Markham Pond Ecological Restoration and Parkland Plan

Prepared by:
Ramsey-Washington Metro Watershed District
City of Maplewood

BARR
4700 West 77th Street
Minneapolis, MN 55435-4803
Phone: 952-832-2600
Fax: 952-832-2601

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Executive Summary

Markham Pond is located in Hazelwood Park, between Hazelwood and Kennard Streets, south of Beam Avenue, in Maplewood, Minnesota, a suburb of St. Paul. Markham Pond is a man-made degraded Type-5 wetland (Minnesota Public Water # 62-141W) on Kohlman Creek, which ultimately drains to Kohlman Lake approximately one mile to the west. Kohlman Lake is impaired under the State of Minnesota criteria for nutrients.

In 2010 the Ramsey-Washington Metro Watershed District (RWMWD) completed a TMDL study for Kohlman Lake and developed a TMDL implementation plan. As part of the TMDL implementation plan, the RWMWD targeted upstream Markham Pond for ecological improvements that included contaminant-assimilative enhancements that will reduce nutrient input to Kohlman Lake. The RWMWD and the City of Maplewood recognized the broad ecological need and benefit of a more holistic approach to restoration of the area. Ecological restoration and contaminant-assimilative enhancements are the foundation of the RWMWD/City of Maplewood sponsorship of this plan for Hazelwood Park and Markham Pond.

This Ecological Restoration and Parkland Plan is the result of a collaborative effort among the numerous stakeholders and public participants. The stakeholder process that was part of the development of this Plan is described in **Section 1.3**. Once fully implemented, Markham Pond and its surroundings will be a revived natural resource with ecological features that educate and reflect nature's intent, while being a fully integrated suburban public amenity for all to enjoy. **Section 2** summarizes the goals and policies of this Plan.

Table 1 (page 5) summarizes the potential plan projects, providing budget-level cost estimates and identifying lead agencies. Each of these projects is described in the following pages, with feasibility studies of specific restoration elements detailed in the Appendices of the document. The locations of the potential projects are shown in **Figure 1**.

Funding for the implementation tasks in this Plan is not currently dedicated. Along with providing a coordinated and effectual plan of action, this document is intended to serve as a platform for seeking funding opportunities. The coordinated approach, stakeholder involvement, and feasibility analyses should make the projects outlined here competitive and ready for grant award and/or capital-improvement program inclusion.

This Ecological Restoration and Parkland Plan is the result of a collaborative effort among the numerous stakeholders and public participants. Once fully implemented, Markham Pond and its surroundings will be a revived natural resource with ecological features that educate and reflect nature's intent, while being a fully integrated suburban amenity for all to enjoy.

