A topographic map of the Yahara region, showing a watershed boundary shaded in blue. The map features a complex network of ridges and valleys, with several large lakes visible. The background is a light blue and green topographic relief map.

Yahara CLEAN Strategic Action Plan for Phosphorus Reduction

November 9, 2012

Report for
The Clean Lakes Alliance

For more information or to download the report contact:

Clean Lakes Alliance

150 East Gilman Street, Suite 2600

Madison, Wisconsin 53703

(608) 255-1000

www.cleanlakesalliance.com



Preface

In early 2010, the Clean Lakes Alliance (CLA) set out to bring together the expertise and passion of people dedicated to cleaning up Dane County lakes. By uniting the efforts of farmers, scientists, business and non-profit organizations, riparian landowners, citizen groups and units of government, CLA was able to create a true alliance of all stakeholders to advance the progress that had already been made toward protecting and enhancing the water quality of the lakes in the Yahara River watershed.

In the fall of 2010, the landmark Yahara CLEAN report was published and demonstrated the urgency of reducing the overabundance of phosphorus in our lakes. CLA subsequently reaffirmed the goal of reducing the amount of phosphorus in the Yahara chain of lakes by fifty percent and commissioned a comprehensive engineering analysis to model proven phosphorus-reduction strategies. Then the CLA Strategic Direction Committee — a unique group of scientists, engineers, government agency personnel, business leaders, and others drawn from the CLA Community Board — prioritized the Yahara CLEAN Engineering Report recommendations into the Yahara CLEAN Strategic Action Plan, which outlines the 14 most important, achievable and cost-effective lake-improvement steps that can be taken by urban and rural stakeholders in the coming years to achieve that goal.

CLA has worked with partners to identify lead agencies, address budget gaps and needed policy changes, as well as identify action teams for implementing these important phosphorus-reduction actions. Going forward, CLA will collaborate with these action teams to set implementation schedules, develop citizen action and monitoring programs to increase public involvement, raise funds for both programs and projects, and continue to engage stakeholders through outreach and communication.

The Clean Lakes Alliance (CLA) is a not-for-profit organization devoted to improving the water quality of the lakes, streams, and wetlands of the Yahara River watershed. We are a unique partnership of diverse stakeholders who are building on — and expanding upon — decades of ongoing efforts to preserve and restore our waterways. Our goal is to raise community awareness of the issues facing the watershed, advocate for the welfare of the lakes, and help procure the necessary funding to clean and protect those waterways. Working closely with state, county, and local government agencies, as well as waterway user groups, riparian owners, and community non-profits, CLA will serve as both a positive voice for the promotion of our cherished lakes and a fundraising vehicle for achieving our goals.

Our Vision

We see a future in which everyone realizes that our lakes are the center of our community.
Healthy Lakes. Healthy Community.

The Mission goes one step further to share how we plan to accomplish Our Vision...

Our Mission

The mission of the Clean Lakes Alliance is to continue to build a community of people, businesses, organizations, and government agencies dedicated to continuously improving and protecting water quality in the Yahara River watershed.

Acknowledgements

This plan would not have been possible without many hours of dedicated work from the following individuals.

Clean Lakes Alliance Strategic Direction Committee

Lars Barber, Principal, W.F. Baird & Associates
Kevin Connors, Director of Land and Water Resources Department, Dane County
Lloyd Eagan, Water Leader, Wisconsin Department of Natural Resources
Greg Fries, City of Madison Engineering
Michael Gerner, Clean Lakes Alliance Executive Board
Tom Groth, Global Director, Thermo Fisher Scientific
Sue Jones, Land and Water Resources Department, Office of Lakes and Watersheds, Dane County
John Kothe, President, Kothe Real Estate Partners
Richard Lathrop, University of Wisconsin Center for Limnology
John Magnuson, Professor Emeritus, University of Wisconsin Center for Limnology
David Merritt, Policy and Program Development, Dane County
Randy Peterson, Vice President of Engineering and Corporate Services and Sustainability, Lands' End
Genesis Steinhorst, City of Madison Engineering
Dave Taylor, Director of Special Projects, Madison Metropolitan Sewerage District

Yahara CLEAN MOU Signatory Agency Lead Staff

Sue Jones, Land and Water Resources Department, Office of Lakes and Watersheds, Dane County
Sue Josheff, Wisconsin Department of Natural Resources
Dennis Presser, Wisconsin DATCP
Genesis Steinhorst, City of Madison Engineering

Yahara Pride Farm Conservation Board

Jeff Endres, President, Endres Berryridge Farms
Dave Fahey, Middleton Community Bank
Michael Gerner, Grant Thornton LLP
Don Heilman, Clean Lakes Alliance
Will Hensen, Hensen Brothers Dairy Farm
Rob Klink, AA Seeds LLC
Scott Maier, Treasurer, Maier Farms
Walter Meinholz, Blue Star Dairy Farms
Chuck Ripp, Secretary, Ripp's Dairy Valley Farm
Dave Taylor, Madison Metropolitan Sewerage District
James Tye, Clean Lakes Alliance
Bob Uphoff, Vice President, Uphoff Ham and Bacon Farm

Clean Lakes Alliance Community Board

Michael Gerner*, Community Board Chair, CLA Board of Directors
John Kothe*, Community Board Vice-Chair, Owner of Kothe Real Estate Partners
Jacci Meier*, Co-Chair of the Clean Lakes Festival, Clean Lakes Alliance Board of Directors, Baird & Associates
Randy Peterson*, Vice President, Engineering and Corporate Services and Sustainability at Lands' End

Chris Clark, Head Coach of Men's Crew, University of Wisconsin – Madison
Jeff Endres, Owner at Endres Berry Ridge Farm
Louisa Enz, Realtor at Stark
Chuck Gates, President, Yahara Lakes Association Representative
Marilee Gorman, "Friends" of Clean Lakes
Kristin Kirkconnell, Senior Vice President at American Family Insurance
John Kothe, President of Kothe Real Estate Partners
Tyler Leeper, Owner of Wingra Boats
Jim Lorman, Professor at Edgewood College
Dave Lumley, CEO at Spectrum Brands
Tim Metcalfe, President at Metcalfe's
Bob Miller, Mayor of Monona
Michael Mucha, Madison Metropolitan Sewerage District
Brennan Nardi, Editor of Madison Magazine
Stacey Neu, Vice President, Spectrum Brands
Brian Potts, Foley and Lardner LLP
Bob Sorge, Vice President, Strategic Partnerships at Madison Community Foundation
Bryon Thompson, Executive Vice President of TermSync
Russ Tieman, President of Mad-City Ski Team
Jim Welsh, Natural Heritage Land Trust

* 2013 Board of Directors

Clean Lakes Alliance Staff

Don Heilman, President
James Tye, Vice President
Nancy Sheehan, Policy & Program Coordinator

Strategic Action Plan Donors

American Transmission Company
City of Madison
Dane County
Hy Cite Corporation
Lands' End
Madison Community Foundation
Madison Metropolitan Sewerage District
Spectrum Brands

Executive Summary

The impaired water quality of the Yahara River chain of lakes, Mendota, Monona, Waubesa, and Kegonsa, can be seen in the number of beach closures due to potentially toxic blue green algae, the lack of water clarity, and the smell of decay from our over-fertilized lakes. Past efforts to clean the lakes of these problems led to improvements in the treatment of sewage and other point sources of pollution. Today's challenge is to address phosphorus enriched runoff from urban and rural lands, known as non-point source pollution.

The Yahara CLEAN Strategic Action Plan for Reducing Phosphorus enumerates fourteen specific actions with clear achievable phosphorus reduction goals to clean the lakes. The actions promote proven, cost-effective urban and rural practices to address phosphorus pollution now. The goal of the plan is to produce dramatic improvements in lake water quality by achieving a 50% reduction in the average annual phosphorus load from direct drainage sources in the Yahara chain of lakes. If no other significant water quality threats intervene – and once phosphorus load reduction goals are realized -- we will double the number of days when the lakes are clear, our beaches are open, and we will significantly reduce the number toxic algal blooms that limit recreational enjoyment of the lakes.

Overall, 71% of the phosphorus load reduction must come from rural areas. Fortunately, many farmers and livestock owners are already hard at work to reduce phosphorus enriched runoff. They will be intensifying their efforts to improve cropping, tillage, and in-field practices and managing manure and nutrients to meet the goals in the plan. Yahara Pride Farms will be supporting farmers in their phosphorus reduction efforts. Building more community manure digesters will be one important action to help farmers manage manure so that less phosphorus reaches area lakes and streams.

Overall 28% of the phosphorus load reduction comes from urban areas. It will be challenging to meet the phosphorus reduction goals in urban areas since so much of the land is developed and there is little opportunity to clear stormwater of phosphorus before it reaches the lakes. To meet this challenge urban residents and municipalities will be called upon to improve leaf management and control of construction erosion, stabilize urban waterway banks, and reduce the amount of total suspended solids from runoff in municipal stormwater.

Through the combination of urban and rural actions, we will reduce phosphorus loads into Lake Mendota by 53%, Lake Monona by 26%, Lake Waubesa by 50%, and Lake Kegonsa by 56%. Phosphorus reductions in the Lake Mendota watershed will provide additional benefits to the rest of the lakes since phosphorus from Mendota flows to each of the downstream lakes via the Yahara River. In the next few years, we will use emerging technologies, like alum additions in waterways, to further reduce the phosphorus load to Lake Monona and achieve the 50% target.

The estimated net cost to implement all the Yahara CLEAN actions is \$78.6 million dollars, after a deduction of \$49.5 million in private business investment in community digesters. The remaining funds will be raised through a combination of public and private sources.

In summary, the Clean Lakes Alliance and Yahara CLEAN partners support the following points:

It's Possible... We can rehabilitate the lakes, doubling the number of "clear" water days

Commitment... We have strong commitment and partnerships to renew and expand the effort

Road Map... We have 14 actions to reduce phosphorus by 50% in each lake

Action... We are poised to take action as a community and involve all citizens in the efforts

Yahara WINS... We are in a pilot program to reduce rural and urban phosphorus enriched runoff, a partnership of 21 municipalities and several nonprofits

Support Clean Water... Support elected officials in their efforts to clean the lakes

Contents

Preface	1
Acknowledgements	2
Executive Summary	4
I. Yahara Lakes: Past, Present, and Future.....	6
II. Background and Partners.....	8
III. How Phosphorus Travels Through the Yahara Chain of Lakes.....	10
IV. A Summary of the Yahara CLEAN Engineering Report.....	12
Urban Actions.....	13
Rural Actions	14
Summary of Rural and Urban Actions.....	16
Emerging Technologies	18
V. Lake by Lake Analysis	19
Lake Mendota	19
Lake Monona	22
Lake Wingra	24
Lake Waubesa	25
Lake Kegonsa.....	27
VI. Cost to Clean Up the Lakes	29
VII. Next Steps for Implementing the Actions.....	30
VIII. References	31

I. Yahara Lakes: Past, Present, and Future

The lakes in the Yahara River watershed, Lakes Mendota, Monona, Wingra, Waubesa, and Kegonsa, are vital to the economy and to the overall quality of life of the region. Yet there is widespread recognition that the water quality of the lakes has deteriorated over the years since the area was settled as Wisconsin's capital. Each summer, beaches are closed due to water quality concerns and blue green algal blooms turn our lake waters into a soupy green mess. These water quality concerns limit our enjoyment of the lakes and beaches. How did the lakes get into this state?

