Kohlman Basin Area Water Quality Enhancements Study

Prepared for
Ramsey-Washington Metro Watershed District

April 2007

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Executive Summary

The restoration and future management of Kohlman Lake depends upon controlling both internal and external sources of phosphorus to the lake. If external sources are not controlled, it is possible that measures to control internal phosphorus loading will be short lived. Because flow through Kohlman Basin is high and the area available to construct treatment projects is small, external phosphorus load reduction will be more expensive when compared to systems without these restrictions. However, modeling has shown that even the small reductions will benefit the lake. Reduction of the lake's external phosphorus sources will also extend the life of internal measures (i.e., alum treatment or dredging) to control phosphorus loading to the lake. Three innovative projects are presented in this report that would serve to lower the external phosphorus load to Kohlman Lake.

The construction of permeable lime barriers in Kohlman Basin offers the potential for significant *soluble* and *non-settleable* phosphorus reduction at a relatively low cost.

The construction of a sand filter to treat the future runoff from the former site of the Country View golf course area north of Beam Avenue would provide a high level of treatment in a relatively small space.

The Hazelwood Park Pond SAV/PSTA project is an opportunity to work with the MnDNR, the City of Maplewood, and potentially other interested parties to create an improved Hazelwood Park Pond that offers both water quality, recreational, and educational benefits. This project, perhaps more than any other presented in this report, is an opportunity to improve an existing resource in a multi-agency effort that would be a highly visible project within the District's boundaries.

Few organizations have implemented these types of projects. Where they have been researched and implemented, however, they show promise in reducing soluble and non-settleable fractions of phosphorus in runoff. If the District wishes to significantly reduce the TP concentration in Kohlman Lake, these projects offer an innovative way to achieve that goal.

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1.0 Introduction

Kohlman Lake (DNR #62-0006), is the first (most upstream) lake in the Phalen Chain of Lakes and is located within the City of Maplewood (Figure 1). Kohlman Lake is currently listed on the Minnesota Pollution Control Agency's (MPCA) 2006 303(d) Impaired Waters List for excess nutrients. Over the past 5 years, the Ramsey-Washington Metro Watershed District (District) has pursued studies that search for phosphorus removal opportunities in Kohlman Lake's tributary watershed and within the lake itself.

Reduction of the lake's internal load in Kohlman Lake is expected to lower the total phosphorus (TP) concentrations in the lake to below the District's short-term goal of 90 µg/L (under wet, dry and average climatic conditions). The feasibility of an in-lake alum treatment of Kohlman Lake was evaluated in the *Internal Phosphorus Load Study: Kohlman and Keller Lakes* (Barr, 2005a). Although the feasibility of dredging was evaluated to some degree in the internal phosphorus load study, a more detailed and site-specific look at the feasibility of dredging Kohlman Lake is currently underway. In order to lower TP concentrations in the lake further, additional removal of external phosphorus loads, especially removal of *soluble* phosphorus (also referred to as "dissolved phosphorus") and *non-settleable* phosphorus (phosphorus attached to very fine particles suspended in runoff) loads, will likely be necessary.

The Kohlman subwatershed and its numerous water quality ponds and wetlands are doing a good job of removing particulate phosphorus upstream of Kohlman Lake. However, a significant soluble and non-settleable phosphorus load in the flows through these systems remains. Ninety percent of this load enters Kohlman Lake through Kohlman Basin and adds to the lake's poor water quality by increasing phosphorus concentrations in the lakes downstream. This report details the results of an evaluation of phosphorus reduction projects (especially projects that target soluble and non-settleable phosphorus) for Kohlman Basin and the surrounding areas.[1]

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[1] It is important to note that another study (the Phalen Chain of Lakes Study of Untreated Tributary Drainage and Other Improvement Areas project (Barr, 2005)) specifically evaluated treatment opportunities in areas that are currently untreated (i.e. runoff does not drain through any ponds, wetlands or treatment systems). No capital projects that would significantly reduce Kohlman Lake's external load were identified in this study, although several residential areas were targeted for focused prevention programs (referred to as "residential measures"). Although no capital projects were identified for the Kohlman Lake Subwatershed, two of the projects that were identified in the Keller Lake Subwatershed have been pursued - Gervais Ave Pond and West Keller Pond are under construction.

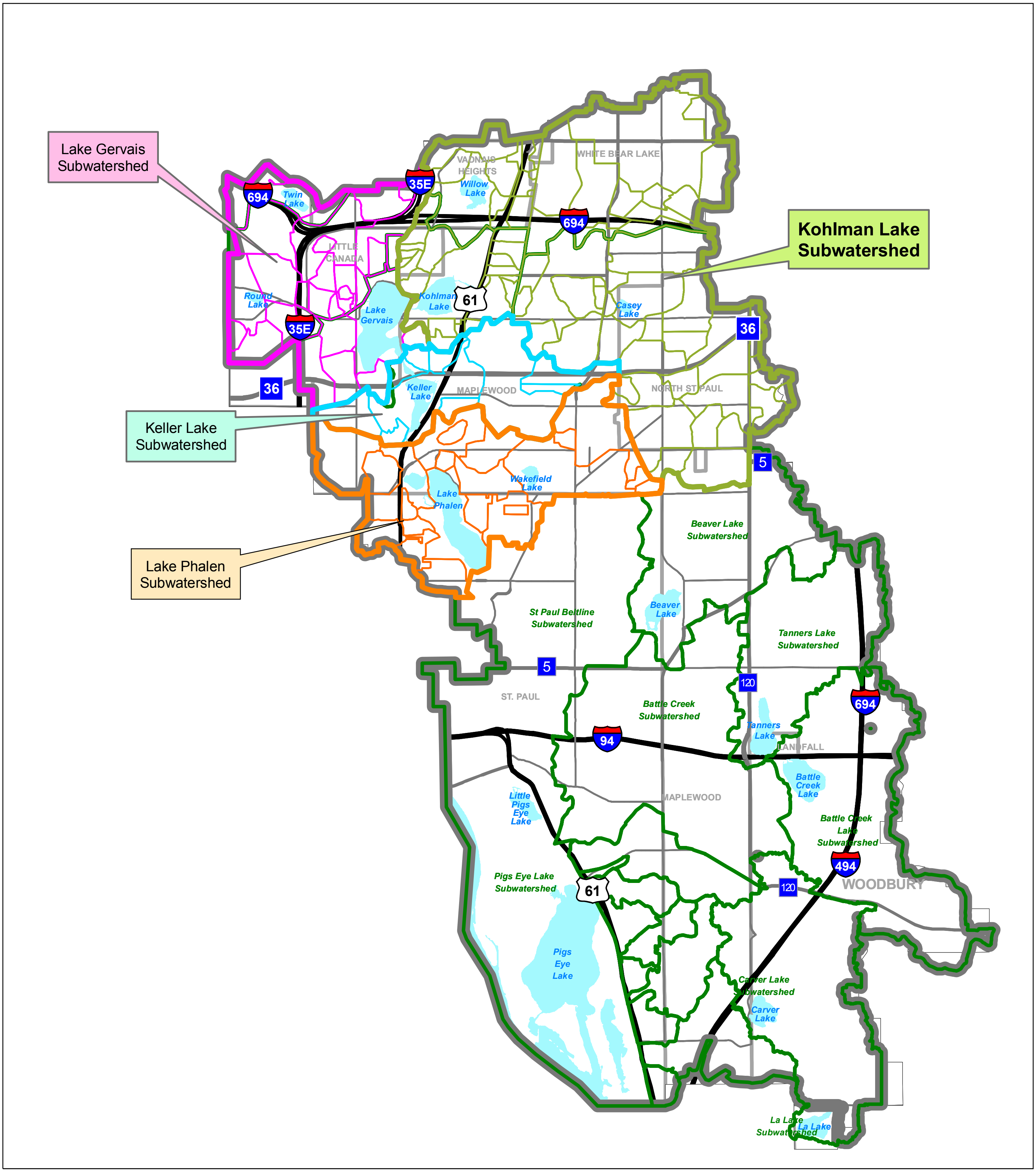

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Figure 1

LOCATION MAP

Kohlman Basin Area
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Implementation of the District's 1-inch infiltration standard for all permitted development activity will help remove soluble and non-settleable phosphorus in the subwatershed. However, the need for still more treatment of subwatershed flows will likely be necessary to achieve long-term goals, specifically the MPCA's proposed shallow lake criteria of 60 µg/L.

During the creation of the *Phalen Chain of Lakes Strategic Lake Management Plan: Improvement Options and Recommendations (SLMP)* (draft, Barr, October 2004) and the *Kohlman and Keller Lakes Total Maximum Daily Load Report (TMDL)* (draft, Barr, July 2005b) it was estimated through modeling that an overall 25 percent reduction in Kohlman Basin phosphorus outflows, in addition to a 90 percent reduction in the lake's internal phosphorus load, could bring Kohlman Lake's TP concentration down to the MPCA's proposed shallow lake nutrient criteria of 60 µg/L. Consequently, the goal for this study was to find ways to reduce the existing TP concentration in Kohlman Basin outflows by 10 to 15 percent through the implementation of capital projects in the Kohlman Basin area. This percentage assumes that the infiltration standard and other potential regional infiltration projects throughout the Kohlman Basin drainage District could reduce the overall load by the remaining ~10 to 15 percent (thus reducing the total Kohlman Basin phosphorus outflow by ~25 percent).

According to monitoring data collected in 2002, the TP concentration of Kohlman Basin's outflow was, on average, 150 µg/L. One-third of that TP concentration (on average) can be attributed to soluble phosphorus. The soluble fraction of phosphorus ranged from 10 to 90 percent of the TP leaving Kohlman Basin. For this reason, it has been determined that in order to increase the removal of TP in Kohlman Basin, the soluble fraction of phosphorus traveling through Kohlman Basin cannot be ignored.[2]

Because phosphorus reduction in Kohlman Basin must target soluble and non-settleable phosphorus constructing traditional water quality treatment ponds was deemed ineffective (detention ponds cannot, in and of themselves, effectively remove soluble and very fine particulate pollutants). Therefore, numerous new technologies and innovative approaches were considered here, in addition to some more conventional approaches such as chemical treatment (i.e. alum, iron, and coagulating polymers), in-line treatment systems (e.g. StormTreat™ Systems), traditional constructed wetlands

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[2] The remaining two thirds of the total phosphorus flowing through Kohlman Basin is attached to particles suspended in the flow. Some of these particles will settle out upon entering Kohlman Lake. Others, however, are very fine particles that will remain suspended in the water column. Very small particles are not easily settled out in standard water quality ponds, and are also targeted implicitly in the technologies investigated in this report. Throughout this report, these particles are referred to as "non-settleable".

and infiltration. Other new technologies considered but deemed either inappropriate for project goals or unacceptable due to high levels of uncertainty in treatment efficiency include:

- Adsorption/Ion exchange
- Flow through box filtration
- Drain inlet media filters

2.0 Description of Sites

Ninety percent of Kohlman Lake's external phosphorus load enters Kohlman Lake through Kohlman Basin. For this reason, this study began by searching the area tributary to, and including, Kohlman Basin for possible phosphorus removal project sites. Figure 2 shows network of drainage areas tributary to Kohlman Basin. The following general criteria were used to select possible sites for projects.

Preferred sites were those that:

- Are relatively close to Kohlman Basin. Capital projects further upstream would treat less of the overall flow that eventually travels through Kohlman Basin.
- Would not require pumping runoff to a higher elevation before it is treated.
- Are not already in use for recreation (for this reason, the heavily used soccer fields in Hazelwood Park were ruled out).
- Could facilitate treatment of a significant fraction of the flow tributary to and/or through Kohlman Basin.
- Would not require significant clearing of trees in natural areas

With these criteria in mind, four different sites were chosen for further evaluation in this study. These areas are shown on Figure 3, and are described in more detail below.

- **Kohlman Basin**

  Kohlman Basin is a series of settling ponds and wetlands separated by weirs—two of which are permeable. The site is located south of Beam Avenue, north of Kohlman Avenue, and between HWY 61 and the Bruce Vento trail (just West of Hazelwood Street). In the *Watershed Management Plan for the Ramsey-Washington Metro Watershed District 2006-2016* (draft, RWMWD, 2006) the cells of Kohlman Basin are referred to as KOHL-KBA, KOHL-KBB, KOHL-KBC and KOHL-KBD (East to West, or upstream to downstream). Water leaving Kohlman Basin from cell KOHL-KBD flows west under HWY 61 via a large culvert and then travels directly to Kohlman Lake.

  All of the flow that drains from the 6,829 acres of the Kohlman Creek Subwatershed (the largest drainage District tributary to Kohlman Lake) and the areas tributary to Kohlman Basin itself pass through Kohlman Basin before entering Kohlman Lake. Kohlman Basin and its weirs were designed to maximize the potential for settling particulate phosphorus from this runoff. Kohlman Basin's sedimentation basin (in cell KOHL-KBA) and permeable weirs serve to slow flow through the chain of cells, maximizing the potential for the settlement of particulate matter. Soluble and non-settleable phosphorus, however, unless taken up by Kohlman Basin's plant community, can pass through the system under existing conditions. For this reason, Kohlman Basin was the most obvious place to look for improvements in soluble and non-settleable phosphorus reduction.