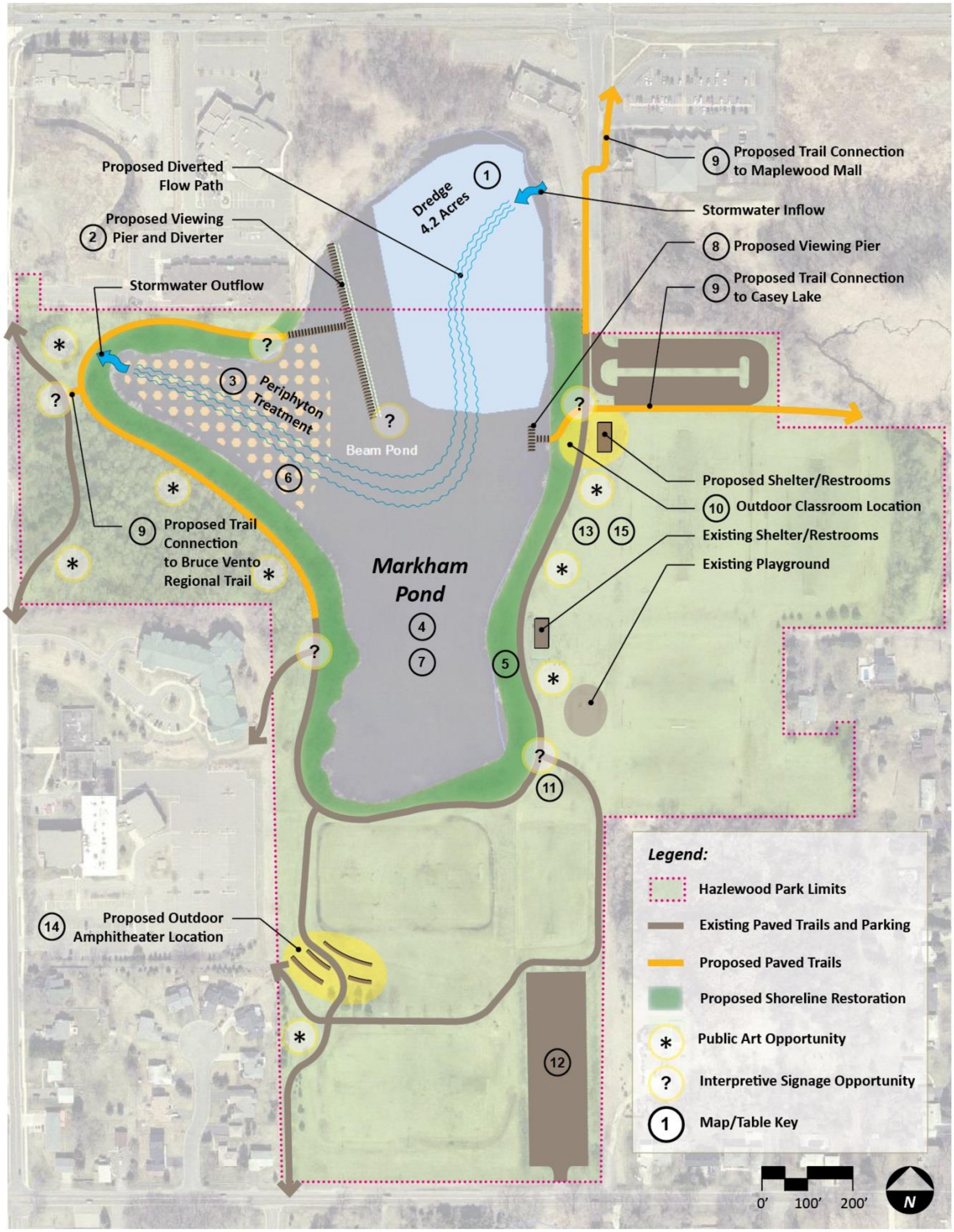

Figure 1. Markham Pond Ecological Restoration and Parkland Plan Elements (see Table 1 for descriptions).

Table 1. Summary of Markham Pond Ecological Restoration and Parkland Projects with Cost Ranges

Map #	Project Opportunities	Cost Range ($1,000s)	Phosphorus Reduction	Other Benefits	Lead Agency[1]
1	**Dredging** and removal of sediments from the pond bottom at strategic locations to enhance particulate settling	290-320	81 lb/yr	Ecological	RWMWD
2	**Flow diverter** installed that also serves as viewing pier	160-360	156 lb/yr	Access	RWMWD
3	**Periphyton system** installation of a calcareous- based phosphorus assimilation cell	920	162 lb/yr	Education	RWMWD
4	**Long-term carp control** and possible removals	5-260	Yes	Ecological	RWMWD
5	**Shoreline habitat restoration**	243	Yes	Habitat and Aesthetics	RWMWD
6	**Macrophyte control and management** as part of a periphyton system	8[2]	Yes	Habitat	RWMWD
7	**Monitoring** toward adaptive management	5[2]	No	Water Quality and Education	RWMWD
8	**Fish stocking** and diversity improvements	1-3[2]	Yes	Ecological	MDNR
	Shore and open water viewing enhancements	20	No	Recreation and Education	City
9	**Trail system integration** creating connections to Vento trail, Casey Lake, and Maplewood Mall	100	No	Recreation and Education	City
10	**Outdoor classroom area** for demonstrations and hands-on learning	50	No	Recreation and Education	City
11	**Interpretive signage**	20	No	Recreation and Education	City
12	**Reduction in impervious area** to maintain or increase parking capacity while exploring shared parking and alternative parking surfaces	5-650	Yes	Education	City
13	**Public art** added to projects	1-50	No	Aesthetics	City
14	**Amphitheatre**	250-350	No	Recreation and Entertainment	City
15	**General park improvements,** field upgrades, and restrooms	50-300	No	Recreation and Aesthetics	City

Notes: 1 City of Maplewood (City);
Minnesota Department of Natural Resources (MDNR);
Ramsey-Washington Metro Watershed District (RWMWD)
2 Estimated Annual Cost

1 Introduction

1.1 Markham Pond

Markham Pond is a 13-acre pond located in Maplewood's Hazelwood Park, in the Ramsey-Washington Metro Watershed District (RWMWD) drainage area SB18-14 (Kohlman Creek subwatershed). The total tributary watershed area of 3,530 acres includes Kohlman Creek, Hazelwood Park, drainage area SB-16, Maplewood Mall, and local neighborhoods.