Yahara Lakes Past

There are many reasons that water quality in the Yahara lakes has deteriorated from what early settlers described as clear waters with white sandy bottoms. As the land around the lakes developed into agricultural and urban areas, there was little recognition that development on the land was reducing water quality in the lakes. Like many cities in the late 1800's, Madison installed sanitary sewers that discharged human sewage directly into the lakes. Farmers drained wetlands to prepare the land for agriculture. Cities installed storm sewers and filled wetlands for urban development. These practices allowed nutrient-rich water to quickly drain to our lakes and tributaries.

Because of these practices, as early as 1882, the first noxious growth of blue-green algae was observed in Lake Mendota, but the real problems with algae growth began occurring in Lake Monona in the early 1900's when Madison's sewage started entering the lake. Civic leaders of the day tried many approaches to clear the waters of algal blooms and excessive aquatic plants. The science of what causes water quality problems was just beginning. In the next few decades, the first steps towards improving water quality began. Wastewater treatment plants were built. Then, in 1936, Madison's sewage effluent was sent to Madison Metropolitan Sewerage District (MMSD), which discharged via Nine Springs Creek into Lake Waubesa. Sewage was diverted around the lower Yahara lakes in 1958 and from Lake Mendota in 1971. These steps to control the sources of impaired water quality that come from pipes leading into waterways, also known as point sources, led to many water quality improvements.

Yahara Lakes Present

Today, the science of lake ecology has made considerable advancements. We now understand more about the many sources of pollution that impair water quality. We also know more about how to control the diffuse sources of impaired water quality, known as non-point sources. Non-point sources of pollution include streams that feed sediment and nutrients into the lakes, stormwater and construction site runoff, and runoff from agricultural fields. Because the sources of non-point pollution are more diffuse, the actions that reduce their impact on water quality will require the cooperation of everyone in the Yahara lakes community – farmers and city dwellers, municipalities and unincorporated areas. That is today's challenge.

This plan addresses one important non-point source pollutant, excess phosphorus. Phosphorus is a nutrient that occurs naturally and is used in fertilizer and animal feed. It is also found in food, leaves, and animal waste. When phosphorus finds its way into our waters, from agricultural and stormwater

“Over the years, the issues facing the lakes have changed and the cumulative effects of many pollutant sources now are the greatest challenge. Sources include rural and urban runoff containing nutrients and sediment, over-application of phosphorus fertilizer and manure to soils already high in that nutrient, urbanizing landscapes, and uncontrolled storm sewer outfalls.”

Yahara CLEAN Report

runoff, it fuels excessive algal growth and can cause harmful algal blooms, changes in how aquatic plants and animals interact, decreased water clarity, and poor water quality. According to lake scientists, one pound of phosphorus in a water body can grow up to five hundred pounds of algae. Excess phosphorus enters our waterways from both rural and urban areas.

The Yahara CLEAN Strategic Action Plan for Reducing Phosphorus (Plan) enumerates specific actions to reduce the amount of phosphorus that enters our Yahara lakes and streams. The actions represent what scientists, agricultural experts, lake managers, and engineers know today about proven ways to reduce phosphorus runoff into waterways. The actions in this plan take us the next step on the road to improved water quality. They focus on the more diffuse sources of impaired water quality, known as non-point sources. If we are successful, we will see more days when the lakes have clear water, our beaches are open, and we will have far fewer algal blooms.

Yahara Lakes Future

As a result of this plan, there will be many efforts over the next ten years to reduce phosphorus. But phosphorus is not the only threat to water quality. Other threats include nitrogen from runoff and groundwater inflows, chloride from winter salt spreading in the streets, the impact of climate change, beach impairments from waterfowl bacteria and stormwater runoff, and the continuing invasion of non-native species that can upset the balance with our native aquatic plants and animals. There are many groups in the Yahara lakes community that are working to address these threats. For one, lake scientists at the University of Wisconsin–Madison and governmental agencies will continue to study and advance the understanding of lake ecology, as they have for decades. The Department of Natural Resources will continue to work with lake groups, municipalities, and citizens to set standards and help improve water quality. Dane County will continue to work with farmers, property owners, and the construction businesses to address agricultural and stormwater runoff. Many lakes and watershed groups will continue their efforts to address water quality threats specific to their lakes and streams.

As we put the phosphorus reduction practices enumerated in this plan into place over the next ten years, we will accomplish many things. We will advance our knowledge of the best practices to use. We will reduce the phosphorus load into the lakes substantially. We will see many improvements in water quality. However, we cannot lose sight of the other threats to water quality and the impact of ten years of continuing development of the land surrounding the lakes. We will have to assess and address the impacts of climate change, beach impairments, invasive species, winter salting, and other threats in a comprehensive watershed improvement plan. We will also assess the impact of the proposed actions and adapt them to current conditions in the watershed.

Improving the water quality of the lakes is a journey. We are firmly on the path, thanks to past efforts of engaged and active groups in the community. As we move forward, we will have to continue to come together as a community to address the many factors that impact water quality in the lakes. Each of us must commit to understanding how our actions can help clean the lakes, and then put that understanding into action. The future quality of our Yahara lakes and tributaries depends on it.

II. Background and Partners

The Yahara lakes community has put together an impressive number of partnerships to address the water quality concerns of the lakes. Because space is limited not all previous efforts can be acknowledged. We focus on those programs and partners upon which this plan is a direct descendant. This strategic action plan would not be possible without their efforts. Some of the groups include the Wisconsin Department of Natural Resources (DNR), Dane County, the Yahara Lakes Legacy Partnership (YLLP), Yahara CLEAN partners, the Yahara Pride Farms Board, the University of Wisconsin-Madison, the Madison Metropolitan Sewerage District (MMSD), the City of Madison, and the Clean Lakes Alliance.

Wisconsin Department of Natural Resources Partnerships

The Wisconsin Department of Natural Resources (DNR) has sponsored many projects to clean the Yahara lakes. The 1981-1990 Six-mile Creek/Pheasant Branch Priority Watershed Project, through a partnership between DNR, the Department of Agriculture Trade and Consumer Protection (DATCP), Dane County, and Columbia County, installed erosion controls in agricultural areas and improved stormwater management in urban areas in the western portion of Mendota's watershed. The 1988-1998 Priority Watershed Project for the Yahara River and Lake Monona Watershed reduced agricultural sources of sediment by forty-eight percent (48%). From 1993 to 2008, the Yahara Mendota Priority Watershed Project promoted traditional conservation practices such as grass waterways, contour strip cropping, streambank protection, barnyard runoff systems, nutrient management, and wetland restoration.

The DNR recently worked with a robust group of partners to develop a Total Maximum Daily Load (TMDL) Plan for the Upper and Lower Rock River Basin, which was submitted to the U.S. Environmental Protection Agency (EPA) for review in August, 2011. The EPA approved the plan in September, 2011. The Rock River Basin TMDL, which includes the Yahara lakes, details the levels of phosphorus and sediment reduction that are needed from point and non-point sources to meet EPA water quality standards. Wastewater treatment plants within the Yahara River watershed are working together to reduce phosphorus and total suspended solids loads coming from urban and rural stormwater runoff to achieve the new water quality standards.

Yahara CLEAN Partnerships

In 2008, a partnership called Yahara CLEAN (Capital Lakes Environmental Assessment and Needs) was forged between the City of Madison, Dane County, DNR, and DATCP. The partners assessed and modeled major sources of sediments, nutrients, and beach bacteria, and proposed solutions to remediate those sources. They engaged hundreds of area residents and experts to create a vision for the lakes and to provide input on the improvement actions being contemplated. They engaged lake scientists at the DNR and the University of Wisconsin Center for Limnology to assess lake response to phosphorus reduction actions in the watershed. They established clear and achievable goals and an implementation plan for achieving a fifty percent reduction in phosphorus runoff.

The Yahara Lakes Legacy Partnership supported the Yahara CLEAN partners as they developed their plan of action. In September 2010, the Yahara CLEAN partnership released its report, ***A CLEAN Future for the Yahara Lakes: Solutions for Tomorrow, Starting Today***. The report identified seventy (70) actions to help clean up the lakes. The actions include recommendations for reducing sediment and nutrient input into the lakes and improving beach water quality through stormwater management and goose control measures. Moving forward from these intensive efforts, the signatory agencies for Yahara CLEAN have partnered with groups like the Clean Lakes Alliance to further engage the community and develop a focused plan to clean the lakes.

Clean Wisconsin

Clean Wisconsin, along with Gathering Waters, were founding members and active participants in the Yahara Lakes Legacy Partnership throughout the Yahara CLEAN project. More recently, Clean Wisconsin backed changes to state rules NR 102 and 217 (the "phosphorus rules") and NR 151 to address phosphorus pollution in our waterways. The phosphorus rule, which became effective in 2010, uses all the flexibility of the federal Clean Water Act to allow phosphorus reductions in the most cost-effective manner. In particular, the rule allows for point sources to address non-point sources of phosphorus pollution through "adaptive management." According to Clean Wisconsin, "permittees who choose this option may avoid high-cost technology upgrades that would not improve water quality." The adaptive management approach has led to major county-led efforts and the Madison Metropolitan Sewerage District's Yahara WINs partnership.

Yahara WINS Partnership

Yahara WINS is a partnership focused on improving water quality in the Yahara River watershed by reducing phosphorus loads. The partnership includes regulated point sources like the Madison Metropolitan Sewerage District; municipal stormwater systems like the City of Madison and other towns, cities, villages; Dane County; farm producers; and environmental organizations. The Clean Lakes Alliance, Yahara Pride Farms, Sand County Foundation, and Clean Wisconsin are signatory partners.

Using the watershed adaptive management process allowed in the recently adopted state rules NR 102 and 217, this partnership aims to reduce phosphorus loading into the Yahara lakes and gain permit compliance. Watershed adaptive management allows innovative approaches to the complex problem of non-point source pollution. A goal of this partnership is to invest in a low-cost mix of practices that will truly improve water quality by addressing runoff from agricultural fields, construction sites, and urban areas. Yahara WINS is currently operating a pilot project north of Lake Mendota and hopes to move to a full scale adaptive management project beginning in 2016.

III. How Phosphorus Travels Through the Yahara Chain of Lakes

The Yahara River Watershed

To help focus the phosphorus reduction recommendations of the Yahara CLEAN report and estimate the water quality benefits of implementation, the CLEAN partners asked Dr. Richard Lathrop, Department of Natural Resources, and Dr. Stephen Carpenter, Director of the University of Wisconsin Center for Limnology, to study the linkage between annual phosphorus loads entering each of the four Yahara lakes and the summer water quality responses of those lakes to load reductions. This work was based on more than thirty years of phosphorus loading and in-lake water quality data available through 2008.

Lathrop and Carpenter found that, during times of drought, the water quality of the lakes was substantially better since there was little stormwater runoff to carry phosphorus into the lakes. They used this information to develop phosphorus loading targets for the lakes. According to Lathrop, "Experience from past droughts when runoff was minimal indicates the Yahara lakes respond rapidly to reduced phosphorus inputs. This rapid response is encouraging. It shows that immediate improvements in the lakes' water quality can be expected if management is successful in decreasing phosphorus loads."

