W122	10	1	37	5798	2	15	596	1	7	1	29	0.7	13
W124	1	0	74	172	0	74	248	30	0	0	74	0.7	24
W125	11	1	34	2598	1	34	238	33	8	1	28	0.7	27
W126	16	1	24	9059	3	5	566	2	14	2	10	0.9	3
W128	5	1	61	1649	1	47	323	17	4	1	51	0.8	9
W129	18	2	22	8431	3	6	477	5	12	2	15	0.7	26
W134	7	1	52	2567	1	35	369	13	6	1	36	0.9	5

Table D-9. Continued.

Apple River Basin Water Quality – Total Suspended Solids and Phosphorus with Rankings.

Subwatershed	Subwatershed Area (Acres)	Percentage of Overall Size of Watershed	Rank for Overall Watershed Size	Total Suspended Solids Annual Discharge (Pounds)	Percentage of Contributing TSS from Watershed	Rank for Total TSS	Total Suspended Solids Annual Loading (Pounds Per Acre)	Rank for TSS Annual Per Acre	Total Phosphorus Annual Discharge (Pounds)	Percentage of Contributing Phosphorus from Watershed	Rank for Total P	Total Phosphorus Annual Loading (Pounds Per Acre)	Rank for P Annual Per Acre
W135	21	2	16	6934	3	11	333	16	15	3	8	0.7	15
W137	11	1	33	3359	1	28	303	18	8	1	27	0.7	16
W138	15	1	25	4274	2	23	278	26	11	2	18	0.7	21
W139	18	2	20	7422	3	8	407	10	15	3	9	0.8	7
W140	3	0	72	588	0	68	232	35	1	0	70	0.5	48
TOTAL	1131			273088					599				

* Shaded subwatershed indicates that some or the entire subwatershed is internally drained.

Table D-10.
Internally Drained Basin Water Quality – Total Suspended Solids and Phosphorus with Rankings.

Subwatershed	Subwatershed Area (Acres)	Percentage of Overall Size of Watershed	Rank for Overall Watershed Size	Total Suspended Solids Annual Discharge (Pounds)	Percentage of Contributing TSS from Watershed	Rank for Total TSS	Total Suspended Solids Annual Loading (Pounds Per Acre)	Rank for TSS Annual Per Acre	Total Phosphorus Annual Discharge (Pounds)	Percentage of Contributing Phosphorus from Watershed	Rank for Total P	Total Phosphorus Annual Loading (Pounds Per Acre)	Rank for P Annual Per Acre
W51	8	1	27	1724	1	27	212	18	5	1	27	0.6	10
W52	6	1	30	1516	1	28	252	14	4	1	28	0.7	4
W53	12	1	21	2971	1	20	243	15	9	2	19	0.7	7
W54	8	1	26	1833	1	26	216	17	5	1	26	0.6	13
W55	2	0	35	306	0	35	152	30	1	0	35	0.4	27
W56	6	1	28	809	0	31	126	33	2	1	31	0.3	33
W57	10	1	23	2003	1	24	191	22	6	1	22	0.6	14
W58	53	6	6	7219	3	10	137	32	20	4	9	0.4	31
W59	14	2	20	6214	3	12	449	2	11	2	16	0.8	1
W65	22	2	15	5822	2	14	270	12	12	3	14	0.6	19
W66	24	3	14	5005	2	15	209	19	12	3	15	0.5	21
W67	38	4	10	23013	9	3	614	1	28	6	6	0.7	3
W68	71	8	3	10502	4	9	148	31	25	5	7	0.4	32
W69	16	2	18	2808	1	22	180	26	6	1	24	0.4	30
W70	113	12	1	25512	10	2	226	16	48	10	1	0.4	26
W71	35	4	11	6199	3	13	178	28	14	3	13	0.4	29
W72	18	2	17	3351	1	19	183	25	7	2	20	0.4	28
W75	41	4	9	11123	4	8	272	11	21	4	8	0.5	23
W77	58	6	5	19456	8	5	333	8	35	7	3	0.6	16
W78	6	1	29	740	0	32	122	35	2	0	32	0.3	34
W82	19	2	16	7039	3	11	378	5	11	2	17	0.6	18
W90	88	9	2	29896	12	1	340	6	47	10	2	0.5	20
W102	46	5	7	18020	7	6	394	4	32	7	5	0.7	8
W103	5	1	33	559	0	34	123	34	1	0	34	0.3	35
W104	66	7	4	19690	8	4	298	10	34	7	4	0.5	22
W105	12	1	22	1900	1	25	160	29	5	1	25	0.5	24
W106	9	1	25	3945	2	18	447	3	6	1	23	0.7	6
W123	2	0	34	669	0	33	304	9	2	0	33	0.7	5
W141	25	3	13	4566	2	17	180	27	15	3	12	0.6	17
W142	10	1	24	2030	1	23	196	20	7	1	21	0.7	9
W143	5	1	32	1248	1	29	269	13	4	1	29	0.8	2
W144	5	1	31	896	0	30	189	23	3	1	30	0.6	12
W145	14	2	19	2822	1	21	196	21	9	2	18	0.6	11
W146	26	3	12	4843	2	16	187	24	16	3	11	0.6	15
W150	43	5	8	14599	6	7	339	7	19	4	10	0.4	25
TOTAL	935			250847					485				