Markham Pond (Minnesota Public Water # 62-141W), also known as Hazelwood Park Pond or Beam Avenue Pond, appears to have originally been a low floodplain of a drainage way now called Kohlman Creek. The area around Markham Pond was a gravel pit previous to 1972. The pond was likely constructed by the City of Maplewood (City) in the 1960s, then redesigned, deepened, and expanded in 1972 as a stormwater management basin. The City acquired land adjacent Markham Pond in 1976. The reconstructed pond included an outlet structure with a stop-log weir that was set at an overflow elevation of 875 feet above mean sea level (AMSL). The pond bottom elevation is predominantly at 872 feet AMSL and most of the pond is about 3-feet deep. The lowest point on the pond bottom is approximately 871 feet AMSL.

Based upon flow and total-suspended-solids data collected from Markham Pond in 2010, it is estimated that approximately 0.5 centimeters of solids accumulate on the pond's bottom every year. At this accumulation rate, over the 40-year lifespan of the pond, it is estimated that about 8 inches of sediment have accumulated on the pond bottom.

Markham Pond ultimately drains to Kohlman Lake which is impaired under the State of Minnesota shallow lakes criteria for nutrients (phosphorus). In 2010 the RWMWD completed a TMDL study for Kohlman Lake and followed with a TMDL implementation plan approved by the Minnesota Pollution Control Agency (MPCA) in May 2010. As part of the comprehensive approach to reducing phosphorus input to the lake, the RWMWD targeted Markham Pond for ecological and assimilative-capacity improvements.

This Ecological Restoration and Parkland Plan examines alternatives for restoring the pond's ecological function and improving its assimilative capacity and integrates those actions with projects aimed at enhancing community access and education opportunities.

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Figure 2. Markham Pond Area and the Hydraulic Connection to Kohlman Lake

1.2 Hazelwood Park

Prior to 1972 the land that is now Hazelwood Park was operated privately as a sand and gravel pit. In 1972 the City acquired a portion of the land for a stormwater holding pond. In 1976 the City acquired and opened Hazelwood Park as a soccer field and in 1978 the City received a federal grant to continue to develop soccer fields. In the 1990s the City purchased property from Ramsey County and added it to the northwest side of the park.

Today, Hazelwood Park is part of the City park system. The park and open-space area encompass about 54 acres. The park is classified by the City as a youth athletic park and neighborhood park. It is located at 1663 County Road C, in Maplewood. As a youth athletic park, many of the facilities within the park are athletic based. The park features and amenities include:

1. Picnic shelter (24 people)
2. Children's play area
3. Multiple soccer fields without lighting
4. A soccer field with lighting
5. Internal trail system
6. Two parking lots for vehicles

Figure 3. Hazelwood Park

1.3 Stakeholder Input to the Plan

This Plan was conceived and developed with a spectrum of input from stakeholders and interested parties. The first phase of the input process included a set of stakeholder meetings where invitations were given to public and private organizations that were likely to have interest or jurisdiction regarding planning and implementation issues. **Appendix I** includes the minutes and attendee lists from these meetings. Representatives from the following organizations attended at least one of these meetings:

1. City of Maplewood
2. City of North St. Paul
3. First Evangelical Free Church
4. H.B. Fuller, Inc.
5. Minnesota Department of Natural Resources
6. Minnesota Pollution Control Agency
7. Ramsey County Parks
8. Ramsey-Washington Metro Watershed District
9. University of Minnesota
10. US Army Corps of Engineers
11. Walker Methodist Hazel Ridge

The second phase of stakeholder input will involve a Maplewood Parks public-input process for the Plan. The City will engage the property owners within 500 feet of the property during public-participation meetings. The meeting will occur as part of the formal process for receiving input from residents and others regarding proposed park improvements.

1.4 Funding the Plan

Funding for the proposed projects in this Plan is not currently dedicated. Along with providing a coordinated and effectual plan of action, this document is intended to serve as a platform for seeking funding opportunities. The coordinated approach, stakeholder involvement, and feasibility analyses should make the projects outlined here competitive and ready for grant award and/or capital-improvement program inclusion.

As opportunities arise, the agencies listed in **Table 1** will use this plan to promote and describe the projects outlined here.

2 Goals and Objectives

The location of Markham Pond makes it an ideal candidate for improved water quality, recreational, and educational activities, increasing the value of the pond and its surrounding area.

Markham Pond has long served as an important nutrient-removal basin in the watershed and offers an opportunity to provide additional contaminant assimilation needed to mitigate the impaired status of Kohlman Lake. It is mostly surrounded by Maplewood's Hazelwood Park, which provides opportunity for access improvements and improved trail connections, such as a connection to the Bruce Vento Regional Trail Corridor, located less than a quarter mile west of Markham Pond. Hazelwood Park currently provides a range of athletic opportunities, but lacks infrastructure for water-based activities such as wildlife viewing and water-quality-improvement participation and education.