Lathrop and Carpenter also analyzed the journey of phosphorus pollutants throughout the Yahara River watershed system. The Yahara River watershed contains all the land, tributaries, and streams that drain to the Yahara lakes. In their study, Lathrop and Carpenter included the Yahara River chain of four lakes, which includes Mendota, Monona, Waubesa, and Kegonsa. Lake Wingra was not included in their study because, due to its smaller size and much shallower depth, the lake responds (in terms of algal growth) differently to phosphorus inputs than the four major lakes. In addition, suitable long-term phosphorus load dataset also not available for Lake Wingra.

While much of the Yahara watershed is farmed, it also contains most of the urban land in the Madison metropolitan area; all or parts of five cities, seven villages and sixteen towns; and is home to about a quarter million people. Because water naturally moves downstream in the watershed, any activity affecting the water quality in upstream waters impacts the water quality of downstream rivers and lakes. This basic dynamic can be seen in the Yahara Watershed.

The Yahara River, which flows south from Columbia County, through Lakes Mendota, Monona, Waubesa, and Kegonsa to the Rock River in Rock County, carries water from lake to lake. Pollutants that are washed off the land during rain events are transported to Lake Mendota via its major tributaries (Pheasant Branch, Six mile Creek, Yahara River, and Token Creek) and various inflowing storm sewers and drainage ditches. In turn, phosphorus flows from Mendota's outlet via the Yahara River to Lake Monona even as new sources of pollutants enter Lake Monona from the urban land that drains to the lake. Thus, Monona's "direct drainage area" is defined as the land area that drains to Monona downstream of Mendota's outlet. The water that originated from upstream lands, streams, and lakes continues to flow downstream from Monona's outlet via the Yahara River to lakes Waubesa and Kegonsa, even as new sources of phosphorus enter from each of those lakes' direct drainage areas.

In their analysis, Lathrop and Carpenter found that the Yahara River, after it leaves Mendota, is an important conduit for phosphorus. Because of its large watershed area, Mendota had the highest average input load of phosphorus of all the lakes. They also found that, excluding other minor sources of phosphorus from the atmosphere and groundwater, Lake Mendota contributes 60% of Monona's combined surface water phosphorus load (upstream outlet river load plus direct drainage load). In Lake Waubesa, the upstream river load from Lake Monona was 83% of the combined surface water sources. In Lake Kegonsa, the upstream river load was 76% of the combined sources. They concluded

that a reduction in phosphorus coming from Lake Mendota will benefit all the lakes in the Yahara River chain. In forming their recommendations, Lathrop and Carpenter also took into consideration the biological availability of the various phosphorus loading sources in prioritizing load reduction efforts for the Yahara lakes.

Based on the recommendations in the Lathrop and Carpenter report, the Yahara CLEAN partners have developed the following goals for the ***Yahara CLEAN Strategic Action Plan for Reducing Phosphorus***. The goals focus on reducing the direct drainage basin load of phosphorus to each lake. The downstream lakes will benefit from both the reduction in phosphorus coming from upstream lakes (especially Lake Mendota) and by management practices installed in their direct drainage basins. The lake by lake goals are:

- **Lake Mendota:** Reduce the average annual phosphorus load to Lake Mendota by at least fifty percent (50%). This will produce measurable water quality benefits in Mendota and a significant phosphorus load reduction to all the downstream lakes.
- **Lake Monona:** Reduce the average annual phosphorus loads by 50% from the direct drainage sources to Lake Monona. Lake Monona will benefit from the combination of phosphorus reductions from both direct drainage sources and from Lake Mendota's outlet. This will produce measurable water quality benefits in Monona.
- **Lakes Waubesa and Kegonsa:** Reduce the average annual phosphorus loads from direct drainage sources to Waubesa and Kegonsa by 50%. These lakes will also benefit greatly from the reduction in phosphorus loads to the upstream lakes.

In summary, the goal of the *Plan* is to reduce the average annual phosphorus load from direct drainage sources to each lake in the Yahara chain of lakes by 50%. To meet these goals for the Yahara lakes, the Yahara CLEAN partners and the Clean Lakes Alliance contracted with Strand Associates to recommend actions that will reduce the phosphorus loads delivered to the Yahara lakes.

IV. A Summary of the Yahara CLEAN Engineering Report

The Clean Lakes Alliance (CLA) brought together a diverse group of scientists, engineers, government officials, and business people forming the new Strategic Direction Committee (Committee) to determine the best course for development of an action plan for reducing phosphorus runoff to our lakes. After a rigorous selection process, Strand Associates was chosen to create the report.

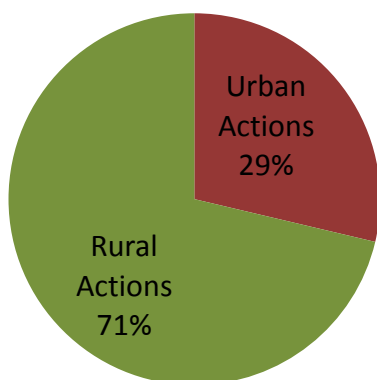
The Yahara CLEAN Engineering Report (2012) produced by Strand Associates includes a watershed analysis for each of the four major Yahara lakes and an assessment of the amount of phosphorus entering each lake. Strand engineers used this information to model the effect of various actions intended to reduce the amount of phosphorus (the phosphorus load) delivered to the lakes.

The first order of business was to assemble a diverse group of stakeholders in a workshop to guide Strand as they began their work. Workshop participants represented various stakeholders from the rural agricultural community to the urban dweller and from governmental organizations to academic institutions. The group began with a list of seventy-five (75) actions. To whittle this list down to a more manageable number, the Committee developed monetary and nonmonetary factors to score and then rank each action. Nonmonetary factors included: shorter timeline, maintaining working farmland, relying on proven technology, and providing visible public benefits, among others. For example, one important goal of this project is to demonstrate a positive change in the quality of the Yahara lakes within a reasonable timeframe of ten years. Actions that can produce measurable progress within five years and reach their target phosphorus diversion within ten years were assigned a high score. Those actions with longer timeframes were given lower scores. An estimate of the cost for each action in dollars per pound phosphorus diverted (\$/lb phosphorus diverted) was also developed.

Actions that were administrative in nature or were pilot projects were set aside during this phase of the project. Of the remaining forty-five (45) actions, approximately thirty (30) of the highest-ranked actions were presented to the Committee and the Yahara CLEAN partners and discussed in great detail over a series of many meetings. The Committee shifted five of the actions into a separate category called emerging technologies to be considered after further study. The committee also set aside two actions that have low potential for phosphorus reduction but may be considered later when the Committee addresses water quality at beaches. Through this process, a list of fourteen (14) actions was created. The phosphorus reductions calculated for each action are based on models and assumptions and more than thirty years of monitoring data.

The combination of actions is tailored for each lake in the Yahara River chain and focuses on a fifty percent (50%) reduction in the direct drainage sources of phosphorus to each lake. The actions are further divided into rural and urban actions. The urban actions account for twenty-nine percent (29%) of the phosphorus reduction and rural actions account for seventy-one percent (71%). The split between urban and rural actions reflects the makeup of the land that drains into the lakes. According to the Watershed-Wide SWAT Model produced by Montgomery Associates as part of the Yahara CLEAN report, twenty-seven percent (27%) of the land is urban and seventy-three percent (73%) is rural. The actions are discussed in more detail in the next two sections.

Yahara CLEAN Action Plan Total P Diverted per Year



	Total P Diverted per Year (lbs)	Present Value Cost Over 20-Years (Millions)	Percent of Total P Diverted	Percent of Total Cost
Total All Lakes				
Urban Actions	13,400	\$29.8	29%	38%
Rural Actions	32,800	\$48.8	71%	62%
Total All Lakes	46,200	\$78.6	100%	100%

Urban Actions

Agriculture and livestock production has always had a prominent role throughout the Yahara River watershed. However, times are changing and now the watershed is home to many towns, villages, and cities. The second most populous city in Wisconsin, Madison, can be found in the Yahara River watershed.¹ Metropolitan areas like Madison have a major impact on surface water quality and present unique challenges to maintaining water quality. The pavement, roads, and buildings in urban areas do not allow rainwater to penetrate into the ground. Instead, the rain is diverted into storm sewers and flows directly into the lakes and streams. This urban runoff carries sediment and other pollutants, like phosphorus, directly into the lakes.

Towns, villages, and cities are also part of the solution. The Yahara CLEAN plan provides specific actions that homeowners, businesses, and governmental agencies can undertake to reduce phosphorus inputs into the Yahara lakes. Indeed, twenty eight percent (28%) of the phosphorus load reduction suggested in the plan call upon urban citizens and municipalities to unite to make a difference.

¹ Population estimates for the Yahara Waters are a quarter million people.
<http://www.danewaters.com/articles/historyandsetting.aspx>

In general, the urban actions include:

- Improve leaf management

Municipalities in the watershed have different methods for managing leaves. As part of this plan, the City of Madison is partnering with the United States Geological Survey (USGS), DNR, and others to study the phosphorus and sediment delivery from leaves so that improved leaf management policies can be developed. Municipalities statewide will also know the impact of leaf management practices on water quality and can take credit for them in their stormwater discharge permits.

- Improve control of construction erosion

At the County level, the strategic action plan calls for improving construction site erosion control education and enforcement. This action results in the lowest cost per pound of phosphorus removed in the urban action category.

- Maintain permitted stormwater facilities

The strategic action plan calls for a countywide inspection and maintenance program to ensure all permitted stormwater facilities are maintained and operating as planned.

- Stabilize urban waterway banks

Extended periods of high water, as well as times when heavy rains increase the flow of water in urban waterways, can contribute to stream bank erosion. The periodic sloughing of bank material into urban waterways contributes to sedimentation and transport of Total Suspended Solids (TSS) and phosphorus to the lakes. Streambank restoration to stabilize the banks is an important step towards reducing phosphorus loading into urban waterways.

- Reduce total suspended solids (TSS) from runoff in municipal stormwater by forty percent (40%) or more

While most Municipal Separate Storm Sewer Systems (MS4s) in the Yahara River watershed are at or above a twenty percent (20%) TSS reduction within their community, which was a requirement of their stormwater discharge permits, the newly adopted Rock River Total Maximum Daily Load (TMDL) includes further reductions and assumes each MS4 has already reached a forty percent (40%) reduction. Meeting the 40% TSS reduction requirement would generally be accomplished through stormwater detention ponds and other urban best management practices and will improve water quality considerably.

Rural Actions

There are many thriving agricultural enterprises throughout the Yahara River watershed. Agricultural farms and livestock operations pose challenges to maintaining and improving water quality. Like their urban counterparts, farmers and livestock owners are part of the solution. Overall, seventy-one percent (71%) of the phosphorus load reduction must come from rural area actions. This will involve farmers working with each other and local and county governments to improve manure and nutrient management and cropping and tillage practices.

Fortunately many farmers and livestock owners are already hard at work to reduce phosphorus enriched runoff. Many livestock owners complete "Comprehensive Nutrient Management Plans" while many farmers follow Best Management Practices in terms of crop management and soil enrichment. Some of the actions described below build on these efforts.