- **Hubbard Broadcasting/KSTP Site**

  This is a 2-acre site located just South of the first cell of Kohlman Basin, in drainage area KOHL-KBB. This site is currently owned by Hubbard Broadcasting. Until 2000, Ramsey County leased this site from Hubbard Broadcasting for use as one of the County's compost facilities. Discussions with Hubbard Broadcasting general attorney David Jones (personal communication, Oct. 4, 2006) indicate that Hubbard Broadcasting would be open to hearing about any District ideas for the site and that the company does not currently have plans to develop the site. However, some concerns regarding past use of the site as a County compost facility are still unresolved and, although Hubbard Broadcasting is verbally willing to consider proposals from the District, there is no guarantee that the site is available for use for any sort of surface water quality treatment activities.

  Nevertheless, the site is appealing because it lies immediately South of the first cell of Kohlman Basin and immediately east of the second cell. Its proximity to Kohlman Basin, and the fact that it is currently an unused, open space make it a desirable spot for a future project. However, the elevation of the site (it is, on average, 8 feet higher than the water in Kohlman Basin) is not optimal.

- **Hazelwood Park Pond (also known as "Beam Avenue Pond" and "Markham Pond")**

  This pond is located in Maplewood's Hazelwood Park, in drainage area SB18-14. The pond receives flow from Kohlman Creek, Hazelwood Park, and drainage area SB18-16, as well as the highly impervious Maplewood Mall area and local neighborhoods. There is visible accumulated sediment in the pond. In 2000, the District used P8 modeling to estimate the current (2000 conditions) phosphorus removal of the pond (30 percent) and to estimate the rate of sedimentation that the pond experiences (80 cy/year). The conclusion of the report was that dredging the sediment was not imminently necessary to improve particulate phosphorus removal effectiveness and that the District should "monitor the pond visually for signs of sediment-related problems and defer excavation efforts until they are necessary."

(Appendix A). However, soluble and non-settleable phosphorus removal and enhanced sediment removal opportunities still exist with this site.

The Minnesota Department of Natural Resources (MnDNR) at one time considered turning Hazelwood Park Pond into a kids' fishing pond, and still considers this to be a viable project in the future (Dave Zapetillo, MnDNR, personal communication, June 27, 2006.) The City of Maplewood Parks and Recreation department also considers this pond to be in good position for improvement of some kind (Bruce Anderson, Director of Maplewood Parks and Recreation, personal communication, October 4, 2006.) Its location, existing access, and surrounding environmental/ recreational features (Bruce Vento trail and Hazelwood Park's existing parking lots and heavily used soccer fields) make it a prime candidate for both a kids' fishing pond and for public education. Both the MnDNR and Maplewood Parks and Recreation (according to Dave Zapetillo and Bruce Anderson) seem interested in some sort of joint water quality/recreational improvement venture with the watershed District.

- **Beam Avenue Development Site (Former Country View Golf Course)**
  This site, essentially comprising drainage area KOHL-01C and KOHL-01D, is directly north of Beam Avenue, just across the street from Kohlman Basin. The site comprises ~50 acres that were, until 2005, the home of the Country View Golf Course. Maplewood land use plans show that this site will be developed as a commercial area in the near future. The new rules implemented by the District on October 1, 2006 will require infiltration for this site. However, the soils and close proximity to groundwater throughout the site will likely limit the potential for site infiltration. The District rules will then allow for alternative compliance via stormwater filtration. This area offers a unique opportunity for the District to work closely with the site developer(s) to incorporate water quality treatment methods that will address soluble and non-settleable phosphorus removal in this area. For the purposes of this study, it was assumed that approximately half of this area would be treated by a capital project.

  The fact that a project at this site would be a part of a new development design (as opposed to a retro-fit endeavor) makes this a desirable, and unique, project site within the District.

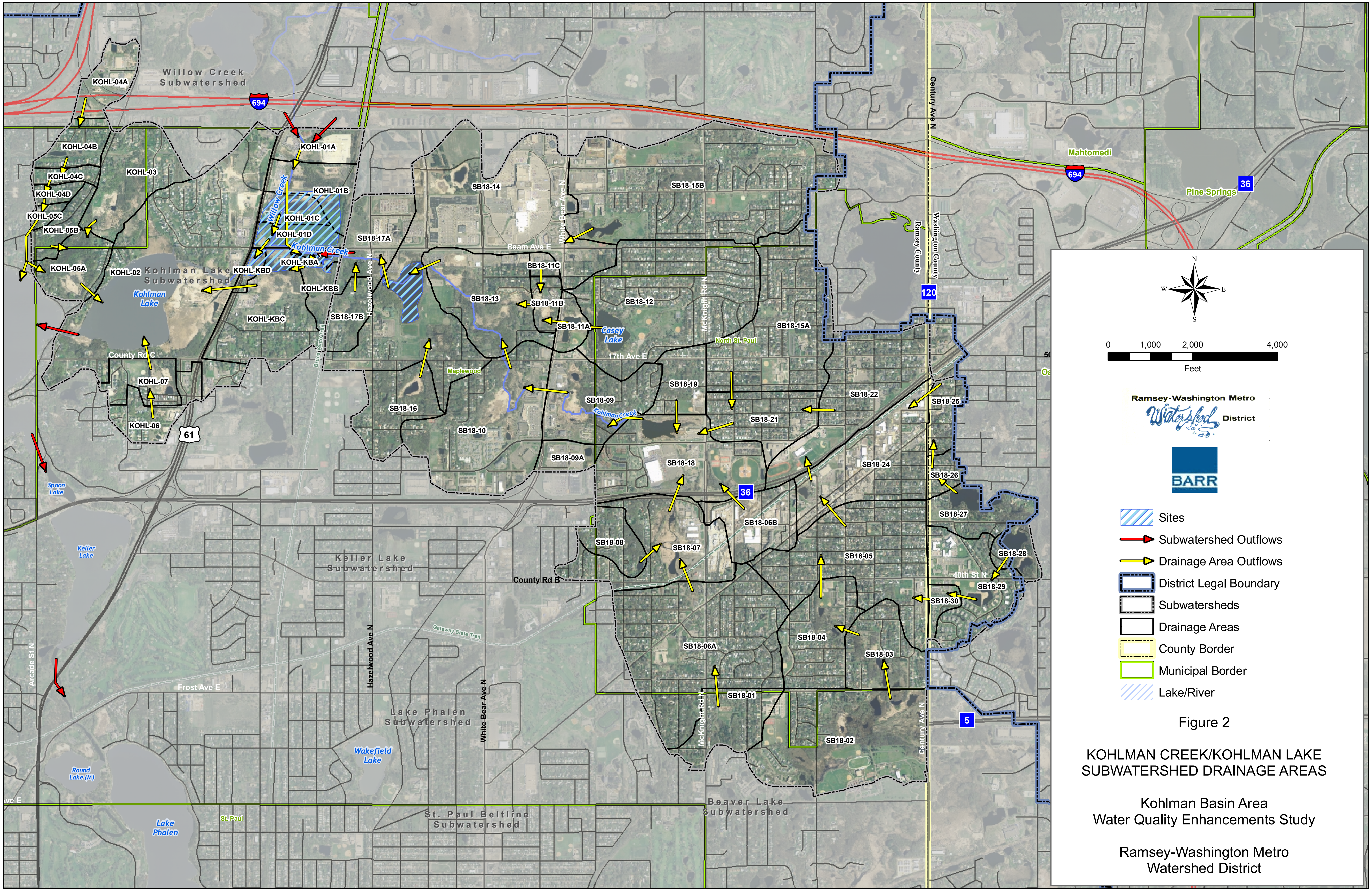

Figure 2

KOHLMAN CREEK/KOHLMAN LAKE SUBWATERSHED DRAINAGE AREAS

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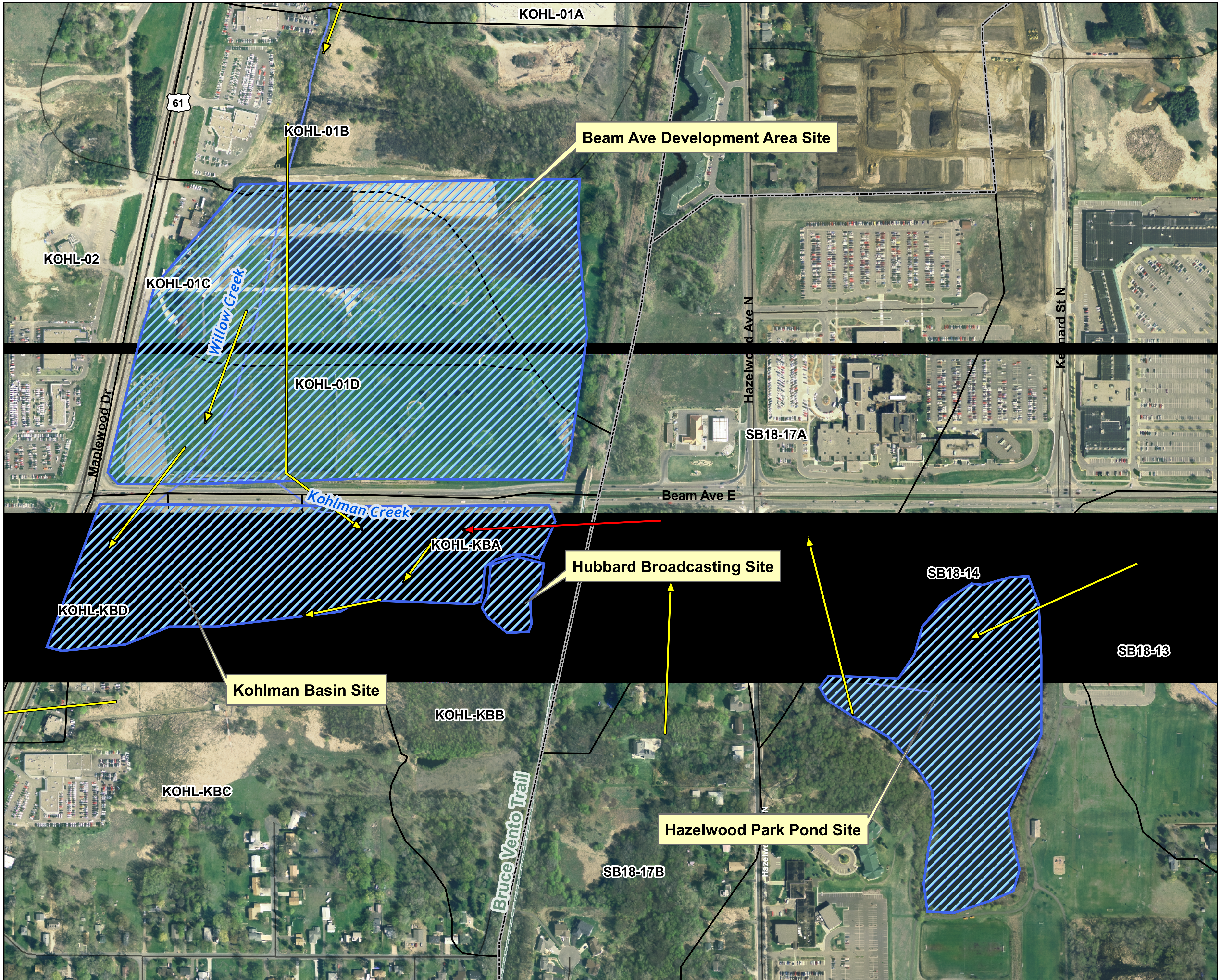

Sites
Subwatershed Outflows
Drainage Area Outflows
Drainage Areas

N W E S

0 200 400 800
Feet

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Figure 3

SITES CONSIDERED IN THE KOHLMAN BASIN AREA WATER QUALITY ENHANCEMENT STUDY

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3.0 Description of Innovative Technologies Considered

The purpose of this study was to evaluate new treatment technologies such as amended sand filters, permeable lime barriers, periphyton, and submerged aquatic vegetation treatment, as well as natural flocculent/coagulant products to incorporate into the area in and around Kohlman Basin, to further aid in the removal of soluble and non-settleable phosphorus in the Kohlman Subwatershed. The areas considered for these projects are shown on Figure 3.

Chemical treatment (i.e. alum, ferric chloride, a broad array of coagulation polymers), traditional constructed wetlands, in-line treatment system such as StormTreat™ Wetland Systems, and infiltration were considered at some level during this study; however, since these are more common ways of addressing soluble and non-settleable phosphorus, they are not included as a part of this section. The focus of this section is to summarize new and innovative technologies that reduce soluble and non-settleable phosphorus.

Sections 3.1 through 3.4 of this report describe these technologies and how they could be implemented in certain areas in and around Kohlman Basin. Section 3.5 summarizes the available performance data and costs for these projects, and describes the projects that were ultimately deemed the most viable.

It should be noted that all of the technologies presented here are considered to be, to varying degrees, experimental. Although these technologies have been researched by different groups (results are provided in this report), these are new technologies that, to a large degree, have not been implemented in the field by many organizations. This is likely due to the inherent risks that employing new technologies involve. It is likely that implementation of these types of projects would indeed be a “learning experience” and treatment success would improve over time as projects are fine tuned. This certainly introduces an element of risk (in terms of whether treatment goals are met, as opposed to a risk to the environment) for the District, but it also provides an opportunity to take the lead on implementing innovative technologies that hold promise. Creating significant improvement in lake water quality may well require the District to take the lead on implementing new technologies that have a calculated risk, but also a reasonable expectation for success. The technologies described below are thought to fit this category.

3.1 Limestone and Submerged Aquatic Vegetation/Periphyton Treatment Wetlands

3.1.1 General Description

Periphyton Stormwater Treatment Areas (PSTAs) and Submergent Aquatic Vegetation constructed wetlands (SAVs) utilize the concept of algal/vegetative uptake of soluble phosphorus to remove phosphorus from water. Periphyton is algae that grows onto a submerged substrate such as rocks, aquatic vegetation, woody debris or soil.[3]

One of the key components in successful PSTAs and SAV constructed wetlands is a crushed limestone substrate that allows for the formation of calcium bound phosphorus (Ca-P). Calcium acts as a long-term sink for phosphorus that has been taken up by periphyton and vegetation in the system. When the periphyton and vegetation die, the phosphorus is released and the calcium from the limestone binds it, eventually creating an inert mineral called apatite.