* Shaded subwatershed indicates that some or the entire subwatershed is internally drained.

Appendix E

Monitoring Protocol

Monitoring Protocols

Introduction

Baseline phosphorus modeling of each lake and river basin has been completed. The Stormwater Plan has set water quality goals for each basin. The next step is to assess the potential benefit of a proposed practice as well as continue to monitor the resource for water quality changes.

Specific Monitoring Objectives

The following objectives are based on Stormwater Management Goals and adequately assessing proposed practices as well as progress toward the goals. The protocol herein shall provide a better understanding of the water quality of the lakes and river. The protocols are to meet the following objectives:

1. Assess the potential phosphorus reduction provided by a potential practice. (For small practices this protocol may be waived.)
2. Monitor the effectiveness of selected practices.
3. Monitor watershed water quality.
    a. Develop long term reliable data sets that can assess current status and trends (Document magnitude and direction of change.)
4. Monitor in-lake/in-river water quality.
    a. Develop long term reliable data sets that can assess current status and trends. (Document magnitude and direction of change.)

Justification for Protocol

The natural environment is complex and typically in a state of flux making evaluation difficult. This is true due to the many variables that work together in natural processes. Due to the natural variability, it is necessary to develop defined repeatable procedures to evaluate selected parameters in nature. This is also true in utilizing mathematical models to assess specific parameters.

The data collected must be credible. Developing protocols help ensure that the data is credible, defendable and accurate. Misinformation can occur when data are too hastily or sloppily collected, stored, analyzed, or presented. Protocols establish data collection methods, data storage, and analyses and presentation. All individuals involved with the data must be committed to conduct concise, clear, accurate analyses and presentation of data.

Protocol A: Practice Modeling

The baseline data of total phosphorus loading was completed using SLAMM. Therefore, when possible the practice should be modeled using SLAMM to evaluating practices for consistency, and because of the program's capabilities. SLAMM has the ability to model a wide range of practices and contains some fail safes to alert the user if standard design practices are being violated. A significant problem with SLAMM, however, is that it will require some training for the user to be able to effectively operate that program. The modeling program P8, however, is more simplistic and easier to use. It does not provide the same level of detail and does not contain the design standards, but it typically provides similar results to the SLAMM model.

The Practice Modeling Protocol is as follows:

1. Complete preliminary design of practice including locating the practice.
2. Determine watershed (size and land use parameters) that flows to proposed practice.
3. Select model. (SLAMM recommended.)
4. Open modeling program.
5. Load specific program parameters (Standard Amery Land Use Files for SLAMM).

6. Input watershed information/variables.
7. Input practice information/variables.
    a. If practice does not specifically match practices contained in model, utilize a practice that most closely matches the one designed. (An example of this
8. Run model.
9. Review results.
    a. Are results close to expected results?
        i. Are all inputs entered correctly?
        ii. Do proposed reductions meet plan goals?
10. Modify design, as necessary.
11. Re-run model
12. Review Results.
    a. Are results close to expected results?
        i. Are all inputs entered correctly?
        ii. Do proposed reductions meet plan goals?

Protocol B: Practice Monitoring

The exact monitoring protocol for each practice will need to be practice specific. However, this protocol will provide an outline for developing practice specific protocols. Accurately monitoring of an installed practice shall be done over a long period of time as field results often vary greatly and the intent is to capture magnitudes of change and trends. A significant variable is the duration and intensity of storm events. The timing of sample collection during a storm event can also impact results. Obtaining multiple samples during a storm event can reduce sampling fluctuations.