Again, rural actions undertaken around streams and rivers that feed into Lake Mendota are critical to reducing phosphorus loading to all the lakes. Remember--phosphorus flowing into Lake Mendota can travel to the rest of the lakes in the chain through the Yahara River.

The strategic plan calls for systemic action in:

- Managing Manure and Nutrients, and
- Improving Cropping, Tillage, and In-Field Agricultural Practices.

Systemic actions needed to improve manure and nutrient management include the following:

- Increase the availability of testing soil phosphorus levels for each farm field within the Yahara River watershed. Testing will help to identify those fields with higher concentrations of phosphorus;
- Develop a screening tool that will provide a simple, quick, and cheap method for identifying individual fields with high nutrient and sediment runoff; and
- Expand nutrient management resources and practices that maximize economic return and minimize threats to water quality.

Systemic actions needed to improve cropping, tillage, and other in-field actions include the following:

- Increase soil erosion control practices such as contour cropping, strip cropping, and terracing;
- Increase conservation tillage (leaving crop residue on fields) and no-till;
- Increase the planting of cover crops;
- Construct stream buffers; and
- Promote the restoration of and harvest the biomass from stormwater wetlands.

The Yahara Pride Farms organization is working to reduce phosphorus runoff in rural areas through voluntary, non-regulatory, incentive-based, certified best-management practices.

Manure digesters will help farmers to better manage manure on their fields so less phosphorus enters our lakes. As a commercial venture, the digesters will pay for themselves over time.

Community Manure Digesters

One of the plan actions specific to Lake Mendota calls for building additional community manure digesters. The construction of manure digesters will help to reduce the amount of manure that is applied on lands with high soil phosphorus levels. The farms that contribute to the digesters generally have very high concentrations of animals and produce a significant amount of manure. The digesters process the manure and produce a liquid digestate. According to the Engineering report, the Waunakee digester reduces, by up to sixty percent, the amount of phosphorus in the liquid portion of the manure that is returned to the farms. The digested solids can be sold to companies that make them into other products or export them out of the Yahara River watershed. The liquid digestate can be used to “water” crops—providing moisture and nutrients when the crop most needs them.

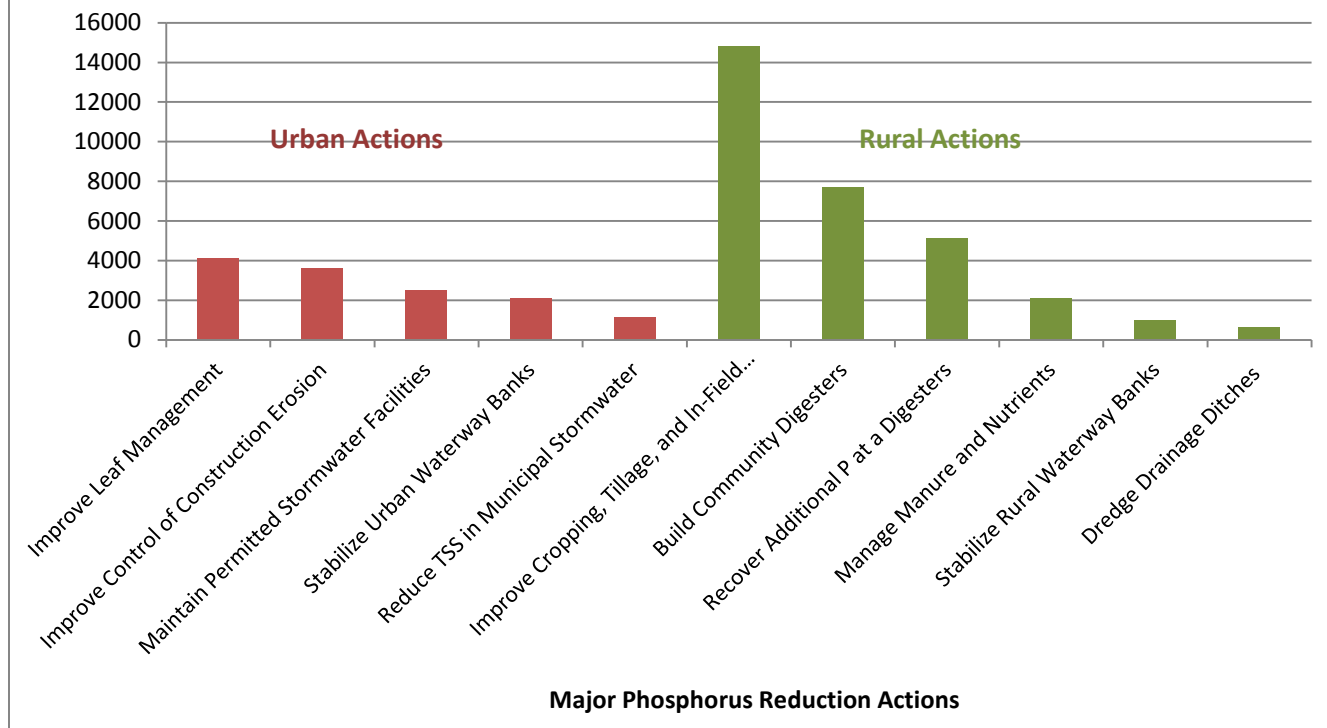
The benefits of community digesters are numerous. Applying digested manure rather than raw manure to fields will reduce the amount of phosphorus enriched runoff to the lakes. There are enhanced nutrient management requirements that come with being part of the digester cluster; these requirements will help farmers reduce the amount of phosphorus runoff to the lakes. Finally, digester sites with storage will reduce the need to spread manure in the winter when it has a higher chance of running off into nearby waterways.

Summary of Rural and Urban Actions

The following chart summarizes the Yahara CLEAN Strategic Action Plan for phosphorus reduction. Some of the rural actions are specific to Lake Mendota and are discussed in more detail in the Lake Mendota section. The present value cost used in the table refers to the cost in currently valued dollars of funds to be expended over a period of time.

Yahara CLEAN Strategic Action Plan				Total P Diverted Per Year (lbs)	Goal	Lead Agency	Present Value Cost over 20-Year Period (Millions)	Present Value Cost per lb Diverted (20-Year)
All Lakes								
Urban Actions								
Improve Leaf Management	4,100	20% increase in collections	MAMSWap ¹ and each municipality	\$4.1	\$50			
Improve Control of Construction Erosion	3,600	Reduce sediment runoff in new development by 80%	Dane County	\$1.7	\$25			
Maintain Permitted Stormwater Facilities	2,500	Achieve compliance from 400 (out of 1500 total) noncompliant facilities	Dane County	\$1.7	\$34			
Stabilize Urban Waterway Banks	2,100	13,700 linear feet	Each Municipality	\$4.7	\$113			
Reduce TSS in Municipal Stormwater	1,100	Achieve 40% target for all facilities	Department of Natural Resources	\$17.6	\$860			
Urban Subtotal	13,400			\$29.8	\$111			
Rural Actions								
Improve Cropping, Tillage, and In-Field Practices	14,800	54,900 acres per year	Dane County	\$14.5	\$49			
Build Community Digesters	7,700	5 systems	Dane County	\$60.0	\$390			
<i>Adjustment for Business Investment in Digesters</i>								
<i>Subtotal for Community Digesters</i>								
Remove Additional P at Digesters	5,100	5 systems	Dane County	\$10.0	\$98			
Manage Manure (m) and Nutrients (n)	2,100	11,572 (m) plus 15,700 (n) acres per year	Dane County	\$3.2	\$81			
Stabilize Rural Waterway Banks	1,000	17,000 linear feet	Dane County	\$2.1	\$104			
Dredge Drainage Ditches	600	2.5 miles per year	Dane County	\$2.4	\$218			
Relocate or Cover Livestock Facilities	600	14 sites	Dane County	\$2.1	\$174			
Harvest Wetland Plants	600	1,700 acres (once/3years)	Dane County	\$2.0	\$170			
Promote Restoration of Wetlands	300	100 acres/year	Dane County and Natural Heritage Land Trust	\$2.0	\$328			
Rural Subtotal	32,800			\$48.8	\$74			
Total All Lake Direct Drainage Load Reductions	46,200			\$78.6	\$85			
Total All Lake Direct Drainage Load Inputs	95,000							
Percent All Lake Load Reduction Achieved	49%							
¹ Madison Area Municipal Storm Water Partnership								

Yahara CLEAN Strategic Action Plan Total P Diverted Per Year (lbs)



Emerging Technologies

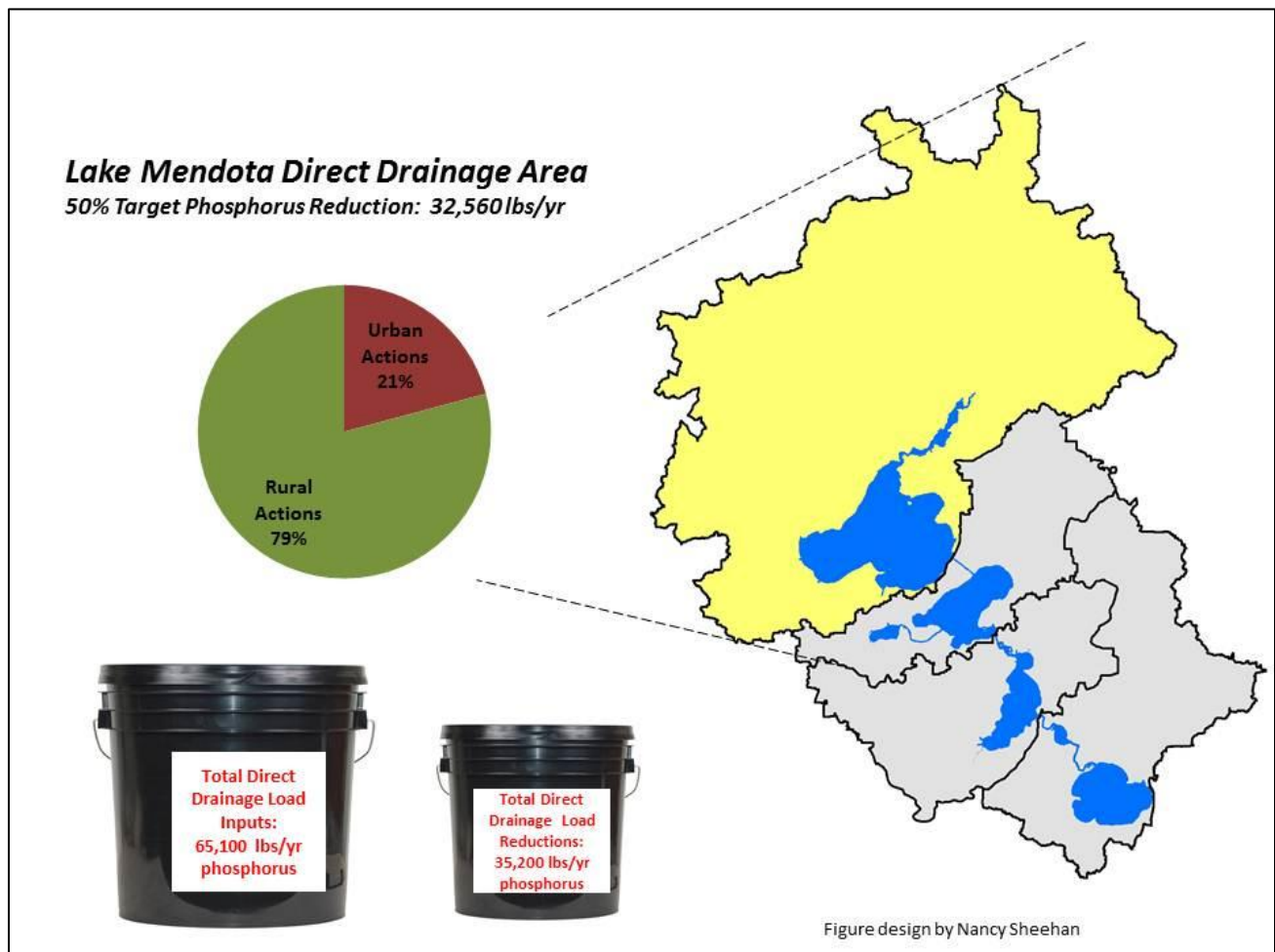
The Engineering report includes actions described as Engineered Actions. There are seven actions in this category including: “Build Community Digesters,” “Recover additional P from Digesters,” and five “Alum Addition Pilot Projects” in Lakes Mendota and Monona. At the direction of the Strategic Direction Committee and Yahara CLEAN partners, “Build Community Digesters” and “Recover additional P from Digesters” have been moved into the Rural Actions category. They are further discussed in that section. The Strategic Direction Committee and Yahara CLEAN partners felt the five “Alum Addition Pilot Projects” should be considered separately as emerging technologies. They are discussed in this section.