These systems require pretreatment. As such, PSTAs and SAVs are best used as polishing units in a treatment train for stormwater runoff.

Figure 4 A PSTA System in Southern Florida

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[3] "Periphytic" algae differs from "planktonic" algae that floats in the water column of a water body. Planktonic algae is the type of algae that limnologists typically referring to when discussing transparency issues caused by algal growth in a pond or lake. Periphytic algae is often associated with nuisance scums along shorelines (making rocks slippery) and in shallow parts of lakes and wetlands.

3.1.2 Site Specific Considerations

3.1.2.1 Hydraulics

- A 14-day residence time is recommended for optimal treatment. However, lower levels of phosphorus reduction can be achieved with lower residence times.
- Inlet flow control may be necessary to limit sloughing of periphyton and physical damage of the PSTA during high flow events.
- Startup time may vary (up to one season under current conditions) for natural colonization of periphyton and SAV. Using propagules and seeding should decrease (but not eliminate) this delay.
- Varying depths and flow can reduce treatment by 25 percent or more.
- Leakage control is necessary in multiple cell systems to avoid short-circuiting of the treatment train.
- PSTAs and SAVs target soluble and non-settleable phosphorus and should be used at the end of a treatment train that removes most particulate matter and floating debris.

3.1.2.2 Macrophyte Coverage and Growth

- Sparse macrophyte coverage is advantageous to periphyton for attachment and as anchors during high flow events, preventing washout. High macrophyte coverage will limit phosphorus uptake by periphyton.
- Periphyton mats grow optimally in water containing < 50 μg/L total phosphorus.

3.1.2.3 Limestone

- Avoid limestone high in phosphorus.
- Systems with high sediment input will be less effective due to burial of the installed limestone base layer.

3.1.2.4 Maintenance

- PSTAs and SAV wetlands may require management to remove emergent aquatic vegetation (i.e. cattails) that can shade and hinder submerged plant growth.
- Sediment removal and replacement of dissolved limestone is necessary over time.
- If a diversion system is necessary to limit the amount of treated flow, inspection of the diversion structure will be needed.

3.1.3 Literature Review of Performance Data

A Florida treatment train consisting of wetlands in a series; including floating and emergent aquatic and vegetation, and finally a PSTA wetland; reduced phosphorus concentrations from 109 μg/L to 49 μg/L (CH2M Hill, 2003). The inlet hydraulic loading rate (HRT) to the PSTA was 10.4 cm/d. Periphyton relative growth rates were 20 to 25 percent faster in mesocosms with higher velocity. Increases in periphyton growth were correlated with phosphorus uptake. Velocities ranged from 0.22 to 2.0 cm/s in periphyton mesocosms and 0.1 to 1.0 cm/s in *Ceratophyllum* mesocosms (Hiaasen et al. 2003, Simmons et al. 2003). Water depth in the studies listed ranged from 9 to 60 cm (~2 feet).

DeBusk et al. (2003) showed that approximately 71 to 85 percent of phosphorus in harvested material from a shallow periphyton dominated system was non-labile, or permanently bound. Thirty to 33 percent of the phosphorus was Ca-P while the remaining portion was bound with organic material (67 to 70 percent). Another study on PSTAs in the Everglades showed that approximately 5 percent of TP retained in the benthic material was released during desorption studies (Everglades Report 2006a). Performance of a combined vegetated wetland (SAV and periphyton) and limestone system (STA1-W) reduced TP loading by 55 percent for WY2005 in the Everglades. Total phosphorus input concentration to the system averaged 247 μg/L and the output averaged 98 μg/L (Everglades Report, 2006b)

Table 1 Relative Reliability, P Removal, Maintenance and Cost for PSTA/SAV systems, based on review of available literature

PSTA/SAV	Low		Med		High
Reliability			•		
P Removal			•		
Maintenance			•		
Cost				•	

3.1.4 Potential Sites

3.1.4.1 Hazelwood Park Pond

Because Hazelwood Park Pond likely has a TP concentration that is greater than 50 μg/L, a system focusing on more SAV for phosphorus uptake may be more suitable than a PSTA. Improvements including limestone installation and vegetation planting would be made to the western end of Hazelwood Park Pond (in the "thumb-shaped" part of the pond) to increase phosphorus removal from flow moving through the system. Dredging the accumulated sediment from the north and south lobes of the pond would increase the treatment of the flows coming into the pond from Kohlman Creek on the east side, essentially providing pretreatment for the SAV wetland part of the pond.

Because of the high amount of flow moving through Hazelwood Park Pond, treatment efficiency is not expected to be as high as other experimental systems with longer residence times, but increased removal (relative to existing conditions) will still occur with the improvements.

Cost and Estimated Performance at Hazelwood Park Pond Site:

Capital Cost .... $914,000[4]
Annual Maintenance $7,000
Total annual cost (including annualized capital cost)............... $86,700
Annual P removal (Pounds) 162
Annualized Cost per pounds P removed.................................. $535
Percentage of Kohlman Basin TP removed 6%

3.1.4.2 Hubbard Broadcasting/KSTP Site

Constructing a PSTA/SAV wetland at the KSTP site location would be similar to a SAV wetland at Hazelwood Park Pond. However, additional excavation would be necessary to create the proper elevation for the wetland to function properly (the Hubbard Broadcasting site is, on average, 8 feet higher than the water that would be entering the site from upstream.). This increases the estimated cost per unit phosphorus removal. A portion of the flow exiting Hazelwood Park Pond would bypass the site to protect the system from damage during high flow.

The current level of pre-treatment provided by Hazelwood Park Pond would likely eliminate the need for further pre-treatment upstream of a PSTA/SAV wetland at the Hubbard Broadcasting site.

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[4] All project capital costs include a basic cost estimate plus a 20% increase for engineering and a 40% increase for contingency. Annual maintenance costs include a 40% increase for contingency. Cost per pounds P removed also includes engineering and contingency. All costs are in 2005 dollars (2006 dollars can not yet be estimated from 2005 dollars).

Cost and Estimated Performance at Hubbard Broadcasting Site:

Capital cost	$1,036,000
Annual maintenance	$3,000
Total annual cost (including annualized capital cost)	$93,300
Annual P removal (Pounds)	70
Annualized cost per pounds P removed	$1,333
Percentage of Kohlman Basin TP removed	2%

3.2 Permeable Lime Barriers

3.2.1 General Description

Permeable reactive barriers (PRBs) are designed to allow phosphorus binding as the water and barrier come into contact. In this case, permeable barriers constructed from limestone were evaluated. Crushed limestone can be used to create flow-through barriers to reduce soluble and non-settleable phosphorus concentration through the formation of calcium bound phosphorus (Ca-P). Limestone can also be placed in boundary areas of wetlands or other BMPs, creating additional sites for Ca-P formation (as well as periphyton growth) and retention. Lime can be effective in shallow, littoral areas or wetlands where pH is elevated due to algal activity.

Limestone PRBs are generally used in systems with total phosphorus concentration magnitudes in terms of ppm (mg/L) (as opposed to ppb, or μg/L) because greater removal efficiency can be achieved. Binding of phosphorus by calcium is still achieved in systems with lower concentrations of phosphorus. However, this has been detected in ultra-oligotrophic (extremely nutrient deficient) lakes that have been treated with lime in the past (Huser and Rydin, 2005). Phosphorus binding with calcium is not as efficient as that seen with iron or aluminum. While calcium is not affected by low redox potential/low oxygen conditions that can cause iron to release phosphorus, low to neutral pH will limit Ca-P formation.

In a finishing system, such as a treatment wetland, barriers constructed between cells can provide removal of soluble and non-settleable phosphorus through binding mechanisms with calcium. If stormwater flows are great, additional lime can be added to the system to increase contact time. This could include, for example, multiple barriers within one BMP structure.

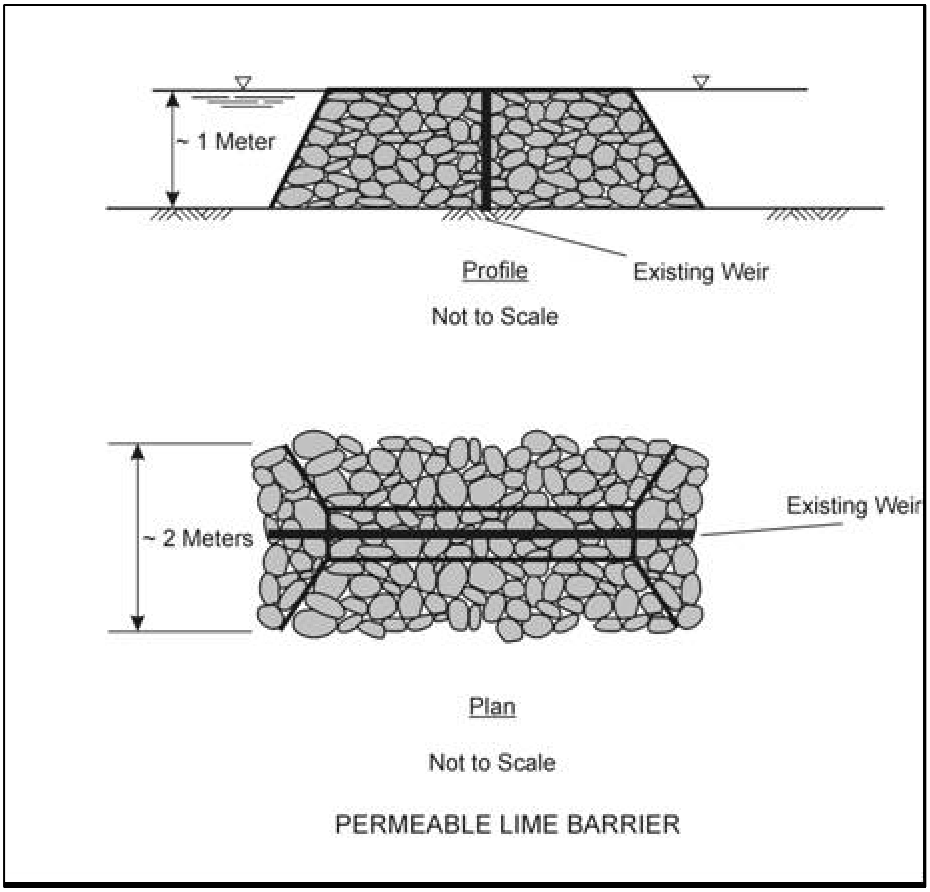


Figure 5 Schematic of a Permeable Lime Barrier as it would be Constructed Around Kohlman Basin's Permeable Weirs

3.2.2 Site Specific Considerations

- High flows through will limit contact time between the PRBs and phosphorus.
- Phosphorus bound to calcium may be released under low pH conditions (caused by high respiration and limited light availability)
- Wetland systems with higher water column pH will provide greater performance for phosphorus removal.

3.2.3 Maintenance

- Annual inspection of barriers should be conducted to assure proper flow through the barrier.
- Replacement of lime barriers will be necessary as they dissolve over time.

3.2.4 Literature Review of Performance Data

Data is limited in regards to using limestone PRBs for surface water applications. PRBs have been used successfully to treat both acid mine drainage and reduce nutrients from on-site wastewater treatment systems with high phosphorus concentrations. In one wastewater treatment system, phosphorus concentration was reduced from 11 mg/L to 2.3 mg/L using blast furnace slag with a recommended minimum contact time of 3 to 4 minutes (Yassini, personal communication, 2006.).

In a finishing system, such as a treatment wetland, limestone barriers constructed between cells can provide removal of soluble and non-settleable phosphorus through binding mechanisms with calcium. Calcium carbonate and calcium hydroxide were used in several treatments to reduce phosphorus in water retention basins/dugouts and stormwater ponds (Murphy et al. 1990, Babin et al. 1989). Applications of calcium hydroxide reduced total phosphorus levels by up to 80% in dugouts while direct application of calcium carbonate showed no effect. Lime added to acidified lakes in Sweden also showed the potential for phosphorus uptake shown in sediment cores collected from a number of lakes (Huser and Rydin 2005).

Table 2 Relative Reliability, P Removal, Maintenance and Cost for limestone PRB Systems, based on review of available literature

Limerock PRBs

	Low		Med		High
Reliability			No data		
P Removal		●			
Maintenance	●				
Cost	●				

3.2.5 Potential Sites

3.2.5.1 Kohlman Basin

The existing permeable weirs within Kohlman Basin (that separate the second, third and fourth cells of the basin) could be amended with limestone to create lime PRBs that would enhance calcium bound phosphorus formation in Kohlman Basin. Limestone would be placed on both sides of the existing permeable weirs.

Cost and Estimated Performance at Kohlman Basin Site:

Capital cost	$118,000
Annual maintenance	$1,000
Total annual cost	$11,300
Annual P removal (Pounds)	113
Annualized cost per pounds P removed	$100
Percentage of Kohlman Basin TP removed	4%

3.3 Enhanced Sand filtration systems

3.3.1 General Description

Sand filtration systems are typically designed to remove particulate matter and phosphorus from stormwater flows. With the addition of steel fiber or steel wool blankets, additional removal of soluble and non-settleable phosphorus is possible. Other types of filter amendments, such as peat, perlite, zeolite, calcareous sand and limestone have been researched. However, these amendments currently hold less promise for the treatment of soluble and non-settleable phosphorus than steel wool amendments.