The Practice Monitoring Protocol is as follows:

1. Determine or develop resources for information on storm events.
    a. If possible find a resource where the storm events duration, intensity (amount/time) and total amount of precipitation can be obtained. The Amery Municipal Airport may have such information available. If not, plan and set up a system to obtain storm event data. (Make sure location is not obstructed by buildings or trees. Also, verify that the device is calibrated correctly and providing accurate results. Test the device/system prior to use. Keep records on calibration checks and system tests.)
    b. Creation of artificial storm events. For specific practices it may be advantageous to create controlled storm events. (An example where an artificial storm event would be useful would be for pervious pavement, where it would be beneficial to determine actual infiltration rates. This would provide information on what storm events that practice will be effective during.) Determine delivery rate discharge nozzle(s). Delivery systems that can create an artificial event can be such things as fire trucks, water tankers and garden hoses. Verify that the same information; duration, intensity and total amount of water can be obtained as you would for a regular storm event.
2. Determine or verify drainage area that flows to device. (This may not be necessary for artificial storm events.)
3. Determine type of sampling that will be preformed.
    a. Manual single grab samples.
        i. Obtain sample bottles specifically for type of test to be preformed (i.e. phosphorus, total suspended solids)
        ii. Plan sample collection locations.
            1. Collect samples at a minimum of two locations (before entering practice (inflow) and from practice discharge point (outflow).)
        iii. Plan sample collection timing. Record time samples taken. For urban runoff it is desirable to try to obtain samples of the first 0.5 inch of runoff from a drainage area as this is considered to be the most polluted.
            1. Sample inflow and outflow at the same time.

2. Sample inflow and release non-reactive dye into water stream. Sample outflow when dye reaches outflow.

b. Automated grab samples.

i. Obtain sample bottles specifically for type of test to be preformed (i.e. phosphorus, total suspended solids)

ii. Plan sample collection locations.

1. Collect samples at a minimum of two locations (before entering practice (inflow) and from practice discharge point (outflow).)
2. Set up automated samplers. Calibrate samplers.

iii. Plan sample collection timing and set up each sampler accordingly.

4. Plan sample event. Watch the weather. If artificial storm event is utilized the day should be precipitation free to avoid skewing results. If manual samples are to be collected designated sample collector(s) must be available. If automated samplers used sample collector(s) should be on site to document storm event and how the practice is operation from a visual observation perspective. Make sure observer(s) understand how the practice is intended to function.
5. Develop data collection sheet that is laminated and have wax pencil for data recording. All sample collector(s)/observer(s) shall have sheet and wax pencil to document role and record data while on site.
6. Conduct Practice Monitoring
   a. Event begins or is started (artificial).
   b. Sampler(s)/observer(s) shall be on site with data sheet and wax pencils.
   c. Prepare for sample collection.
      i. Prepare for manual sample collection. Have bottle(s) on site and in collector(s) possession.
      ii. Inspect automated samplers.
   d. Collect samples at designated time and document observations.
   e. Mark sample bottles with location code and sample date.
   f. Take photography throughout storm event of practice and during sampling procedures.
   g. Refrigerated samples and deliver samples to lab for analysis as soon as possible.
   h. Complete chain of possession sheet on each sample.
   i. Obtain all data sheets from sampler(s)/observer(s).
   j. Photo copy laminated data sheets. After photocopying complete whip sheets completely clean.
7. Obtain storm event information if not artificial.
8. Obtain results from lab.
9. Enter lab results and observations into computerized data sheets where analyses of data can be completed easily and presentation tools can be created easily (recommend Microsoft Excel).
10. Create a file of that includes the lab results, data sheets, storm event information, and any other pertinent data.
11. Compare inflow and outflow results. (It may be possible that no outflow occurred depending on the practices and its design.) Make accurate statistical calculations as appropriate.
12. Create presentation illustration of results showing the comparison between the inflow and the outflow. Note on illustration how samples were collected and the timing of the collection for both the inflow and that outflow.
13. Continue to conduct practice monitoring and record results in computerized data sheets.
14. Create presentation illustration of results that show trends for the practice. Consider storm event information when presenting results.

Presentation materials should not be overly technical or insultingly simple. Graphic illustrations such as bar graphs, pie charts, and line graphs are generally useful way of viewing data. Other statistical calculations should be made as appropriate.

Protocol C: Watershed Monitoring

The exact monitoring protocol for each watershed will need to be watershed specific. However, this protocol will provide an outline for developing watershed specific protocols. Accurately monitoring watersheds shall be done multiple times to obtain a significant data set of field results. Field results are often highly variable and the intent is to capture magnitudes and trends. A significant variable is the duration and intensity of storm events. The timing of sample collection during a storm event can also impact results. Obtaining multiple samples during a storm event can reduce sampling fluctuations. (The watershed monitoring protocol below assumes that there is no base flow. For watersheds with a continuous base flow, a tributary monitoring protocol shall be developed.)