The Engineering report suggests pilot testing for two types of alum projects: storm event-based alum and pond additions. Storm event-based alum projects are proposed at Pheasant Branch and the Yahara River in the Lake Mendota watershed and at Starkweather Creek in the Lake Monona watershed. Event based alum treatments are designed to reduce phosphorus loading in runoff during storm events and have been employed extensively in Florida and Europe. Alum pond treatments are suggested for Tiedeman and West Towne stormwater ponds. The DNR has used alum treatments to “trap” or inactivate phosphorus in the bottom sediment of water bodies since the 1970s. Since alum has not been used extensively for stormwater treatment in Wisconsin, detailed planning and pilot testing are recommended at a few sites prior to more widespread implementation as part of the Yahara CLEAN project. Other emerging technologies will be added to the plan as we monitor and adapt the proposed mix of actions to current conditions in the watershed.

Lake Mendota

Lake Mendota has an average annual load of 73,480 pounds of phosphorus entering the lake from all sources, according to Lathrop and Carpenter. The direct drainage load of phosphorus entering Lake Mendota is mostly from rural sources. According to the DNR, half of the entire Yahara River watershed for the four major lakes drains into Lake Mendota. The load entering the lake from direct drainage sources is 65,120 pounds per year. The target reduction of fifty percent (50%) of the direct drainage sources is 32,560 pounds per year.

The recommended plan diverts 34,700 pounds of phosphorus from Lake Mendota on an annual basis, which is a fifty-three percent (53%) direct drainage reduction. As shown in the following figure, rural actions account for seventy-nine percent (79%) of the diversion and urban actions account for twenty-one percent (21%).



	Total P Diverted per Year (lbs)	Present Value Cost Over 20- Year Period (Millions)	Percent of Total P Diverted	Percent of Total Cost	Cost per Pound Diverted
Lake Mendota					
Improve Control of Construction Erosion	2,100	\$1.0	6%	2%	\$25
Improve Leaf Management	1,900	\$1.9	6%	3%	\$50
Maintain Permitted Stormwater Facilities	1,500	\$1.0	4%	2%	\$34
Stabilize Urban Waterway Banks	1,500	\$3.3	4%	6%	\$113
Reduce TSS in Municipal Stormwater	400	\$6.9	1%	12%	\$860
Urban Subtotal	7,400	\$14.1	21%	25%	\$95
Improve Cropping, Tillage, and In-Field Practices	9,500	\$9.3	27%	16%	\$49
Build Community Digesters*	7,700	\$10.5	22%	18%	\$68
Recover Additional P at Digesters	5,100	\$10.0	15%	17%	\$98
Manage Manure and Nutrients	1,900	\$2.9	5%	6%	\$81
Stabilize Rural Waterway Banks	1,000	\$2.1	3%	4%	\$104
Dredge Drainage Ditches	600	\$2.4	2%	4%	\$218
Relocate Livestock Facilities	600	\$2.1	2%	4%	\$174
Harvest Wetland Plants	600	\$2.0	2%	3%	\$170
Promote Restoration of Wetlands	300	\$2.0	1%	3%	\$328
Rural Subtotal	27,300	\$43.3	79%	75%	\$79
Total All Direct Drainage Load Reductions	34,700	\$57.4	100%	100%	\$83
Total Direct Drainage Load Inputs	65,100				
Percent Direct Drainage Load Reduction	53%				
*Cost includes deduction for business investment in community digesters.					

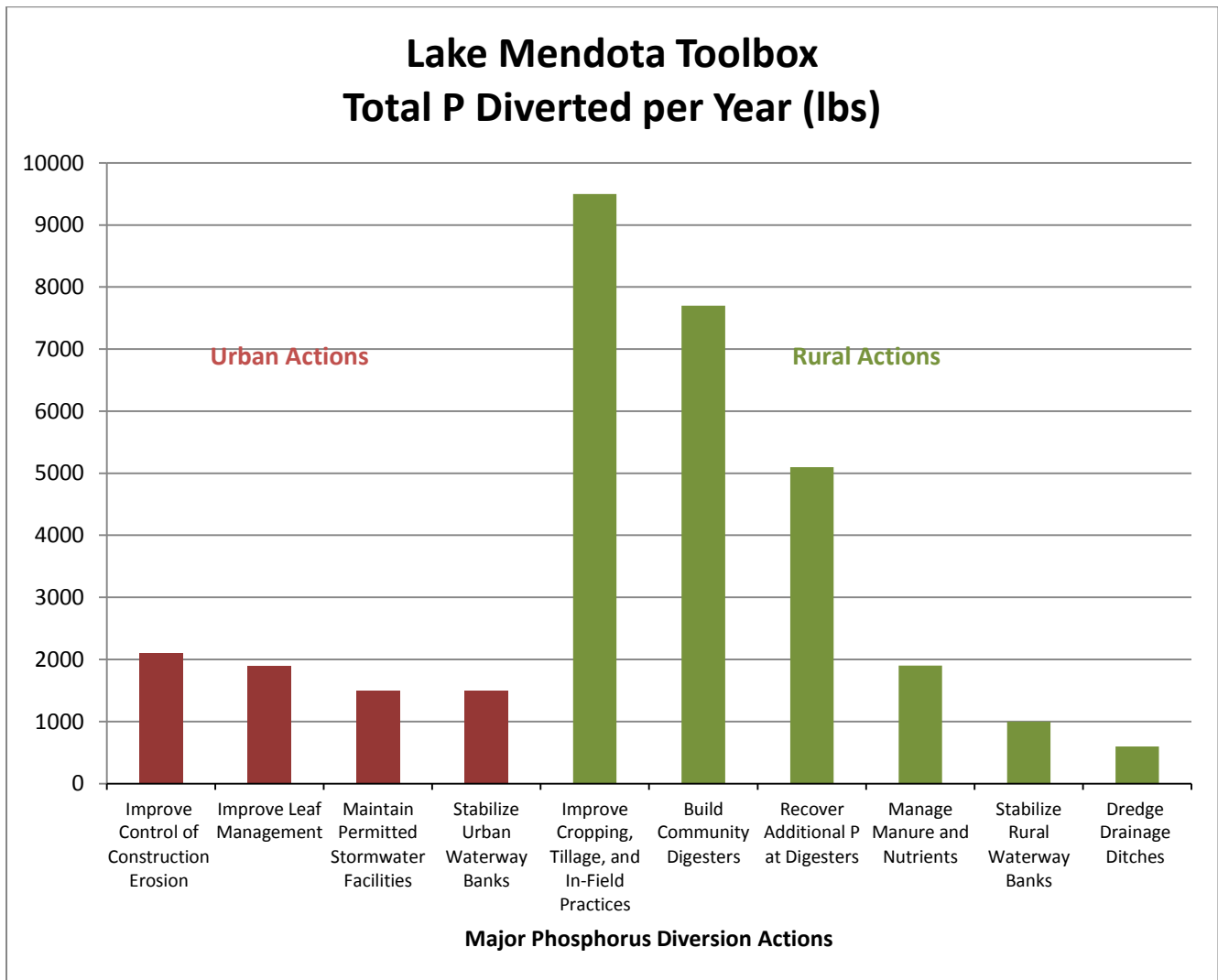
The diversion of phosphorus from Lake Mendota will be accomplished using a combination of actions in the rural and urban areas. Urban actions include improving construction erosion control, inspecting and maintaining stormwater facilities, improving leaf management, achieving a forty percent (40%) or more reduction in TSS in municipal stormwater, and stabilizing urban waterway banks.

Rural actions include actions common to all the lakes, such as improving manure management, and cropping, tillage and in-field practices. Additional action items include:

- building a total of five community digesters to handle manure from farms in the watershed;
- recovering additional phosphorus from digesters for export from the watershed;
- stabilizing rural waterway banks;
- removing sediment from selected drainage ditches (after suitable controls are in place on the adjacent and upstream fields to reduce sediment and nutrient runoff);
- relocating and/or covering livestock facilities in high risk, environmentally sensitive areas;
- Promoting the restoration of drained wetlands for stormwater cleansing functions and harvesting wetland plants to remove phosphorus taken in by the plants.

The rural actions in the Lake Mendota toolbox are the most extensive in recognition of the fact that phosphorus from Lake Mendota flows to each of the lower lakes through the Yahara River and is the

largest source of phosphorus to the downstream lakes. The following figure summarizes the load reductions resulting from the urban and rural actions in the Lake Mendota watershed.