Steel wool blankets are recommended to limit clogging and reduce maintenance. Pretreatment of the stormwater flow is necessary to ensure that proper hydraulics and that infiltration rates are maintained for phosphorus removal. When stormwater flow exceeds the capacity of the filter system, only partial treatment will be possible with higher flows being bypassed around the filter. Because aerobic conditions are required, flow must be diverted from the filter to allow for drainage and drying and, thus, a parallel system is recommended. Sand filters tend to be one of the more expensive treatment technologies. As such, they are typically reserved for developments that have high treatment goals, with very little land space to achieve them.

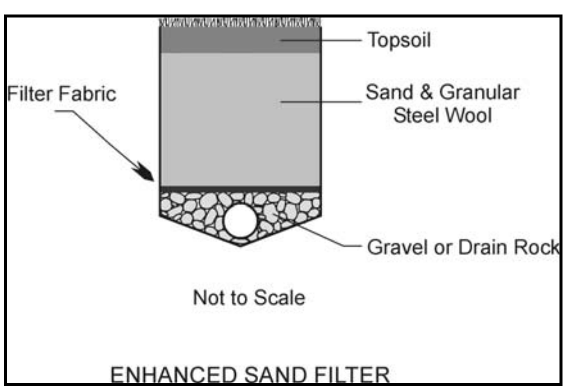


Figure 6 Cross Sectional Schematic of an Enhanced Sand Filter

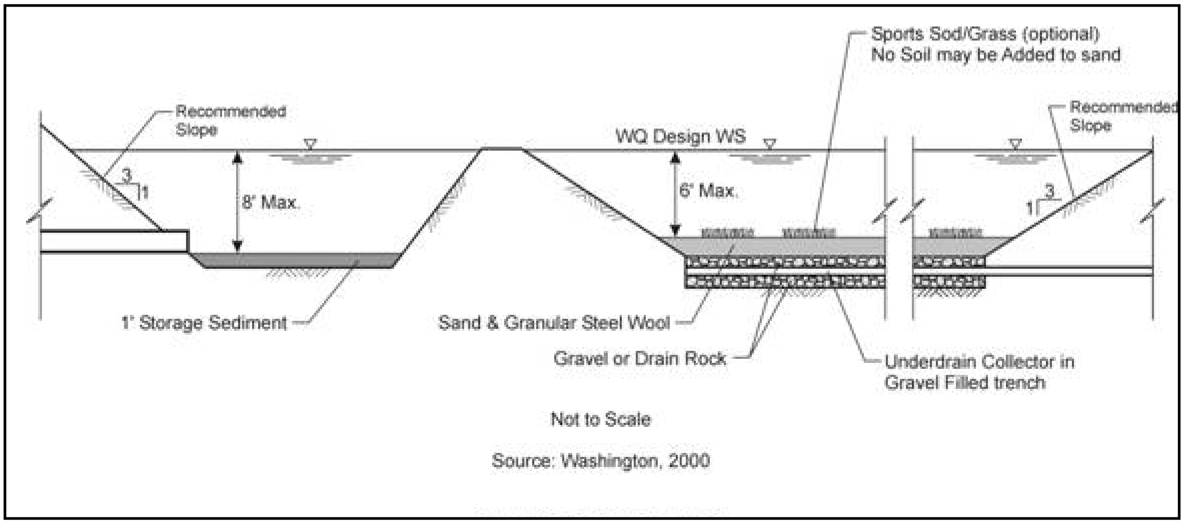


Figure 7 Cross Sectional Schematic of an Enhanced Sand Filter and Pretreatment Cell

3.3.2 Site Specific Considerations

- Space restrictions and high flow rates will limit treatment with some flow bypassing the system.
- Filter clogging may be a problem, especially if pre-treatment is insufficient.

3.3.3 Maintenance

- Cleaning of pre-treatment basin/vault at least every 5 years.
- Surface scraping 1 to 2 times a year to remove buildup. Additional 1 to 2 times per year if no pre-treatment available. A back flushing system could be installed to prevent clogging from incoming sediment.
- Rototilling of surface may be necessary every year to break up surface layer of sediment and maintain hydraulic capacity.
- Replace filter media every 10 years.
- Pretreatment basin (if needed) cleaning every 5 years.

3.3.4 Performance

A sand filter facility in Bellevue, WA receiving stormwater with inflow concentrations of total and soluble phosphorus of 94 and 26 µg/L, reduced loading between 43 and 72 percent (City of Bellevue, Washington, 1999). This facility uses chopped granular steel wool that increased clogging, creating anaerobic conditions within the filter, thereby reducing its effectiveness at removing phosphorus.

A column design by Erickson et al. (2006) provided between 40 and 90 percent removal of soluble phosphorus in a system comprised of C33 sand with granular steel wool or steel wool fabric as an amendment. Steel wool fabric was more efficient at removing phosphorus and was easier to use, but was also more expensive. A relationship between phosphorus sorbed and number of steel wool fabric layers was developed to determine fraction of phosphorus removed from the inflow. This information can be used to help design for a specific removal rate given a specific flow rate and influent TP concentration.

Table 3 Relative Reliability, P Removal, Maintenance and Cost for Enhanced Sand Filter Systems, based on review of available literature

Enhanced Sand Filters

	Low		Med		High
Reliability				●	
P Removal				●	
Maintenance			●		
Cost					●

3.3.5 Potential Site Locations

3.3.5.1 Beam Avenue Development Site (Former Country View Golf Course)

For the purposes of analysis, it was assumed that approximately half of the site (~25 acres) would be treated in an amended sand filter at the Beam Avenue Development Site. Flow bypass would occur at the Beam Avenue site location to prevent high flows from disrupting proper operation of the sand filter. Pretreatment of sand filter inflows would be required.

Cost and Estimated Performance at Beam Avenue Site[5]:

Capital cost	$1,000,000
Annual maintenance	$88,000
Total annual cost	$175,200
Annual P removal (Pounds)	117
Annualized cost per pounds P removed	$1,497
Percentage of Kohlman Basin TP removed	2%

If the entire site were to be treated by a larger version of an amended sand filter, the costs listed about would be roughly doubled, as would the percentage of Kohlman Basin TP removed.

3.3.5.2 Hubbard Broadcasting/KSTP Site

Additional excavation would be necessary to create proper elevation for a sand filter to function properly (the site is, on average, 8 feet higher than the water that would be entering the site from upstream). This increases the estimated cost per unit phosphorus removal. A portion of the flow exiting Hazelwood Park Pond would bypass the site to protect the system from damage during high flow. Pretreatment would not be required at the Hubbard Broadcasting site (the influent water is essentially pretreated already in Hazelwood Park Pond).

Cost and Estimated Performance at Hubbard Broadcasting Site:

Capital cost	$2,200,000
Annual maintenance	$193,000
Total annual cost	$384,800
Annual P removal (Pounds)	134
Annualized cost per pounds P removed	$2,867
Percentage of Kohlman Basin TP removed	5%

3.4 Polymer and Floc Log Systems

3.4.1 General Description

Polymer and Floc Log systems are non-mechanical systems that are designed to flocculate particulate and colloidal (e.g., smaller, and generally non-settling particles) material and remove phosphorus that is bound to or incorporated into these particles. Stormwater is allowed to flow around or through the

[5] Cost estimates and phosphorus removal for the undeveloped site north of Beam Ave are based on the assumption that the drainage areas north of Beam Avenue (KOHL-01C and KOHL-01D) are developed as commercial use in the future, and that roughly half of the drainage from these areas would be treated by the amended sand filter.

device and the polymer substrate dissolves into the stormwater over time while flocculating particles. The flocculated material is then settled and accumulates in a settling basin downstream from the treatment area. Polymer treatment generally involves additional chemical binding with compounds such as alum or CaO in combination with, for example, polyacrylamide.

Figure 8 Floc Logs

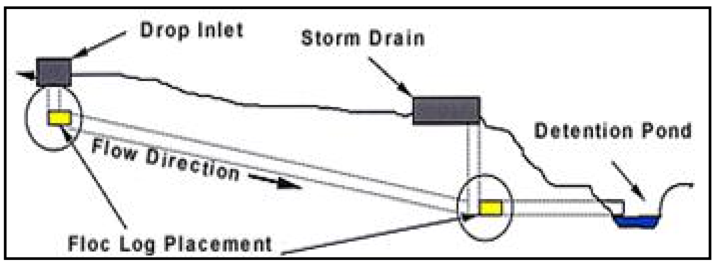


Figure 9 Schematic of Floc Log Placement in a Storm Sewer

3.4.2 Site Specific Considerations

- Polymer treatment systems are ideal for urban stormwater because they enhance the rate of particulate settling thus requiring a relatively small area for treatment compared with other methods.
- A detention basin is required for settling.

3.4.3 Maintenance

- Dredging of sedimentation cell approximately every 10 years.
- Inspection and addition of polymer or Floc Logs every 2 weeks.

3.4.4 Literature Review of Performance Data

Ebeling et al. 2005 reported soluble reactive phosphorus (SRP) removal ranged from approximately 40 to 50 percent in experiments using different polymers (Ebeling et al. 2005). Entry et al. (2002) showed a 50 to 60 percent removal of SRP using ployacrylamide combined with either alum or CaO but no change in when using ployacrylamide alone. Information on specific phosphorus removal rates using floc logs is limited but more information can be obtained directly from the manufacturer through free testing using stormwater collected from Kohlman Basin.

Table 4 Relative Reliability, P Removal, Maintenance and Cost for Polymer/Floc Log systems, based on review of available literature

Polymer/Floc Log Systems

	Low		Med		High
Reliability			●		
P Removal				●	
Maintenance					●
Cost					●

3.4.5 Potential Site Locations

3.4.5.1 Hubbard Broadcasting/KSTP site

Polymer and Floc Log systems were investigated for the Hubbard Broadcasting site to treat flow exiting Hazelwood Park Pond to Kohlman Basin. Partial flow through the area could be treated using Floc Logs while the entire flow could potentially be treated using a polymer system. The first cell in Kohlman Basin (cell KOHL-KBA) would serve as the settling basin for the flocculated material.

Excavation would be necessary to create the elevation needed for stormwater to flow through the chamber where exposure to polymer or Floc Logs will occur. Some bypass of non-treated flows will occur using Flog Logs while a polymer treatment system would treat nearly all flow from Hazelwood Park Pond to Kohlman Basin.

Cost and Estimated Performance of Floc Logs at the Hubbard Broadcasting Site:

Capital cost $269,000
Annual maintenance.. $263,000
Total annual cost.. $277,700
Annual P removal (Pounds) 84
Annualized cost per pounds P removed................................... $3,304
Percentage of Kohlman Basin TP removed 3%

Cost and Estimated Performance of a Polymer System at the Hubbard Broadcasting Site:

Capital cost	$800,000
Annual maintenance	$333,200
Total annual cost	$403,000
Annual P removal (Pounds)	482
Annualized cost per pounds P removed	$836
Percentage of Kohlman Basin TP removed	17%

3.5 Summary of Costs and Benefits of Evaluated Treatment Technologies

Table 5 presents the estimated costs and treatment performances of all of the potential projects described in Sections 3.1 through 3.4 of this report. Assuming a project life span of 20 years and a 6 percent rate of return on investments, the capital and annual costs can be combined to create and annualized cost in 2005 dollars (it is too early to put costs in terms of 2006 dollars). Dividing this annualized cost by the annual pounds of TP that are estimated to be removed by the proposed project yields an annualized cost per pound of TP removed. This is a useful metric that allows a clear comparison of worth between different proposed projects with different capital costs, annual costs and phosphorus reduction efficiencies.

Although a polymer system or a PSTA system in the Hubbard Broadcasting property would potentially result in a relatively low annualized cost per pound TP removed, these projects have a high capital cost, more uncertainty than other projects, and a funding partner has yet to be identified. Alternatively, an enhanced sand filter proposed for North of Beam Avenue could be installed with the site developer as the partner. The Hazelwood Park Pond improvements project also has potential partners that have shown much preliminary interest. They include the DNR and the City of Maplewood.

The reason for not pursuing a project at the Hubbard Broadcasting site at present can be demonstrated by looking closely at the annual costs, TP reduction goals, and potential conflicts with surrounding land owners, and the unknown future desires of the owner of the property . If we define two project approaches as:

- **Option A** Kohlman Basin Permeable Lime Barrier, Enhanced Sand Filter North of Beam Avenue Development Site, Hazelwood Park Pond PSTA/SAV

- **Option B**: Hubbard Broadcasting Property Polymer System

We can calculate their total annualized costs as follows:

Option A:

\$11,300 + \$175,200 + \$86,700	=	\$273,200 total annualized costs
4% + 2%* + 6% =		12% reduction in Kohlman Basin's TP outflow

Option B:

	\$403,000 total annualized costs
	17% reduction in Kohlman Basin's TP outflow

While TP removal is not as high in Option A as it is in Option B, (12% vs. 17%), Option A is nonetheless recommended over Option B for the following reasons:

- Option A costs \$130,000 less (on an annual basis) than Option B.
- Option A's estimated TP removal, although less than that of Option B's, still meets the goal set forth in the scope of this study (a Kohlman Basin TP removal of 10 to 15%).
- The enhanced sand filter has a potential funding partner—the future developer of the Beam Avenue site as does the Hazelwood Park Pond improvement projects—the MnDNR and the City of Maplewood.
- A potential technical difficulty with polymer systems is that they are passive and the amount of polymer that dissolved into the storm water can not easily be controlled. This could potentially affect the TSS and phosphorus removal performance of the polymer bloc system. It seems prudent, given the high degree of uncertainty in these newer technologies, to not "put all eggs into one basket". Use of a few different types of technologies, implemented over time, seems wise at this time.
- Many unknowns still exist with the former compost facility site (Hubbard Broadcasting site). Therefore, use of the site should be delayed and considered at a future date, if additional treatment is needed.