The Watershed Monitoring Protocol is as follows:

1. Determine or develop resource for information on storm events.
   a. If possible find a resource where the storm events duration, intensity (amount/time) and total amount of precipitation can be obtained. The Amery Municipal Airport may have such information available. If not, plan and set up a system to obtain storm event data. (Make sure location is not obstructed by buildings or trees. Also, verify that the device is calibrated correctly and providing accurate results. Test the device/system prior to use. Keep records on calibration checks and system tests.)
2. Determine outlet sample point. Select a location that can be easily sampled from. Such a point will have a flow depth adequate for an automated sampler or a manual grab sample could be collected from. Culverts, typically, make good sampling locations.
3. Determine or verify watershed drainage area to sample location.
4. Determine type of sampling that will be preformed.
   a. Manual single grab samples.
      i. Obtain sample bottles specifically for type of test to be preformed (i.e. phosphorus, total suspended solids)
   b. Automated grab samples.
      i. Obtain sample bottles specifically for type of test to be preformed (i.e. phosphorus, total suspended solids)
      ii. Set up automated samplers. Calibrate samplers.
      iii. Plan sample collection timing and set up each sampler accordingly.
5. Determine when samples will be taken. For urban runoff, it is desirable to try to obtain samples of the first 0.5 inch of runoff from a drainage area as this is considered to be the most polluted part of the runoff.
6. Plan sample event. Watch the weather. If manual samples are to be collected designated sample collector(s) must be available. If automated samplers used sample collector(s) should be on site to document storm event and record visual observations such as color, odor, and turbidity. Make sure observer(s) understand what they are to be looking for and how they should document their observations.
7. Develop data collection sheet that is laminated and have wax pencil for data recording. All sample collector(s)/observer(s) shall have sheet and wax pencil to document role and record data while on site.
8. Conduct Watershed Monitoring
   a. Event begins.
   b. Sampler(s)/observer(s) shall be on site with data sheet and wax pencils as soon as possible after start of event.
   c. Prepare for sample collection.
      i. Prepare for manual sample collection. Have bottle(s) on site and in collector(s) possession.

ii. Inspect automated samplers.

d. Collect samples at designated time (point in storm event) and document observations.
e. Mark sample bottles with location code and sample date.
f. Take photography throughout storm event of practice and during sampling procedures.
g. Refrigerated samples and deliver samples to lab for analysis as soon as possible.
h. Complete chain of possession sheet on each sample.
i. Obtain all data sheets from sampler(s)/observer(s).
j. Photo copy laminated data sheets. After photocopying complete whip sheets completely clean.

9. Obtain storm event information.
10. Obtain results from lab.
11. Enter lab results and observations into computerized data sheets where analyses of data can be completed easily and presentation tools can be created easily (recommend Microsoft Excel).
12. Create a file of that includes the lab results, data sheets, storm event information, and any other pertinent data.
13. Review data. Make accurate statistical calculations as appropriate.
14. Create presentation illustration of results. Note on illustration how samples were collected and the timing of the collection.
15. Continue to conduct watershed monitoring and record results in computerized data sheets.
16. Create presentation illustration of results that show trends in the watershed. Consider storm event information when presenting results.

Presentation materials should not be overly technical or insultingly simple. Graphic illustrations such as bar graphs, pie charts, and line graphs are generally useful way of viewing data. Other statistical calculations should be made as appropriate.

Protocol D: In-Lake Monitoring

The exact monitoring protocol for each lake and the river will need to be resource specific. This protocol is based on lake monitoring. River monitoring should be completed but due to the watershed size, small changes within Amery area will be difficult to quantify through in-river sampling. This protocol will provide an outline for developing in-lake specific protocols.

The design of an in-lake monitoring protocol shall identify monitoring sites, sampling frequency, etc. The number of monitoring sites selected (or spatial representation) should be based on the level of similarities through the water body (heterogeneity of physical, chemical and biological characteristics within the water resource). The homogenous the resource the less sampling location are generally needed. For North Twin and South Twin Lakes fewer sampling points may be necessary due to their shape and depth. A few more sampling locations may be necessary on Pike Lake.