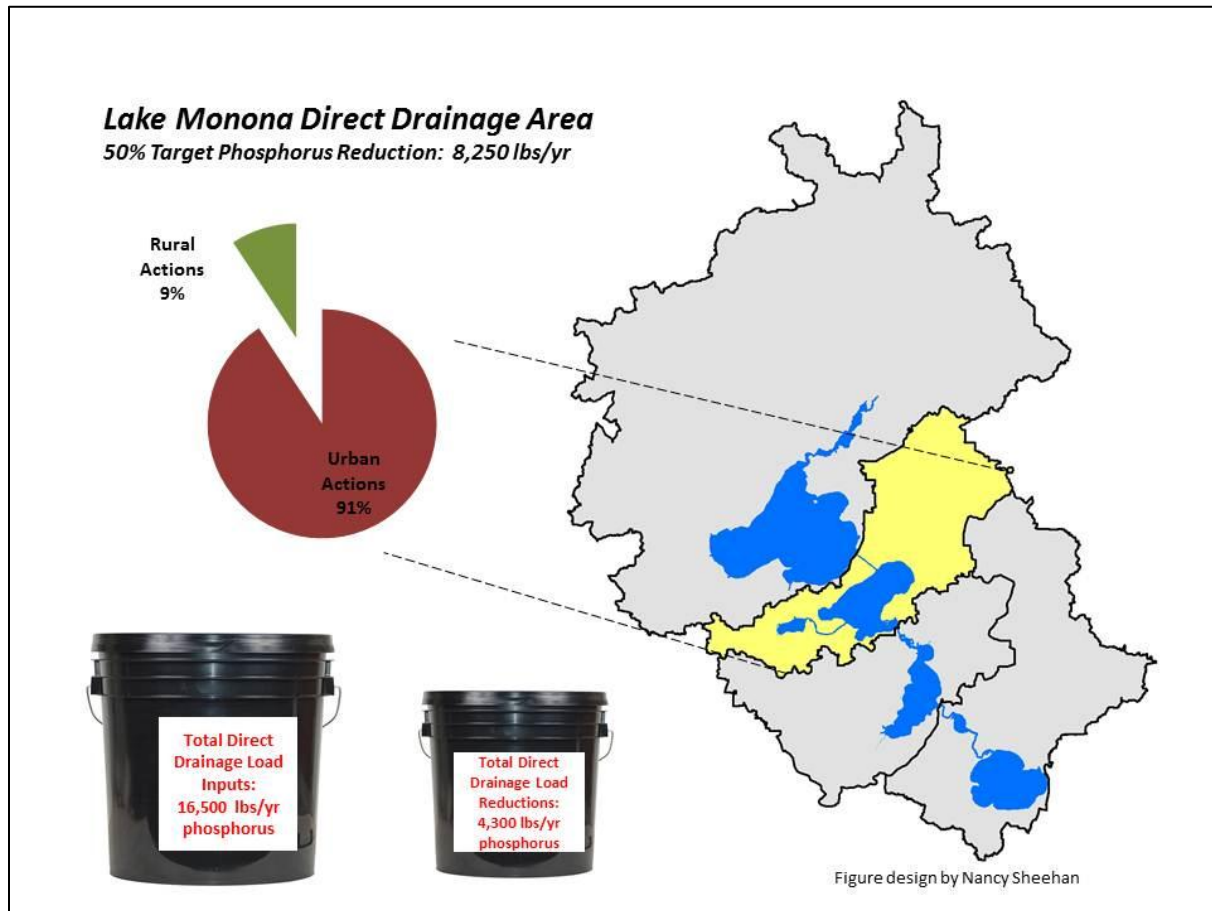
Lake Monona

Lake Monona has an average annual load of 43,820 pounds of phosphorus entering the lake from all sources according to Lathrop and Carpenter. The largest portion of the annual phosphorus load to Lake Monona comes from the outlet of upstream Lake Mendota (24,900 pounds). The load entering the lake from direct drainage sources is 16,500 pounds per year. The target reduction of fifty percent (50%) of the direct drainage sources is 8,250 pounds per year.

For Lake Monona, the recommended actions will reduce the annual phosphorus load by 4,300 pounds, which is less than the 50% target. The Engineering report recommends the addition of alum in Starkweather Creek to meet the 50% target for Lake Monona; however, the Yahara CLEAN partners felt more research was necessary on the impact of alum on the lake. It will be a challenge to meet the 50% target in this urban watershed because so much of the land is developed. Research is on-going and actions using alum could be implemented in a few years. Other emerging technologies, as they become available, could also be used to meet the target for Lake Monona.

Lake Monona will also benefit from the diversion of phosphorus from Lake Mendota. Based on Lathrop and Carpenter flow through calculations, the fifty-four percent (54%) direct drainage load reduction in Lake Mendota will reduce the load passed through from Lake Mendota to Lake Monona by 9,200 pounds (more than two times the amount of direct drainage reductions).

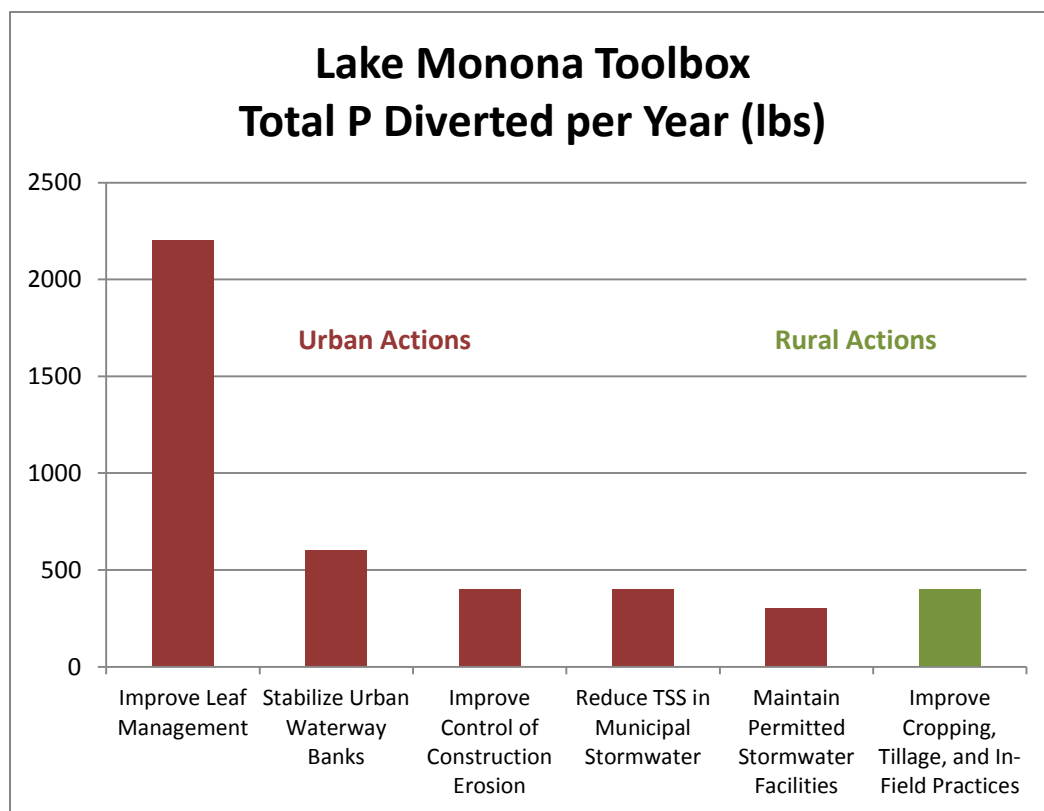
As shown in the following figure, rural actions account for only nine percent (9%) of the total diversion in this watershed and urban actions account for ninety-one percent (91%).



Lake Monona	Total P Diverted per Year (lbs)	20 Year Present Worth Cost (Millions)	Percent of Total P Diverted	Percent of Total Cost	Cost per Pound Diverted
Improve Leaf Management	2,200	\$2.2	52%	20%	\$50
Stabilize Urban Waterway Banks	600	\$1.4	14%	13%	\$113
Improve Control of Construction Erosion	400	\$0.2	9%	2%	\$25
Reduce TSS in Municipal Stormwater	400	\$6.2	9%	59%	\$860
Maintain Permitted Stormwater Facilities	300	\$0.2	7%	2%	\$34
Urban Subtotal	3,900	\$10.2	91%	96%	\$131
Improve Cropping, Tillage, and In-Field Practices	400	\$0.4	9%	4%	\$49
Rural Subtotal	400	\$0.4	9%	4%	\$49
Total All Direct Drainage Load Reductions¹	4,300	\$10.6	100%	100%	\$123
Total Direct Drainage Load Inputs	16,500				
Percent Direct Drainage Load Reduction	26%				
Benefit From Upstream Load Reductions	9,200				

¹ Direct Drainage Load Reductions will be increased through the use of emerging technologies.

Urban actions include improving leaf management, stabilizing urban waterway banks, improving construction erosion control, achieving a forty percent (40%) reduction in TSS from runoff in municipal stormwater, and improving stormwater facilities. Rural actions are those recommended for all the lakes and include manure and nutrient management and cropping, tillage and in-field practices. The following figure summarizes the major load reductions resulting from the urban and rural actions.



Lake Wingra

In the Yahara CLEAN Engineering Report, Lake Wingra, the smallest of the Yahara Lakes has been included as part of the Monona watershed. Lake Wingra has benefited from ongoing efforts of the Friends of Lake Wingra and their strategic publication ***Lake Wingra: A Vision for the Future*** (available at www.lakewingra.org). This report contains bold but practical “health goals” for Lake Wingra with specific targets in four areas: water quality, hydrology, biodiversity, and human use of the lake. The Friends of Lake Wingra, the City of Madison Engineering, Strand Associates, and the University of Madison Department of Civil and Environmental Engineering Professor Chin Wu are now working to develop a specific and long-term watershed management plan for Lake Wingra.

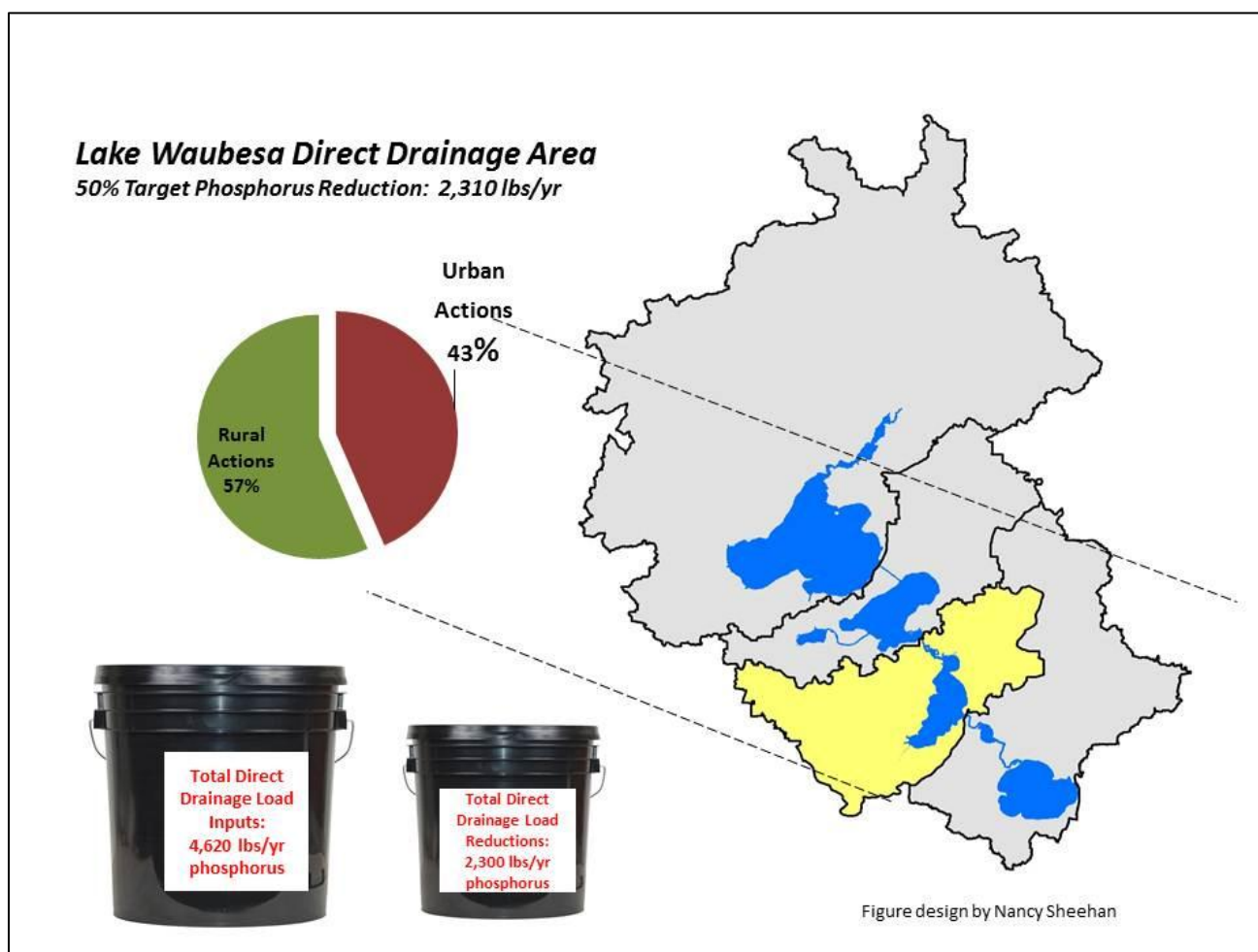
It is important to note that even with these past and future initiatives Lake Wingra will still face high levels of bacteria, algae blooms, and beach closures. The urban actions listed for Lake Monona -- including improving leaf management, stabilizing urban waterway banks, improving construction erosion control, achieving a forty percent (40%) reduction in TSS from runoff in municipal stormwater, and improving stormwater facilities -- will also benefit Lake Wingra. The long-term Lake Wingra watershed management plan will result in additional actions specific to the water quality threats to Lake Wingra.