For these reasons, projects recommended for implementation are:

1. Kohlman Basin Permeable Lime Barriers
2. Enhanced Sand Filter at Beam Avenue Site
3. Hazelwood Park Pond Improvements (PSTA/SAV/kids' fishing pond)

Figure 10 shows the location of these projects. In this figure, the location of the sand filter in the future Beam Avenue Development Site is largely conceptual, as the actual location of the filter would not take place until a developer is involved in the site development.

The estimated effect of these three recommended projects on the TP concentration of Kohlman Lake is presented and discussed in Section 4.0.

One last note on the Hubbard Broadcasting site:
As time passes, and polymer technology and other technologies improve, the KSTP site should not be forgotten. In fact, it may be wise to talk to Hubbard Broadcasting about the possibility of a lease agreement now, in order to secure this space for future use as an additional treatment area of some sort. The prime location of this site (despite its high elevation) cannot be ignored, and it may yet become a useful spot for the watershed District as treatment technologies improve.

Table 5: Proposed Project Capital, Maintenance, Total Annual Costs and Cost Per Pound of Phosphorus Removed

Proposed Project	Capital Cost (2005 $)[1]	Assumed Life Span (years)	Annual Maintenance (2005 $)[3]	Annualized Capital Cost (A/P I = 6%, n = 20, Factor = 0.0872)	Total Annual Costs (2005 $)	Annual TP Removed (lbs TP removed)[4]	Annualized Cost per Annual Pound TP Removed	Percent of Overall Kohlman Basin TP Removed
Kohlman Basin Limerock PRBs	$118,000	20	$1,000	$10,300	$11,300	113	$100	4
KSTP Property Polymer System	$800,000	20	$333,200	$69,800	$403,000	482	$836	17
KSTP Property Floc Logs	$169,000	20	$263,000	$14,700	$277,700	84	$3,304	3
KSTP Property Sand Filter	$2,200,000	20	$193,000	$191,800	$384,800	134	$2,867	5
KSTP PSTA	$1,036,000	20	$3,000	$90,300	$93,300	70	$1,333	2
Enhanced Sand Filtration on Beam Avenue Site[2]	$1,000,000	20	$88,000	$87,200	$175,200	117	$1,497	2
Hazelwood Park Pond Improvements (PSTA/SAV)	$914,000	20	$7,000	$79,700	$86,700	162	$535	6

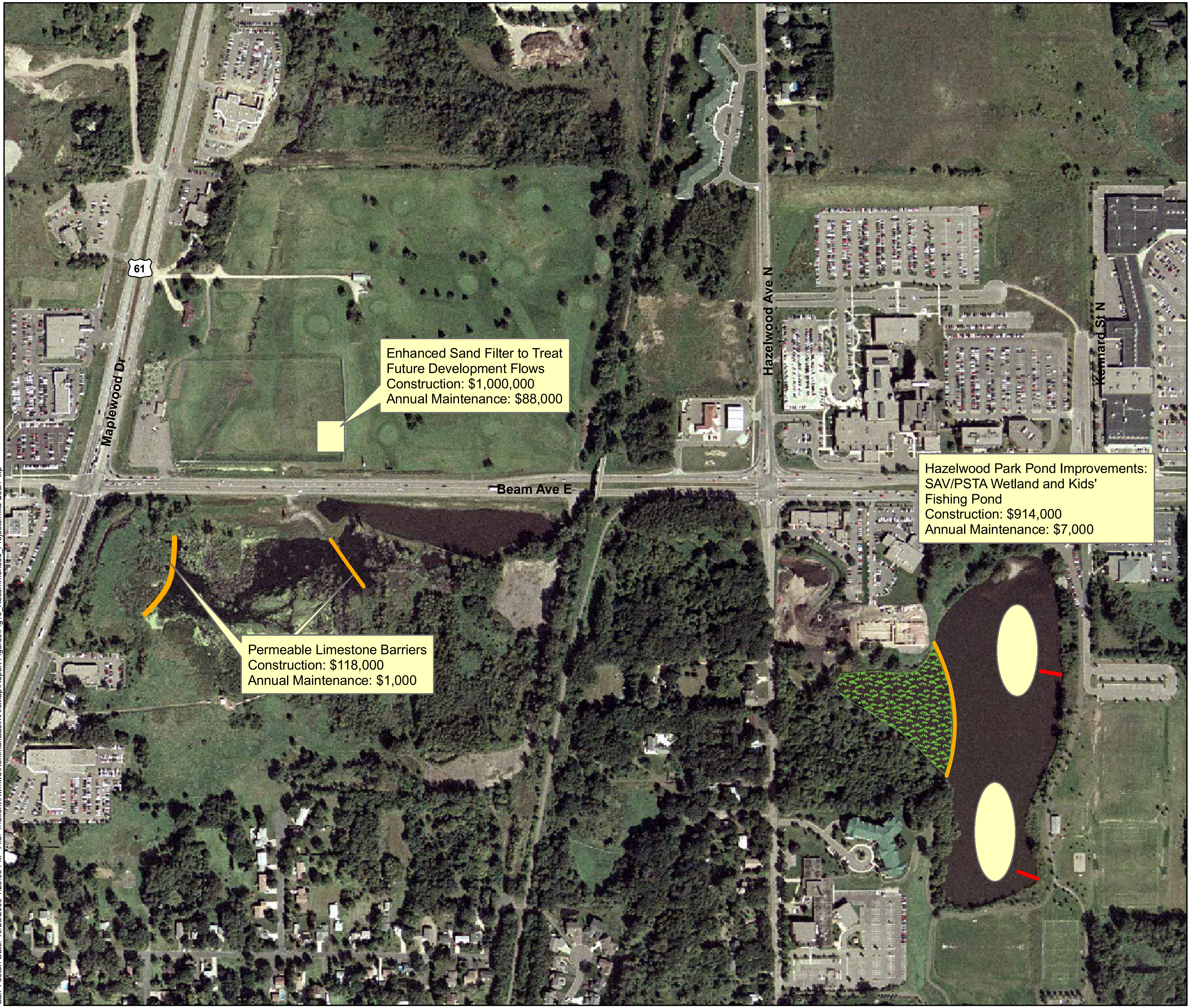
[1]Capital cost includes engineering (20%) and contingency (40%).

[2]Assumes that ~25 acres of the future commerical land developed at the Beam Avenue Development Site is treated by the sand filter.

[3]Maintenance cost includes contingency (40%).

[4]Except for limerock PRBs, annual TP removed is based on 6 months of effective operation, assuming that the technology provides little treatment in winter and early spring.

Note: 2005 Dollars are used here because acurate estimates for conversions from 2005 dollars to 2006 dollars are not yet available.



LEGEND

- Permeable Limestone Barrier
- Fishing Piers
- Periphyton/Submerged Aquatic Vegetation Treatment Wetland
- Dredged "Holes" for Sedimentation and Fishing Habitat

NOTE: Construction Costs include 20% engineering and 40% contingency.
Maintenance costs include a 40% contingency.

200 0 200 400 600 800
Feet

Ramsey-Washington Metro Watershed District

BARR

Figure 10

RECOMMENDED PROJECTS
Kohlman Basin Area
Water Quality Enhancements Study

Ramsey-Washington
Metro Watershed District

4.0 Treatment Efficiency of Recommended Projects and Their Impact on Kohlman Lake Water Quality

Figure 11 shows the impact of the three recommended projects on the in-lake TP concentration of Kohlman Lake.

It is, however, important to look at the effect these projects would have on the lake's TP in the context of other projects and development requirements that are being considered, namely, in-lake reduction of Kohlman Lake's internal phosphorus load and implementation of the infiltration standard as the watershed redevelops.

The effect of the impending infiltration standard on the Kohlman Lake's water quality has already been estimated assuming a period of 20 years of road redevelopment. A memo describing the methodology used in creating the "20-year infiltration model" is included in this report in Appendix B. For this study, the effect of the infiltration standard over the next 10 years was of interest as that is the lifespan of the new Plan. In order to change the "20-year infiltration model" into the "10-year infiltration model", half of the drainage areas that were assumed to have road redevelopment projects in the "20-year infiltration" model were restored to their current level of infiltration. Another twist was put on the "10-year infiltration model" analysis—the uncertainty in whether or not infiltrated water would reach the lake (thereby diluting it) was modeled, and the degree of uncertainty in the resulting TP concentration in the lake is represented in error bars on the results chart (Figure 12).

When looking at Figure 12, it is important to keep in mind the assumption that a certain goal is met if all of the predicted lake TP is less than the goal concentration <u>under all three</u> climatological conditions (as opposed to just the average of the three climatological conditions). This is consistent with the methodology used in the Phalen Chain of Lakes SLMP. However, in meetings with the MPCA during the TMDL process, MPCA staff indicated that looking at the <u>average of the three</u> climatological conditions would be sufficient. However, given the variability of model results, and indeed, lake ecosystem environments, a more conservative approach (trying to meet lake water quality goals for the "worst case scenario" climatic conditions) seems prudent.

Project(s) that meet Kohlman Lake's RWMWD Short Term TP Goal (90 μg/L) for <u>all three</u> (as opposed to the average of the three) climatic conditions:

- Reduce Kohlman Lake's internal load by 90 percent.
- Infiltrate 1-inch in redeveloped areas over the next 10 years and reduce Kohlman Lake's internal load by 90 percent.
- Infiltrate 1-inch in redeveloped areas over the next 10 years and reduce Kohlman Lake's internal load by 90 percent and permeable lime barrier in Kohlman Basin and sand filter at Beam Avenue Development Site.
- Infiltrate 1-inch in redeveloped areas over the next 10 years and reduce Kohlman Lake's internal load by 90 percent and Hazelwood Park Pond SAV/PSTA.
- Infiltrate 1-inch in redeveloped areas over the next 10 years and reduce Kohlman Lake's internal load by 90 percent and permeable lime barrier in Kohlman Basin and sand filter at Beam Avenue Development Site and Hazelwood Park Pond SAV/PSTA

Project(s) that meet Kohlman Lake's RWMWD Long Term TP Goal (70 μg/L) for all three climatic conditions:

- Infiltrate 1-inch in redeveloped areas over the next 10 years and reduce Kohlman Lake's internal load by 90 percent.
- Infiltrate 1-inch in redeveloped areas over the next 10 years and reduce Kohlman Lake's internal load by 90 percent and permeable lime barrier in Kohlman Basin and sand filter at Beam Avenue Development Site.
- Infiltrate 1-inch in redeveloped areas over the next 10 years and reduce Kohlman Lake's internal load by 90 percent and Hazelwood Park Pond SAV/PSTA.
- Infiltrate 1-inch in redeveloped areas over the next 10 years and reduce Kohlman Lake's internal load by 90 percent and permeable lime barrier in Kohlman Basin and sand filter at Beam Avenue Development Site and Hazelwood Park Pond SAV/PSTA.

Projects that meet the MPCA Proposed Shallow Lake TP Criteria (60 μg/L) for all three climatic conditions:

- Infiltrate 1-inch in redeveloped areas over the next 10 years and reduce Kohlman Lake's internal load by 90 percent and permeable lime barrier in Kohlman Basin and sand filter at Beam Avenue Development Site and Hazelwood Park Pond SAV/PSTA.

Definition of CIP Scenarios

A: Conditions Before Owasso Basin, Gervais Mill Pond, Kohlman Basin, NSP Urban Ecology Center and PCU Environmental Learning Center

B: Existing Conditions

D: Permable Lime Barrier in Kohlman Basin

E: Permable Lime Barrier in Kohlman Basin and Sand Filter north of Beam Avenue OR Hazelwood Park Pond SAV/PSTA

F: Permable Lime Barrier in Kohlman Basin and Sand Filter north of Beam Avenue AND Hazelwood Park Pond SAV/PSTA