There are many water chemistry parameters that can be sampled. Each provides information on the health of the water resource. There are other samples that can be taken to determine potential phosphorus loading sources, such as lake sediment sampling. Sampling parameters can be added to this protocol; however, this protocol is based on assessing phosphorus loads and algae growth as it relates to TSI goals stated within the Stormwater Management Plan. Based on this, three parameters are Secchi disk transparency, chlorophyll *a*, and total phosphorus. Again, additional parameters can easily be added but this shall be the base components. If additional parameters are included, some of the follow are recommended: temperature, dissolved oxygen, total suspended solids, pH, alkalinity, soluble reactive phosphorus, total Kjeldahl nitrogen (TKN), and beach/boat launch fecal coliform bacteria. The importance of base parameters is as follows:

- **Secchi disk transparency (Secchi)**
  This parameter is a measurement of water clarity. In many lakes, a reduction of clarity occurs as the

algal population grows. In these cases, a Secchi disk reading can be used an indirect measure of algal density.

- **Chlorophyll *a***
  This parameter is a more reliable indicator of algal quantity because chlorophyll *a* is a chemical extracted directly from the algal cells present in a water sample.

- **Total phosphorus (TP)**
  This parameter is an essential plant nutrient that stimulates the growth of algae in many lakes (the more phosphorus in the lake, the more algae). By measuring phosphorus concentration, monitors can get an indication of water fertility.

The In-Lake Monitoring Protocol is as follows:

1. Determine or develop resource for information on storm events.
   a. If possible find a resource where the storm events duration, intensity (amount/time) and total amount of precipitation can be obtained. The Amery Municipal Airport may have such information available or plan and set up system to obtain storm event data. (Make sure location is not obstructed by buildings or trees. Also, verify that the device is calibrated correctly and providing accurate results. Test the device/system prior to use. Keep records on calibration checks and system tests.) Information should be collected for use as an annual indicator of the type of year the data was collected for such as dry, wet, or average.
2. Determine sample point(s). Select a location(s) that can be located repeatedly by GPS or other verifiable method.
   a. Consider sample location(s) for stratified locations and unstratified conditions.
      i. During stratified conditions, TP will vary at different depths; therefore it is recommended that sampling is taken as each thermocline.
      ii. During unstratified conditions, the lake should be completely mixed and the TP should be the same throughout the lake at different depths.
   b. Minimum sample locations consist of one over the deepest part of the lake. If the lake is segmented or contains a large area at the deepest part of the lake additional sample locations shall be added.
3. Sample timing.
   a. Spring turnover (unstratification). This will be very close to ice-off (within one week of ice-off) and will provide a well mixed lake sample.
   b. Biweekly (recommended) or at minimum of once per month from ice-off to near ice-on conditions.
   c. Spring turnover (unstratification). This will be very close to ice off and will provide a well mixed lake sample.
4. Sample collection at each location at each sample time.
   a. Verify sampling date, weather conditions and go through boating safety and sampling equipment checklists prior to launching the sampling boat.
   b. Finding the sampling site and documenting observations about the water and weather conditions.
   c. Taking a Secchi disk measurement and collecting water samples for chlorophyll *a* and total phosphorus analysis.
      i. Secchi sampling
         1. Readings were obtained over the deepest part of the lake by lowering the Secchi disc into the water until it disappeared. The disc was then raised until it reappeared. The average of the two values is the Secchi depth reading.
         2. This shall be completed twice at each sampling location and averaged.
         3. Complete field notes that detail the sample readings as well as location information, weather conditions and any other pertinent data.

ii. Chlorophyll *a* sampling
    1. Obtain sample bottles specifically for chlorophyll *a* test.
    2. Follow laboratory instructions for sample collection. Verify sample location and depth of collection prior to opening bottle. Collection of samples at varying depths may require additional equipment and thermometer to assess stratified layers.

iii. Total phosphorus sampling
    1. Obtain sample bottles specifically for total phosphorus test.
    2. Follow laboratory instructions for sample collection. Verify sample location and depth of collection prior to opening bottle. Collection of samples at varying depths may require additional equipment and thermometer to assess stratified layers.

d. Return to shore and preparing the chlorophyll *a* and total phosphorus samples for shipment to the laboratory.

5. Obtain results from lab.
6. Enter lab results, observations and Secchi readings into computerized data sheets where analyses of data can be completed easily and presentation tools can be created easily (recommend Microsoft Excel).
7. Create a file of that includes the lab results, data sheets, storm event information, and any other pertinent data.
8. Review data. Make accurate statistical calculations as appropriate.
9. Create presentation illustration of results. Note on illustration how samples were collected and the timing of the collection.
10. Continue to conduct watershed monitoring and record results in computerized data sheets.
11. Create presentation illustration of results that show trends in the watershed. Consider storm event information when presenting results.