Lake Waubesa

Lake Waubesa has an average annual load of 29,060 pounds of phosphorus entering the lake from all sources according to Lathrop and Carpenter. The direct drainage load is 4,620 pounds from a mix of urban and rural sources. The largest load of phosphorus is 22,900 from upstream sources via the Yahara River. The target reduction of fifty percent (50%) of the direct drainage sources is 2,310 pounds per year.

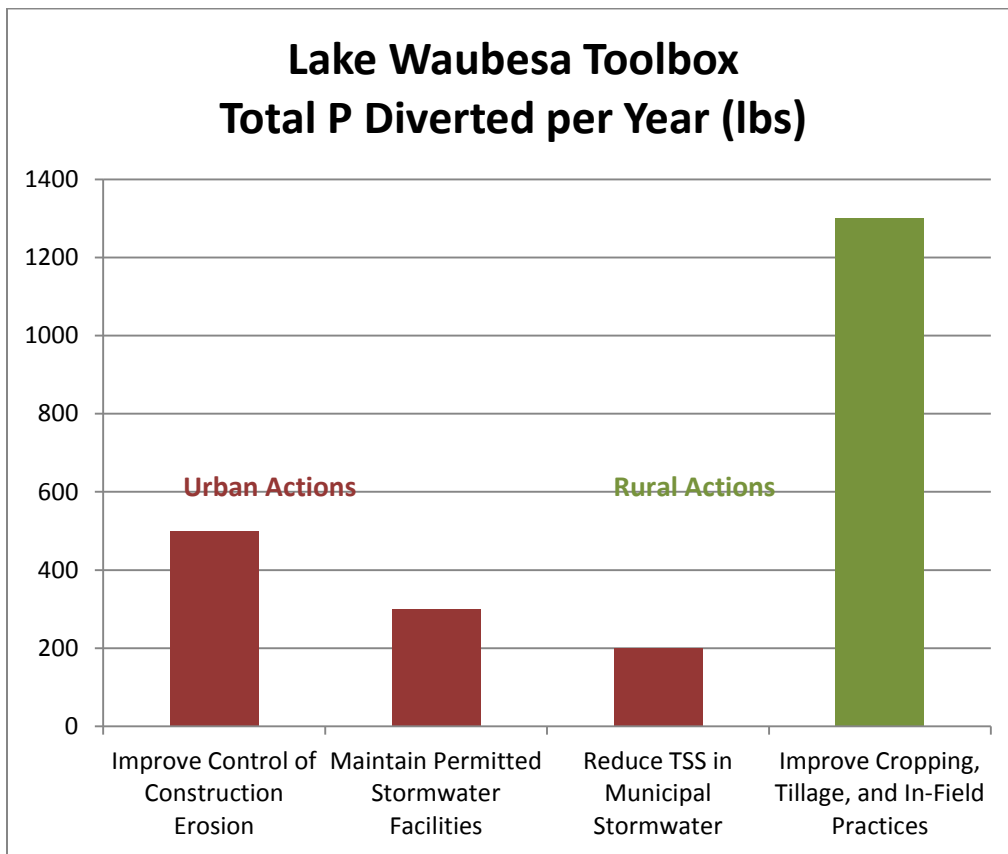
The recommended actions will reduce the annual phosphorus load from direct drainage sources by 2,300 pounds to achieve a 50% direct drainage basin reduction. Lake Waubesa will also benefit from phosphorus diversions in the upper lakes. Based on Lathrop and Carpenter flow through calculations, the direct drainage load reductions in the upstream lakes will reduce the load passed through to Lake Waubesa by 7,900 pounds (more than three times the amount of direct drainage reductions).

As shown in the following figure, rural actions account for fifty-seven percent (57%) of the phosphorus diverted in this watershed and urban actions account for forty-three percent (43%).



Lake Waubesa	Total P Diverted per Year (lbs)	Present Value Cost Over 20-Year Period (Millions)	Percent of Total P Diverted	Percent of Total Cost	Cost per Pound Diverted
Improve Control of Construction Erosion	500	\$0.2	21%	4%	\$25
Maintain Permitted Stormwater Facilities	300	\$0.2	13%	5%	\$34
Reduce TSS in Municipal Stormwater	200	\$3.4	9%	66%	\$860
Urban Subtotal	1,000	\$3.8	43%	75%	\$190
Improve Cropping, Tillage, and In-Field Practices	1,300	\$1.3	57%	25%	\$49
Rural Subtotal	1,300	\$1.3	57%	25%	\$49
Total All Direct Drainage Load Reductions	2,300	\$5.1	100%	100%	\$111
Total Direct Drainage Load Inputs	4,620				
Percent Direct Drainage Load Reduction	50%				
Benefit From Upstream Load Reductions	7,900				

Urban actions include improving control of construction erosion and stormwater runoff and a forty percent (40%) reduction in TSS from runoff in municipal stormwater. Rural actions are those recommended for all the lakes and include manure and nutrient management and cropping, tillage and in-field practices. The following figure summarizes the major load reductions resulting from the urban and rural actions.

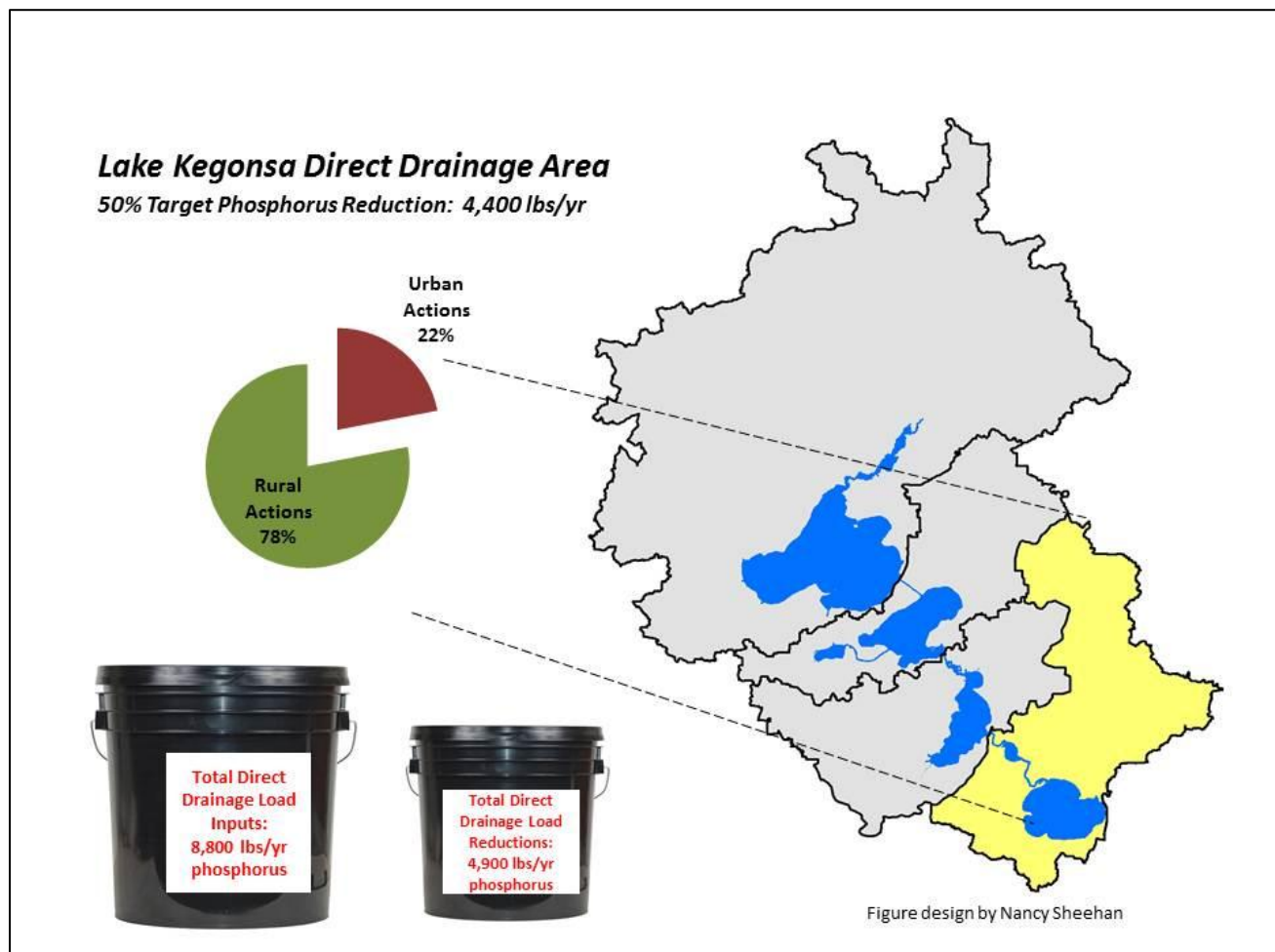


Lake Kegonsa

Lake Kegonsa has an average annual load of 37,720 pounds of phosphorus entering the lake from all sources, according to Lathrop and Carpenter. The largest load of phosphorus is the 26,500 pounds entering from upstream lakes via the Yahara River. The direct drainage load to Lake Kegonsa is 8,800 pounds, mostly from rural sources. The target reduction of fifty percent (50%) of the direct drainage sources is 4,400 pounds per year.