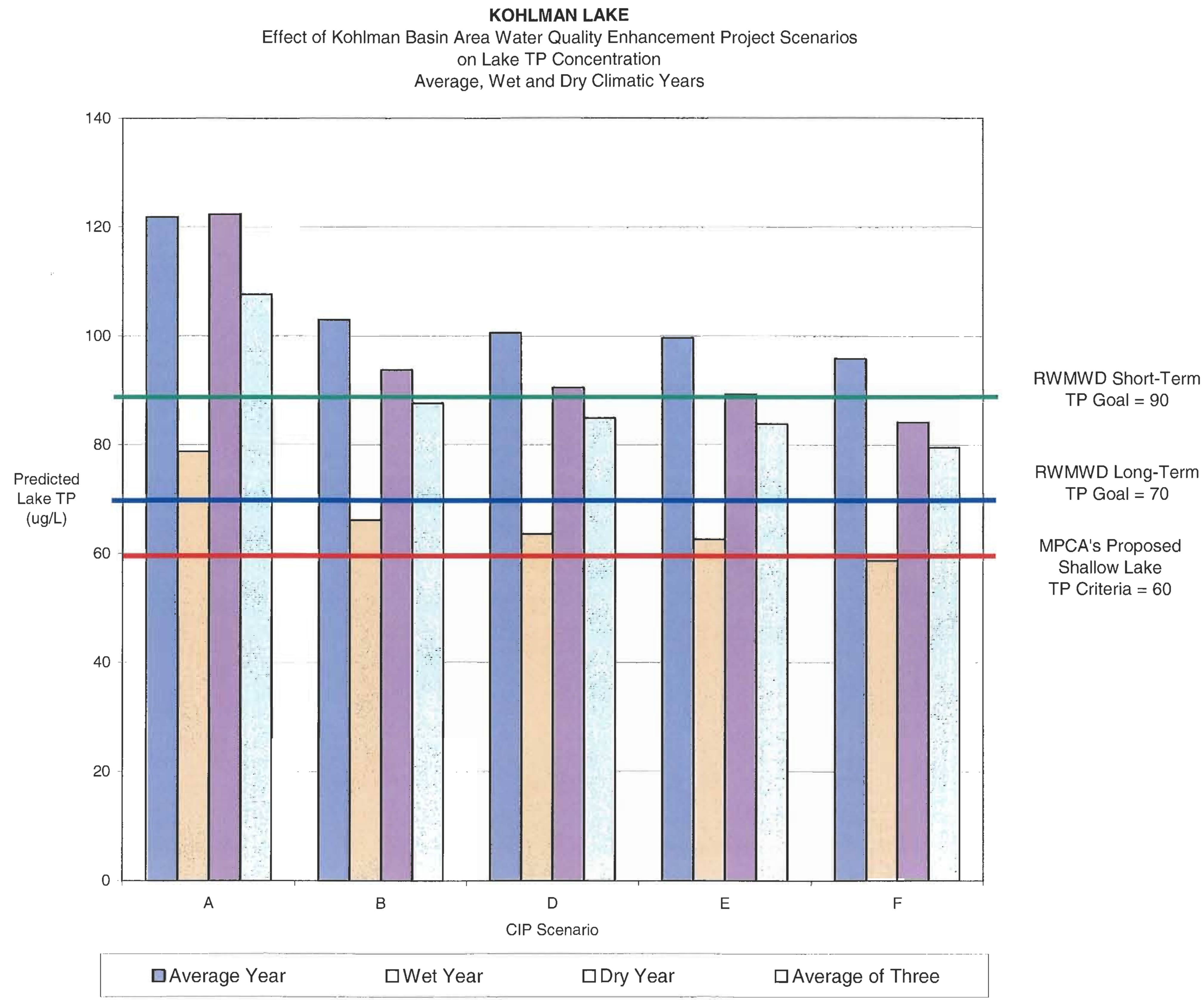


Figure 11

Definition of CIP Scenarios

A: Conditions Before Owasso Basin, Gervais Mill Pond, Kohlman Basin, NSP Urban Ecology Center and PCU Environmental Learning Center

B: Existing Conditions
C: Kohlman Lake's Internal Load Reduced By 90%

D: Permable Lime Barrier in Kohlman Basin
E: Permable Lime Barrier in Kohlman Basin and Sand Filter north of Beam Avenue OR Hazelwood Park Pond SAV/PSTA
F: Permable Lime Barrier in Kohlman Basin and Sand Filter north of Beam Avenue AND Hazelwood Park Pond SAV/PSTA

G: Infiltrate 1.00 inches in some drainage areas over the next 10 years

H: Infiltrate 1.00 inches in some drainage areas over the next 10 years and Scenario C

I: Infiltrate 1.00 inches in some drainage areas over the next 10 years and Scenario E

J: Infiltrate 1.00 inches in some drainage areas over the next 10 years and Scenario F

K: Infiltrate 1.00 inches in some drainage areas over the next 10 years Scenario C and Scenario E

L: Infiltrate 1.00 inches in some drainage areas over the next 10 years Scenario C and Scenario F

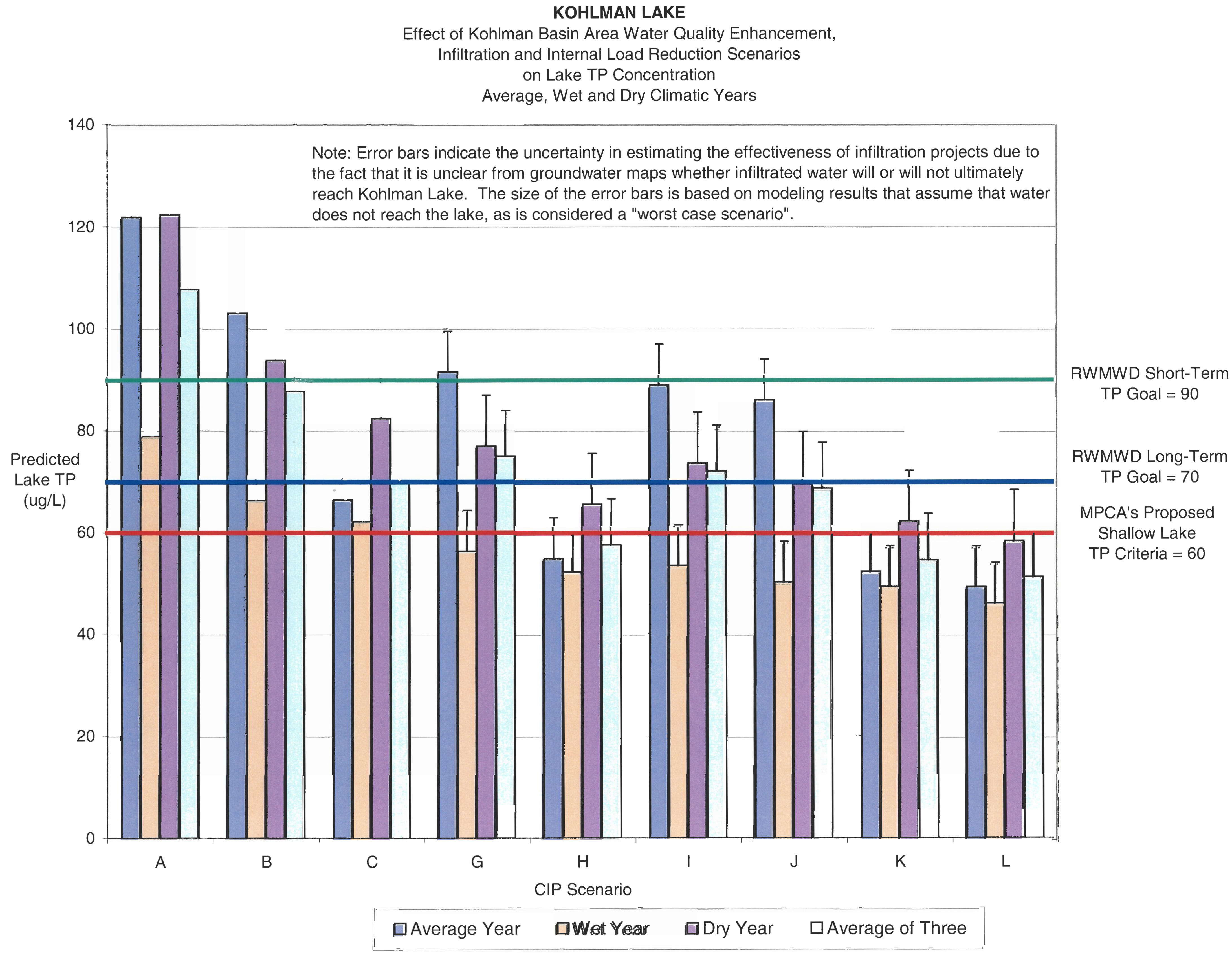


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Figure 12

5.0 Phased Implementation and Monitoring

5.1 Phased Implementation

Although all of the projects discussed in Section 4.0 are recommended for implementation, a phased approach is recommended. Phased implementation will allow for specific monitoring of technologies used before flow and nutrient concentrations are altered by additional BMP installations. Phased implementation also allows time to look for and work with funding partners, to search for and apply for future grants, and to monitor the effectiveness of projects that have already been constructed to confirm or deny the need for additional phosphorus removal.

The permeable lime barrier should be installed before other BMP alternatives. Implementation of enhanced sand filtration north of Beam Avenue will occur at a future date and may involve retrofitting a sand filter into one or more of the infiltration areas planned for the site by its current developer. The Hazelwood Park Pond improvements should be conducted as the final phase. Hazelwood Park Pond improvements are likely to have the largest single improvement to the basin (in terms of phosphorus removal as a percentage of total phosphorus mass input to Kohlman Basin) but will also involve coordination with other agencies such as the MnDNR and the City of Maplewood.

5.2 Monitoring

5.2.1 Limestone Permeable Reactive Barrier

The permeable lime barriers would be monitored through the collection of sediment cores taken from Kohlman Basin, downstream from the barriers, both before and after installation. An initial baseline concentration of sediment phosphorus and calcium will be calculated from cores collected before lime barrier installation. After installation, sediment cores will be collected two times over the next 5 years from the same areas where baseline cores were collected. Comparing the pre- and post-treatment sediment mass will make it possible to estimate phosphorus reduction via calcium binding and accumulation in the sediment. In addition, concentrations of calcium in the water column of the basin, before and after the barriers, should be measured to estimate dissolution of the barrier over time.

5.2.2 Enhanced Sand Filtration at Beam Avenue Development Site and Hazelwood Park Pond SAV/PSTA

A statistical approach is recommended for monitoring effectiveness of both enhanced sand filtration and Hazelwood Park Pond improvements with the following requirements:

- Independent sampling of inflow and outflow to determine pollutant concentration.
- Season long measurement of flow through the system.
- Monitoring of water level in the pond or basin.

A statistical monitoring approach rather than an event based approach is recommended to determine pollutant removal efficiency for enhanced sand filtration. The reason for this is that in order to compare upstream samples to those collected from downstream of the filter, flow conditions should be similar. Because of variable storm flows (residence time will vary based on storm size and duration) it would be difficult to accurately sample the same water at the outlet that was sampled at the inlet before the filter treated the water during an event based sampling period. With a statistically based approach, average inflow and outflow concentrations are attained from random sampling dates (inlet and outlet sample dates are selected independently) throughout the season. These are then used with total flow during the season to determine phosphorus removal efficiency of the specific BMP. One of the additional benefits to using a statistical approach is that it allows sample schedules to be determined in advance and automatic samplers can be programmed based on this sampling schedule.

Hazelwood Park Pond improvement monitoring should be conducted in a similar manner to monitoring for the sand filter and sample collection dates could be scheduled on the same dates chosen for sand filter sample collection. Grab samples from the inlet to the improvement section (assuming access is available) and outlet, along with continuous flow measurements, will allow for phosphorus removal estimates within the pond.

5.3 Example of Possible Implementation and Monitoring Timeline

The following is an example of a potential implementation and monitoring timeline for the projects recommended in this report. This proposed timeline would be appropriate if the District wished to attain the lowest in-lake TP concentration in the near future. If the District chose to achieve the short term goal of 90 μg/L by the next Plan update, then this timeline could be lengthened accordingly.

Phase 1 (2007):

- Completion of the Kohlman Lake TMDL report, including the implementation plan presented in this report.
- Implementation of Macrophyte Management Plan for Kohlman Lake in preparation for treatment of internal load reduction
- Pre-construction monitoring of inflow/outflow TP concentrations in Kohlman Basin
- Pre-construction sediment cores downstream of Kohlman Basin's existing permeable weirs to establish the baseline Ca-P levels in downstream sediments.
- Construction of limestone PRBs in Kohlman Basin (fall, 2007)
- Ongoing enforcement of the 1-inch infiltration standard

Phase 2 (2008 or later):

- Construction of enhanced sand filtration north of Beam Avenue
- Meetings with DNR and City of Maplewood to plan Hazelwood Park Pond improvements project
- Fisheries and Macrophyte survey of Hazelwood Park Pond
- Monitoring of limestone PRBs in Kohlman Basin
- Ongoing enforcement of the 1-inch infiltration standard

Phase 3 (2009 or later):

- Reduction of Kohlman Lake's internal load
- Meetings with DNR and City of Maplewood to plan Hazelwood Park Pond improvements project
- Pre-construction monitoring of inflow/outflow TP concentrations in Hazelwood Park Pond
- Monitoring of enhanced sand filter on Beam Avenue development site
- Monitoring of limestone PRBs in Kohlman Basin
- Ongoing enforcement of the 1-inch infiltration standard

Phase 4 (2010 or later)

- Construction of Hazelwood Park Pond SAV/PSTA/kids' fishing pond
- Monitor effectiveness of alum treatment through examination of sediment cores for mobile phosphorus concentration
- Monitoring of enhanced sand filter on Beam Avenue development site

- Monitoring of limestone PRBs in Kohlman Basin
- Ongoing enforcement of the 1-inch infiltration standard

Phase 5 (2011 or later):

- Monitoring of Hazelwood Park Pond SAV/PSTA/kids' fishing pond
- Monitor effectiveness of alum treatment through examination of sediment cores for mobile phosphorus concentration
- Monitoring of enhanced sand filter on Beam Avenue development site
- Monitoring of limestone PRBs in Kohlman Basin
- Ongoing enforcement of the 1-inch infiltration standard

6.0 Funding Options

Appendix C contains a table of the current grant opportunities (current as of 9/1/2006) that may be relevant to the permeable lime barrier, the sand filter North of Beam Avenue and the Hazelwood Park Pond SAV/PSTA. A Clean Water Legacy Grant application was submitted on September 29, 2006 for the permeable lime barriers in Kohlman Basin. If the project is not selected for funding, other funding sources will be sought out.

In addition, each of the projects (including the reduction of Kohlman Lake's internal phosphorus load) could be funded by the Storm Water Impact fund being developed for permit applicants that cannot meet the District's 1-inch infiltration standard. Because this funding source is not yet established, it may be most appropriate for a longer-term project, such as the Hazelwood Park Pond SAV wetland.

The sand filter North of Beam Avenue would be a cost share project between the developer and the District. This would involve working with the developers of the Country View Golf Course Area to incorporate the amended sand filter concept into their plans. The BMP cost-share program could be used to help fund the project. Also, grant funding could be obtained for this project.

The Hazelwood Park Pond improvements project could be a project whose design and cost could be shared by the District, the MnDNR and the City of Maplewood. It is also possible that a grant could be obtained for the project sometime in the future, especially since it covers water quality improvement, kids' recreation, and possibly public education. The Stormwater Impact Fund could also be used to fund part of this project in the future.

7.0 Conclusions and Recommendations

The restoration and future management of Kohlman Lake depends upon controlling both internal and external sources of phosphorus to the lake. If external sources are not controlled, it is possible that measures to control internal phosphorus loading will be short lived.

Because flow through Kohlman Basin is high and the area available to construct treatment projects is small, external phosphorus load reduction will be more expensive when compared to systems without these restrictions. However, modeling has shown that even the small reductions will benefit the lake, even to the extent that the MPCA's proposed shallow lake criteria (60 μg/L) could be met. Reduction of the lake's external phosphorus sources will also extend the life of internal measures (i.e. alum treatment or dredging) to control phosphorus loading to the lake.

Implementation of the infiltration standard will provide further reduction in the lake's TP concentration, although the magnitude of its impact can vary by as much as 10 μg/L. This is due to the uncertainty of whether or not the infiltrated water will reach the lake (thereby diluting the lake's TP).

The construction of permeable lime barriers offers a two-fold benefit to Kohlman Lake and the District:

- The potential for significant soluble and non-settleable phosphorus reduction at a relatively low cost
- The opportunity to try an innovative technology with a low environmental risk that could be useful in the District's future attempts in reducing soluble and non-settleable phosphorus. The monitoring schedule proposed for this project would verify performance and help the District use this technology effectively in the future.

The construction of a sand filter to treat the future runoff from the former site of the Country View golf course area north of Beam Avenue, provides a high level of treatment in a relatively small space and offers a way to keep the loadings from this future site (that is in such a critical area) as low as possible. Filtration is targeted in this area because the likelihood of high groundwater levels in the area would preclude infiltration. The cost of this project would be borne primarily by the site developer. However, depending on the nature of the final design some cost assistance via the BMP cost-share program may be available to that developer if the final design qualifies.

The Hazelwood Park Pond SAV/PSTA project is an opportunity to work with the MnDNR and the City of Maplewood, and potentially other interested parties to create an improved Hazelwood Park Pond that offers both water quality, recreational, and educational benefits. This project, perhaps more than any other presented in this report, is an opportunity to improve an existing resource in a multi-agency effort that would be a highly visible project within the District's domain. Because of the many benefits that this project could provide, it is a seemingly good candidate for a number of different grant resources, and should be pursued as such as the project evolves.

The three projects proposed in this report are still considered experimental, to varying degrees. Few organizations have implemented these types of projects. Where they have been researched and implemented, however, they show promise in reducing soluble and non-settleable fractions of phosphorus in runoff. If the District wishes to significantly reduce the TP concentration in Kohlman Lake, these projects offer an innovative way to achieve that goal. Implementation of these projects will likely be difficult, and involve an involved process of problem solving for years to come. However, this effort will likely result in not only reductions in phosphorus to Kohlman Lake, but an enlightened approach to watershed management from which many other organizations will benefit.

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Appendix A

October 18, 2000 Memorandum to Ramsey-Washington Metro Watershed District Board of Managers from Jason Westbrock, Barr Engineering Co. Re: Beam Avenue Pond Recommendations

Memorandum

To: Ramsey-Washington Metro Watershed District Board of Managers
From: Jason Westbrock
Subject: Beam Avenue Pond Recommendations
Date: October 18, 2000
Project: 23/62-282 BJL 024
c:

Beam Avenue Pond, also known as Hazelwood Park Pond, is located in Maplewood east of the intersection of Beam Avenue and Highway 61 (see attached figure). The total watershed area that drains to Beam Avenue Pond is approximately 3,630 acres. Located within the pond's 370-acre local watershed is the Maplewood Mall.

The north end of the pond is showing signs of sedimentation. A sediment delta has formed a small island and waterfowl can be seen standing on solid ground in the middle of the pond. A bathymetric survey was performed on August 8, 2000 to determine the extent of the sedimentation. By comparing the results of the 2000 survey with a 1972 contour map, we estimate the amount of sediment deposited in the pond is approximately 2,200 cubic yards. This has reduced the dead storage of the pond from 45.9 acre-feet to 44.5 acre-feet or about 3%.

A water quality model (P-8) was used to estimate the phosphorus removal effectiveness of Beam Avenue Pond. According to the model, soluble phosphorus constitutes the largest fraction of incoming phosphorus. The pond is very effective at removing particulate phosphorus attached to sediment, but the soluble phosphorus is not removed by the pond. Currently, Beam Avenue Pond removes 30% of incoming phosphorus. Because of the large fraction of soluble phosphorus, removing the 2,200 cubic yards of sediment will not improve the phosphorus removal effectiveness of the pond. Chemical treatment will be necessary if the District wants reduce the amount of soluble phosphorus that leaves Beam Avenue Pond.

Currently, the pond is filling with sediment at approximately 80 cubic yards per year. The sediment will eventually form another visible sediment delta and affect the aesthetics of the pond before treatment levels are significantly affected. We therefore recommend that the District monitor the pond visually for signs of sediment related problems and defer excavation efforts until they are necessary.

Appendix B

January 25, 2006 Memorandum to Ramsey-Washington Metro Watershed District Board of Managers from Brad Lindaman, et al., Barr Engineering Co. Re: Kohlman Lake Infiltration Analysis

Memorandum

To: RWMWD

From: Brad Lindaman, Greg Wilson, Erin Anderson Wenz (Barr Engineering Company)

Subject: Kohlman Lake Infiltration Analysis

Date: January 25, 2006

Project: 23/62-893 PLAN

Introduction

This memo report contains a description of a modeling exercise which demonstrates the expected effect that different infiltration standards would have on the in-lake phosphorus concentration of Kohlman Lake over a twenty-year implementation period. Kohlman Lake and its subwatershed was deemed an appropriate example, as the management of Kohlman Lake's water quality has been, and remains, a significant challenge to the RWMWD because:

- The external load of phosphorus to the lake (from its tributary subwatershed) is difficult to reduce through traditional methods (i.e. water quality ponds), as it is largely "treated" through a series of existing ponds and wetlands before it reaches the lake. As a result, the phosphorus that reaches the lake is soluble or associated with very small, unsettleable particles.
- The implementation of infiltration measures is thought to be an effective alternative to, or supplement, to chemical treatment when reducing the soluble portion of the watershed's phosphorus load.
- Kohlman Lake is listed on the Minnesota Pollution Control Agency's (MPCA's) Impaired Waters List and the District is in the process of completing a Total Maximum Daily Load (TMDL) report.
- Kohlman Lake is the most upstream lake in the Phalen Chain of Lakes (comprised of Kohlman Lake, Gervais Lake, Keller Lake and Lake Phalen), and has the worst water quality of the four lakes in the chain. The water quality of Kohlman Lake affects the water quality of the downstream lakes.
- Over the last 10 years, Kohlman Lake's average growing season (June through September) total phosphorus (TP) concentration has been ~110 μg/L, nearly double the MPCA's shallow lake proposed standard for TP (60 μg/L).
- The District's proposed TP goal for the lake, while higher than the MPCA's shallow lake proposed standard, is still a challenging goal to attain (90 μg/L).

Overview of the Kohlman Lake and its Tributary Subwatershed

Kohlman Lake is a Minnesota Department of Natural Resources (DNR)-protected water (#62-0006) located in the city of Maplewood. The lake has a surface area of 74 acres, a maximum depth of approximately 9 feet, and a mean depth of 4 feet. Most of the lake is less than 6 feet deep, with the littoral area comprising 74 acres or 100 percent of the lake (DNR Lake Data). By MPCA standards (a maximum depth of 15 feet or shallower and/or 80 percent or more of the lake is less than 15 feet deep); Kohlman Lake is considered to be a shallow lake. The watershed area in comparison to lake area is relatively large (101:1). Kohlman Lake is a fishing lake used lake primarily for motorboating, canoeing, fishing, picnicking, and aesthetic viewing. Kohlman Lake provides some limited wildlife habitat. Kohlman Lake is polymictic; meaning it mixes several times throughout the year. At times, this mixing can entrain phosphorus that is released from the lake’s sediments into the water column, making more phosphorus available to algae.

The Kohlman Lake watershed comprises a total of 7,484 acres (excluding the lake surface area) and drains portions of the cities of Gem Lake, White Bear Lake, Vadnais Heights, Maplewood, North St. Paul, Little Canada, and Oakdale. Runoff enters the lake from storm sewer outfalls and culverts at various points along the lakeshore and from sheet flow running off the lake’s direct drainage area. The Kohlman Lake subwatershed can be described in terms of four different “drainage districts.” A drainage district is described as a network of drainage areas that all drain to the same point before entering the lake. Each Kohlman Lake drainage district is described below:

- **Kohlman Lake Main Drainage District—**This 6,831-acre drainage district located east of the lake represents the majority of the Kohlman Lake subwatershed. Runoff from this drainage district flows through a series of ponds, wetlands and/or storm sewers; and, ultimately, Kohlman Basin before reaching Kohlman Lake.
- **Kohlman Lake North Drainage District—**This 107-acre drainage district north of the lake represents a very small portion of the Kohlman Lake subwatershed. Runoff from this drainage district flows to a flow splitter, where the flow is routed either to Kohlman Lake or Gervais Lake, depending on the level of water in the flow splitter.
- **Kohlman Lake South Drainage District—**This 83-acre drainage district south of the lake also represents a very small portion of the Kohlman Lake subwatershed. Runoff from this drainage district is routed to two ponds, neither of which have outlets—therefore, only overflow from the ponds reaches the lake.
- **Kohlman Lake Direct Drainage District—**This 463-acre drainage district consists of the area that drains directly to Kohlman Lake without passing through a retention pond. The runoff from this area receives no treatment before it reaches the lake.

Kohlman Lake's largest source of phosphorus is stormwater runoff from its tributary watershed. The Kohlman Lake watershed is completely developed, with few exceptions, and ultimate land use is considered to be essentially equal to existing land use conditions.

Overview of Modeling Methods

In 2004, the Ramsey Washington Metro Watershed District completed a 3-year study that resulted in a Strategic Lake Management Plan (SLMP) for the Phalen Chain of Lakes and its watershed (*Phalen Chain of Lakes Strategic Lake Management Plan: Improvement Options and Recommendations,* Barr Engineering Company, 2004). As a part of the study, the District conducted an extensive survey of the ponds and wetlands throughout the tributary watershed and evaluated the existing and future land uses throughout the tributary watershed. Also, the District conducted extensive monitoring of several lake inflow points and of the lakes themselves. All of this information was used to create and calibrate water quality models for the lakes and their watersheds. A stormwater runoff model (P8 Urban Catchment Model; IEP, Inc., 1990) was used to estimate the water and TP loads from each lake's tributary watershed

An in-lake mass balance model took the watershed loads and generated the resultant lake TP concentration in the lake.

These models were utilized as a part of this demonstration.

Modeling Assumptions

Since this analysis is predicated on evaluating the effectiveness of infiltration amounts required of redevelopment projects taking place over the next 20 years, Barr consulted the Cities of North St. Paul and Maplewood on the time that they expect will elapse before any given street section will be reconstructed. North St. Paul and Maplewood expected it will take 40 and 50 years, respectively, before each street segment will undergo full street reconstruction. As a result, for this exercise, we have assumed that 40 percent of the streets within the Maplewood portion of the Kohlman Lake watershed will be reconstructed within a 20 year period. For the street sections within the remainder of the watershed area, comprising the cities of Gem Lake, White Bear Lake, Vadnais Heights, North St. Paul, Little Canada, and Oakdale we assumed that 50 percent of them will undergo full reconstruction within the next 20 years.

We used the available Ramsey County soils database in GIS to determine the area of soils that would not be suitable for implementation of infiltration measures, within each city's portion of the Kohlman

Lake watershed. We accomplished this by assuming that watershed areas containing SCS Hydrologic Soil Groups D and C/D soils would not be appropriate for implementation of infiltration measures. The inappropriate soil areas determined for each city were then subtracted from the potential areas that would receive treatment as a result of street reconstruction projects.

Based on the available information regarding the rates of street reconstruction and appropriate soils, we randomly chose subwatershed areas that would be assigned the various levels of infiltration/treatment, until the representative percentages of street reconstruction within each city was met. One exception to this approach was that we accounted for the street reconstruction that is expected within Maplewood, during 2006-2010, by including all of the subwatershed areas that had any street segments identified in their 5 Year Capital Improvements Plan. As a result, the expected percentage of treatment for the overall watershed was also met for the 20-year time frame.

The various levels of infiltration/treatment (0.25, 0.50, and 1.00 inches over the directly-connected impervious areas) were each simulated in the original P8 Model for the watershed using the depression storage term. The only limitation to this approach is that the depression storage is completely refreshed within the model following the conclusion of each runoff event. Since RWMWD intends to have infiltration measures designed to infiltrate the storage volume over a 48-hour period at the conclusion of each runoff event, the depression storage term in the P8 model would over-predict the effectiveness of the infiltration measures for events with less than 48 hours of antecedent rainfall. As a result, we evaluated the events that occurred during the average year (2000-2001), originally simulated for the Kohlman Lake watershed, to determine the proportional amount of rainfall that occurred with less than 48 hours of antecedent time. This proportion of rainfall volume, relative to the total annual rainfall, was used to reduce the design volumes assigned to the depression storage term for each infiltration/treatment scenario, after adding back the depression storage originally entered into the model (0.03”).