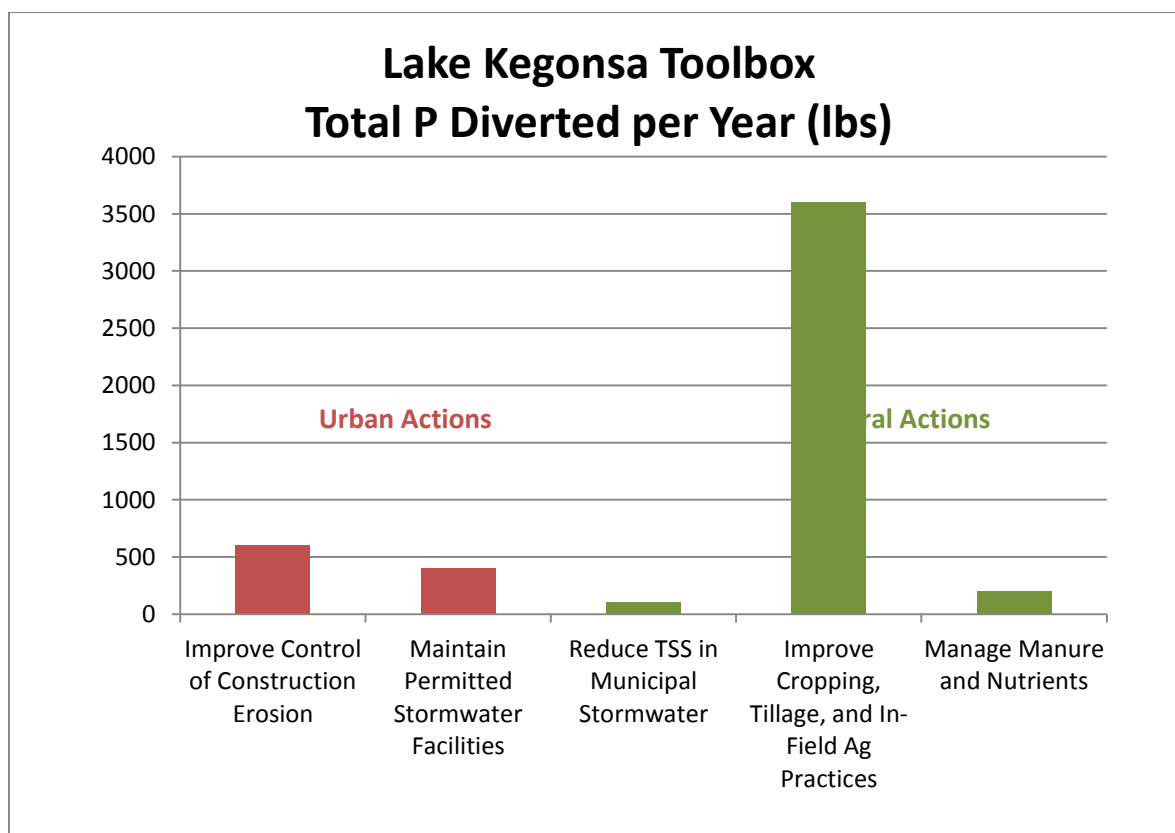
For Lake Kegonsa, the recommended actions will reduce the annual phosphorus load by 4,900 pounds, which is more than enough to achieve a fifty percent (50%) direct drainage basin reduction. Lake Kegonsa will also benefit from phosphorus diversions in the upper lakes. Based on Lathrop and Carpenter flow through calculations, the direct drainage load reductions in the upstream lakes will reduce the load passed through to Lake Kegonsa by 9,500 pounds (more than two times the amount of direct drainage reductions).

As shown in the following figure, rural actions account for seventy-eight percent (78%) of the phosphorus diverted in this watershed and urban actions account for twenty-two percent (22%).



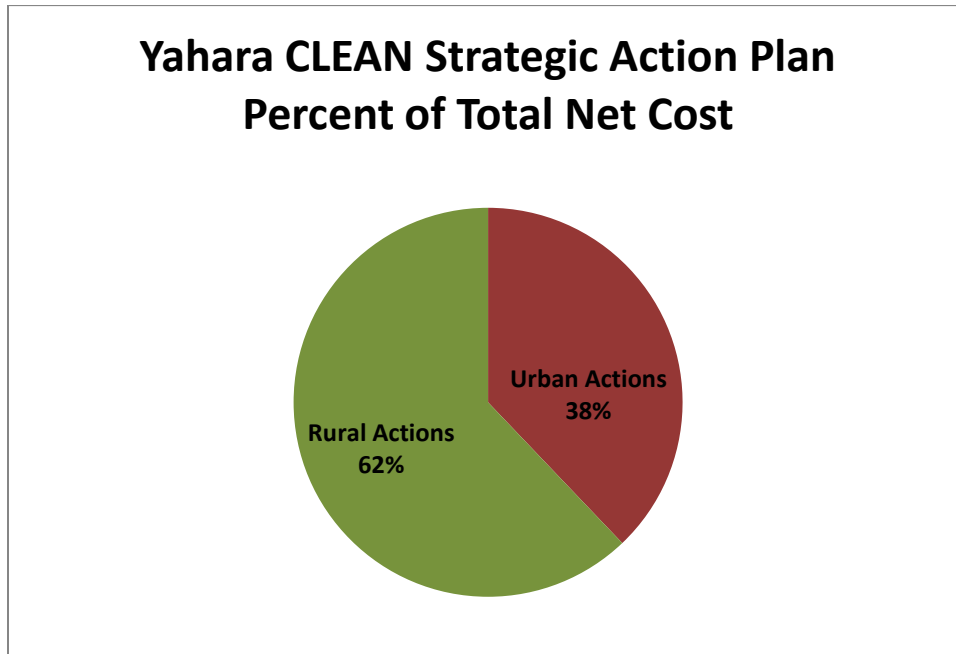
Lake Kegonsa	Total P Diverted per Year (lbs)	Present Value Cost Over 20-Year Period (Millions)	Percent of Total P Diverted	Percent of Total Cost	Cost per Pound
Improve Control of Construction Erosion	600	\$0.3	12%	5%	\$25
Maintain Permitted Stormwater Facilities	400	\$0.3	8%	5%	\$34
Reduce TSS in Municipal Stormwater	100	\$1.1	2%	21%	\$860
Subtotal Urban	1,100	\$1.7	22%	31%	\$77
Improve Cropping, Tillage, and In-Field Ag Practices	3,600	\$3.6	74%	63%	\$49
Manage Manure and Nutrients	200	\$0.3	4%	6%	\$81
Rural Subtotal	3,800	\$3.9	78%	69%	\$51
Total Direct Drainage Load Reductions	4,900	\$5.6	100%	100%	\$57
Total Direct Drainage Load Inputs	8,800				
Percent Direct Drainage Load Reduction	56%				
Benefit From Upstream Load Reductions	9,500				

Urban actions include improving construction erosion control and stormwater facilities and achieving a forty percent (40%) reduction in TSS from runoff in municipal stormwater. Rural actions include improving manure and nutrient management, and improving cropping, tillage, and in-field agricultural practices. The following figure summarizes the major load reductions resulting from the urban and rural actions.



VI. Cost to Clean Up the Lakes

The estimated net cost to implement all the Yahara CLEAN actions is \$78.6 million dollars, after a deduction of \$49.5 million in private business investment in community digesters. The remaining funds could be raised through a combination of public and private sources. Overall, urban actions are thirty-eight percent (38%) of the net total cost at \$29.8 million. Rural actions are sixty-two percent (62%) of the net total cost at \$48.8 million. The following figure shows how the cost distribution is split between urban and rural actions.



	Total P Diverted per Year (lbs)	Present Value Cost Over 20-Years (Millions)	Percent of Total P Diverted	Percent of Total Cost	Cost per Pound
Total All Lakes					
Urban Actions	13,400	\$29.8	29%	38%	\$111
Rural Actions	32,800	\$48.8	71%	62%	\$74
Total All Lakes	46,200	\$78.6	100%	100%	\$85

VII. Next Steps for Implementing the Actions

The next steps for implementation will include a set of immediate and near-term steps that will provide significant gains in lake quality within the next ten years by targeting major sources of phosphorus. We now have actions that represent what scientists, agricultural experts, lake managers, and engineers know today about proven ways to reduce phosphorus runoff into waterways. But restoring the water quality of the lakes will require a long-term commitment and particular vigilance in the next few decades from all of us in the Yahara lakes community. What we see in the lakes today is the result of more than a century's worth of cumulative impacts on our streams and lakes. It will take time and resources to bring the lakes back to health. If we are successful, we will see a significant reduction in the amount of phosphorus reaching our lakes. If we achieve our phosphorus reduction targets, we will double the number of days when the lakes are clear, our beaches are open, and we will see far fewer algal blooms.

You can get involved in many ways. The first step is to get informed about what is being done to protect the lakes in your area. Join in efforts to clean the lakes during the annual "Take a Stake in the Lakes" programs sponsored by Dane County. Attend the Clean Lakes Festival held in August each year and learn more through family friendly educational activities. Join the groups that are making a difference. The following is a list of on-line resources to get you started:

Facebook links

<https://www.facebook.com/CleanLakesAlliance>

<http://www.facebook.com/dane.county.waters>

Education and Action links

www.cleanlakesalliance.com

www.myfairlakes.com

danewaters.com/watershed_locator/default.asp

yaharawatershed.org

danewaters.com/business/danestewards.aspx

www.madisonenvironmental.com/projects

danewaters.com/resource/stateofthewaters.aspx

<http://yaharapridefarms.org/>

<http://www.madsewer.org/YaharaWINSHome.htm>

VIII. References

- Dane County Office of Lakes and Watersheds. (2008). Jones, S. [Ed.] *Dane County State of the Waters Report*. Retrieved from: http://danedocs.countyofdane.com/webdocs/pdf/lwrld/lakes/State_of_Waters.pdf
- Department of Natural Resources. (2012). *Why is Storm Water Runoff a Problem?* [Fact Sheet] Retrieved from: http://dnr.wi.gov/topic/stormwater/learn_more/problems.html
- Gaumnitz, L. (2010). *Less P is key*. Retrieved from: <http://dnr.wi.gov/wnrmag/2010/08/phos.htm>.
- Jones, S., Josheff, S., Presser, D., Steinhorst, G. (2011). *Yahara Capital Lakes Environmental Assessment and Needs (CLEAN) and the Yahara CLEAN Plan of Action*.
- Jones, S., Josheff, S., Presser, D., Steinhorst, G. (September, 2010). *A CLEAN Future for the Yahara Lakes: Solutions for Tomorrow, Starting Today*. Retrieved from: http://www.yaharawatershed.org/documents/doc/CLEAN_Report_090910.pdf
- Lathrop, R.C. (2007). *Perspectives on the eutrophication of the Yahara Lakes*. *Lake and Reservoir Management* 23:345-365.
- Lathrop, R.C., & Carpenter, S.R. (February, 2010). *Phosphorus Loading and Lake Response Analyses for the Yahara Lakes*. Retrieved from: http://www.nelson.wisc.edu/partnerships/programs/docs/lathrop_022310.pdf
- Madison Metropolitan Sewerage District. (2012). *Memorandum of Understanding for an Adaptive Management Pilot Project in the Yahara Watershed*. Retrieved from: <http://www.madsewer.org/YaharaWINS/Resources/MOU%20adaptive%20management%20final%20version%2006042012.pdf>
- Montgomery Associates Resource Solutions. *Yahara CLEAN Non-Point Source Modeling Report (Watershed-Wide SWAT Model)*.
- Strand Associates. (2012). *Yahara CLEAN Implementation Plan*.



Clean Lakes Alliance
150 East Gilman Street, Suite 2600
Madison, Wisconsin 53703
(608) 255-1000
www.cleanlakesalliance.com