Results

The table below displays the results, incorporating the assumptions mentioned above, of the resultant phosphorus concentration of Kohlman Lake given the range of infiltration standards implemented over a twenty year period. As mentioned previously, the District’s in-lake phosphorus concentration goal for Kohlman Lake is 90 μg/L lake.

Table 1: Kohlman Lake Estimated Total Phosphorus Concentrations Under a Range of Infiltration Standards Implemented Over a 20-Year Period

Watershed Conditions	Kohlman Lake Estimated Summer Average Total Phosphorus Concentration (μg/L)
Existing	109
Infiltrate 0.25 inches in Reconstructed Areas	103
Infiltrate 0.50 inches in Reconstructed Areas	99
Infiltrate 1.00 inches in Reconstructed Areas	95

Appendix C

Grant Resources

Grant Resources- Current as of 9/1/2006

Agency/ Organization	Program/Criteria	Eligible Applicants	Deadline	Contact
Minnesota Pollution Control Agency (MPCA)	**Phosphorus Reduction Grant**—Assists municipalities with the costs of wastewater treatment projects, or portion thereof, that will reduce the discharge of total phosphorus from the facility to one milligram per liter or less; grants up to 75% of eligible project costs	Municipalities	June 30, 2008	www.pca.state.mn.us/grants/
MPCA	**Total Maximum Daily Load Grant**—Assists municipalities with the cost of publicly owned wastewater or stormwater projects needed to meet waste-load reductions under a TMDL study; grants up to 50% of eligible project costs	Municipalities	Money reserved for projects first in the order that their TMDL study was approved by the EPA, and second, in the order that their applications are received	www.pca.state.mn.us/grants/
MPCA	**Open Grant Program**—Funds projects to develop environmentally sustainable practices in Minnesota through voluntary partnerships and goal-oriented, economically driven approaches to pollution prevention and resource conservation; maximum grant $40,000; requires a 25% match	Any	Pre-proposals due in February; Final proposal due in May	www.pca.state.mn.us/grants/

Grant Resources- Current as of 9/1/2006 (continued)

Agency/ Organization	Program/Criteria	Eligible Applicants	Deadline	Contact
MPCA	**Environmental Assistance Loan Program**—Zero percent interest loan up to $100,000 for projects related to waste reduction, pollution prevention, and other prevention-based or preventative technologies and practices in Minnesota; requires a one-to-one match	Preference given to small and medium-sized businesses and institutions	Accepted on a rolling basis through June 30, 2007	www.pca.state.mn.us/grants/
MPCA	**319 Grant**—Funds projects that address a nonpoint-source pollution issue; cannot be spent on diagnostic work (other than TMDL development); requires a one-to-one match	All entities except federal agencies	September 20, 2006	www.pca.state.mn.us/water/cwp-319.html
MPCA	**Clean Water Partnership Program**—Funds projects that address a nonpoint-source pollution issue; cannot be spent on in-lake treatment; requires a one-to-one match; grant awards up to $500,000	Local unit of government must sponsor a CWP project. The applicant can be a lake association, joint powers board, or other entity but it must involve a local unit of government, which becomes the fiscal agent. The project is most likely to be successful if as many interested parties as possible are involved.	September 20, 2006	www.pca.state.mn.us/water/cwp-319.html

Grant Resources- Current as of 9/1/2006 (continued)

Agency/ Organization	Program/Criteria	Eligible Applicants	Deadline	Contact
MPCA	**Clean Waters Legacy Act—**Provides funding for identified clean-water funding priorities; in 2007 will fund nonpoint restoration activities in targeted watersheds and/or lake basins that will have a TMDL implementation plan approved before the end of 2006	Specific list of eligible organizations or water bodies	September 30, 2006	www.pca.state.mn.us
Minnesota Department of Natural Resources (MN DNR)	**Management of Eurasian Watermilfoil**—Funds projects that manage Eurasian Watermilfoil in common-use areas of lakes and projects that control the spread of Eurasian Watermilfoil in public boat access areas. Also, assessment of potential interference by milfoil with use of a lake may be eligible for reimbursement; Lakes with less than 51 littoral acres are eligible to receive up to $700. Lakes with 51 to 100 littoral acres are eligible to receive up to $1,200. Lakes with more than 100 littoral acres are eligible to receive up to $1,200 plus $7.00 for each littoral acre in addition to the first 100.	Counties, cities, townships, and incorporated lake associations	To be announced	www.dnr.state.mn.us/grants/habitat/eurasian.html
MN DNR	**Flood Hazard Mitigation Assistance**—Grants to provide technical and financial assistance to local governmental units for conducting flood-damage reduction studies and for planning and implementing flood-damage reduction measures; Grants for a maximum of 50% of total eligible project costs up to $150,000	Cities, counties, townships, watershed districts, watershed management organizations, and lake improvement districts	June 1	www.dnr.state.mn.us/grants/water/flood_hazard.html

Grant Resources- Current as of 9/1/2006 (continued)

Agency/ Organization	Program/Criteria	Eligible Applicants	Deadline	Contact
MN DNR	**Stream Bank Maintenance Grants**—Assistance for cutting and removing dead and downed trees and brush from a channel or flood plain, removing large rocks and other debris from a channel or flood plain, and supporting measures which stabilize banks and reduce reoccurrence of snagging and sedimentation; Grants for a maximum of 75% of eligible project costs and range from $5,000 - $15,000	County governments	To be announced	www.dnr.state.mn.us

Grant Resources- Current as of 9/1/2006 (continued)

Agency/ Organization	Program/Criteria	Eligible Applicants	Deadline	Contact
MN DNR	**Environmental and Conservation Partnerships Grants**— *Habitat Enhancement projects include:* restoration of native plant communities, reforestation, protection of wetlands, and abatement of soil erosion. Plantings must consist only of native species. *Research/Survey projects include:* monitoring environmental indicators and researching methods to conserve or enhance fish, wildlife and native plant habitat. These research/survey projects must be directly related to a specific habitat-improvement project. *Environmental Service projects include:* clean up of natural areas such as streams, lakes, and wetlands and developing educational exhibits that demonstrate environmental conservation principles. Other creative project ideas that meet the program purpose above are encouraged. *Ineligible activities include:* curriculum development; construction of trails, buildings, and boardwalks; project administration, overhead, and indirect costs. Grants are awarded for a maximum of 50% of the total project costs. The maximum grant award is $20,000; 50% match required	Private organizations, counties, cities, townships, and school districts	January 31, 2006	www.dnr.state.mn.us/grants/habitat/env_cons_part.html

Grant Resources- Current as of 9/1/2006 (continued)

Agency/ Organization	Program/Criteria	Eligible Applicants	Deadline	Contact
MN DNR	**Shoreland Habitat Restoration Grants**—Funding to expand the diversity and abundance of native aquatic and shoreland plants; improve and protect the quality of shoreline habitat; enhance and protect water quality; raise awareness of the value of native shoreline and aquatic vegetation.	Organizations, associations, private citizens, and local units of government	September 18, 2006	www.dnr.state.mn.us/grants/habitat/shoreland.html
MN DNR	**Minnesota ReLeaf Program**—Grants to purchase and plant predominantly native trees to conserve energy, benefit wildlife, and establish community windbreaks; actions to preserve and maintain healthy community forests; educational programs in conjunction with these activities; and conducting tree inventories for land use and comprehensive planning; requires 50% match; grant awards up to $15,000	Local units of government, nonprofit organizations, and schools	May 2005 was the latest round	www.dnr.state.mn.us/grants/forestmgmt/releaf.html
MN DNR	**Urban and Community Forestry Challenge Grant**—Funds program development including tree inventories, forestry management plans, tree protection, insect and disease control plans, ordinance development, staffing, and staff training; Nonprofit program development including staffing, volunteer training, master plans, and fund-raising support; and information and education projects; 50% match required; grants up to $5,000	Local units of government, school districts, and non-profits	To be announced	www.dnr.state.mn.us/grants/forestmgmt/urban.html

Grant Resources- Current as of 9/1/2006 (continued)

Agency/ Organization	Program/Criteria	Eligible Applicants	Deadline	Contact
Minnesota Waters	**Lake and Stream Conservation Partnership**—These grants support projects that preserve, protect, and restore native plant and wildlife communities along lake and river shorelands including those to improve water quality or increase water infiltration on-site, manage aquatic invasive species to restore the natural ecological system, inventory and assesses a lake and/or river to guide water resource improvement, restoration, and management	Minnesota Waters members and member organizations	September 28, 2006	www.minnesotawaters.org/grant.html
Legislative-Citizen Commission on Minnesota Resources (LCMR)	**LCMR Grants**—Funds are recommended to the legislature for special projects that maintain and enhance Minnesota's natural resources.	Any	No new money will be available until July 1, 2007	www.lcmr.leg.mn/lcmr.htm
U.S. Environmental Protection Agency (EPA)	**Targeted Watershed Grants**—Governors and tribal leaders are invited to nominate their leading watersheds organizations for the grants. For 2006, EPA will award up to $16 million to as many as 20 of the nation's outstanding watershed practitioners; grant guidelines encourage innovative solutions to achieving measurable water quality improvements	Governors nominate watershed organizations	November 15, 2006	www.epa.gov/owow/watershed/initiative/implementation.html

Grant Resources- Current as of 9/1/2006 (continued)

Agency/ Organization	Program/Criteria	Eligible Applicants	Deadline	Contact
Metropolitan Council	**MetroEnvironment Partnership Grants**—Grants to improve the water quality of metro-area lakes and rivers by reducing nonpoint source pollution through education and implementation grants.	Public entity located in metropolitan area	The MetroEnvironment grant program ended in 2005. There are no plans to fund a similar grant program in the future.	es.metc.state.mn.us/mepg/
Metropolitan Council	**Transportation Enhancement Grant—**Project categories for scenic/environmental enhancement and bicycle/pedestrian paths.	Municipality	On hold as of 2006; Generally due in July	www.metrocouncil.org/planning/transportation/TIP/tip2005_2008.htm
Board of Soil and Water Resources (BSWR)	**Local Water Management Planning Challenge Grants—**Proposed projects must implement priority action items in an approved local water management plan. Eligible projects include: • land and water treatment (i.e., install erosion or water quality improvement practices) • inventories (e.g., inventory public and private drainage systems) • water quality monitoring • education activities Up to $25,000, one-to-one match required	Local units of government including counties, watershed districts, and watershed management organizations.	March 2005 was the latest round	www.bwsr.state.mn.us/grantscostshare/lwplanning/index.html

Grant Resources- Current as of 9/1/2006 (continued)

Agency/ Organization	Program/Criteria	Eligible Applicants	Deadline	Contact
BWSR	**Natural Resource Block Grants—**A composite of base grants to implement programs designed to protect and improve water resources. Individual programs under this grant include: Comprehensive Local Water Management; Wetland Conservation Act; Department of Natural Resources Shoreland Management Program; Minnesota Pollution Control Agency Feedlot Permit Program; and the MPCA Individual Sewage Treatment Systems Program.	Counties	Varies	www.bwsr.state.mn.us/grantscostshare/nrbg/factsheet.html
U.S. Department of Agriculture – Natural Resources Conservation Service	**Small Watershed Program (PL - 566) in Minnesota—**Provides technical and financial assistance to local organizations for planning and carrying out watershed projects. Limited to watersheds less than 250,000 acres in size.	Local organizations	Rolling	www.mn.nrcs.usda.gov/programs/water_resources/pl566_projects-new.html

Grant Resources- Current as of 9/1/2006 (continued)

Agency/ Organization	Program/Criteria	Eligible Applicants	Deadline	Contact
U.S. Department of Agriculture – Natural Resources Conservation Service	**Watershed Operations Assistance**—Provided in authorized watersheds to install conservation practices and project measures (works of improvement) throughout the watershed project area. The planned works of improvement are described in watershed project plans and are normally scheduled to be installed over multiple years. All works of improvement, including floodwater retarding dams and reservoirs, are owned and operated by the sponsoring local organizations and participating individuals. Eligibility criteria for authorized watershed projects include: • Public sponsorship • Watershed projects up to 250,000 acres • Benefits that are directly related to agriculture, including rural communities, that are at least 20 percent of the total benefits of the project	Local organizations	Rolling	www.mn.nrcs.usda.gov/programs/water_resources/Watershed_protection_operations.htm

Grant Resources- Current as of 9/1/2006 (continued)

Agency/ Organization	Program/Criteria	Eligible Applicants	Deadline	Contact
U.S. Army Corps of Engineers	**Aquatic Ecosystem Restoration—**Section 206 of the Water Resources Development Act of 1996 provides authority for the Corps of Engineers to undertake restoration projects in aquatic ecosystems, such as rivers, lakes and wetlands. The Corps evaluates projects that benefit the environment through restoring, improving or protecting aquatic habitat for plants, fish and wildlife. A project is accepted for construction after an investigation shows it is technically feasible, environmentally acceptable and provides cost-effective environmental benefits. Costs for Section 206 projects are shared between the federal government (65 percent) and a non-federal sponsor (35 percent), in accordance with the Water Resources Development Act of 1996. The maximum federal expenditure per project is $5 million, which includes both planning and construction costs. The federal government will not pay the costs involved for obtaining the lands and/or easements and future operation and maintenance.	Local organizations	Rolling	www.mvp.usace.army.mil/environment/