The objective of this Plan is to increase the value of Markham Pond, Hazelwood Park, and the surrounding area, in concert with interested organizations. Goals of this Plan include the following:

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Water Quality

1. Maximize the contaminant-assimilation capacity of Markham Pond
2. Minimize the watershed runoff to Markham Pond
3. Reduce sediment disturbance by carp in Markham Pond
4. Stabilize the shoreline of Markham Pond

Fisheries

1. Reduce the carp and goldfish populations
2. Create improved habitat for game fish
3. Enhance the game-fish population

Wildlife Habitat

1. Increase the total spatial extent of naturalized areas
2. Improve habitat and functional quality
3. Improve native plant and animal species abundance and diversity

Recreation

1. Create new opportunities at Markham Pond for passive recreation and viewing
2. Integrate the Hazelwood Park trail system with regional trail systems

Education

1. Develop communication methods that educate park users on water quality and other improvements
2. Develop opportunities for hands-on learning about water quality and other improvements

Aesthetics

1. Create an attractive naturalized landscape

3 Adaptive Management Approach

Natural systems are complex and dynamic, while human observations about natural processes are fragmentary and inaccurate. Usually the best way to use available resources in a sustainable manner is a learning process. Further, the variables that affect natural processes and populations are largely unpredictable and beyond human control. “Adaptive management” of natural resources considers these limitations and prepares a process that evolves as more is learned.

Adaptive management is a simple concept which can be summarized as *try something, observe the results, and modify management based upon the outcome of the previous actions*. It requires a good understanding of the underlying ecological processes and concepts for any restoration or management activity. It also requires planning and a well-conceived, effective monitoring program.

This plan incorporates adaptive management concepts, including a monitoring program and annual review process to evaluate progress toward the goals and objectives outlined in **Section 2** and determine if adaptations are needed. **Section 9** presents a monitoring plan and evaluation process.

This plan incorporates adaptive management concepts including a monitoring program and annual review process to evaluate progress toward goals and objectives.

4 Improving Contaminant Assimilation Capacity

In 2010 water quality monitoring of Markham Pond's inflows, the pond itself, and the pond's outflows were performed. Computer modeling was performed using Delft 3D to determine if contaminant assimilation improvements could be achieved with adjustments to the pond's depth and flow regime. The focus of the modeling was two-fold: 1) to determine whether assimilative performance (phosphorus removal) of the pond could be enhanced by redirecting the pond's inflow around a diverter to prevent short-circuiting flow, and 2) to determine the effect of deepening the pond (through dredging) on phosphorus removal.

This work showed that Markham Pond's contaminant assimilation performance is largely dependent upon improving the removal of small organic particles which settle very slowly in the water column. It was determined that removal of these particles, and therefore phosphorus removal, could be improved by increasing the cross-sectional area of the pond and lengthening the flow path. This would allow more time for settlement of small particles from the water column.

The modeling and analyses are described in **Appendix A**.

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4.1 Dredging

Dredging would slow the flow through Markham Pond by creating a larger cross-sectional area for flow. In selecting potential dredging methods for this work, various project parameters were considered. These include:

- Sediment characterization to determine disposal options
- Depth of water and sediment to be dredged
- Location, access, and distance to disposal area
- Proposed dewatering system; containment dikes, ponds, polypropylene tubes
- Time constraints (dredge spoils consisting of silt and fine material could take over a year to dry without additives)
- Potential beneficial reuse of material
- Available land for disposal, containment, water quality, and drying/dewatering
- Project cost

Several dredging alternatives are described in **Appendix B**. If dredging is conducted in Markham Pond a 4-acre area, dredged to a total depth of approximately 5 feet, is recommended. This alternative has the greatest cost effectiveness for improving the assimilative capacity of the pond and results in fewer disturbances to the pond and surrounding area. **Table 2** summarizes the cost and benefit for the recommended alternatives.

Table 2. Recommended Task and Opinion of Cost and Benefit for Markham Pond Dredging

Dredging Alternative	**4-acre area to 5 ft. depth — landfill disposal**	**4-acre area to 5 ft. depth— land application**
Total Cost	$288,000	$316,000
Estimated annual phosphorus removal improvement (lbs./year)	81 lbs./year	81 lbs./year
Cost-per-pound phosphorus removal improvement (prorated for 20 years)	$178/lb.	$195/lb.

The decision to dispose of the dredged sediment in a landfill or seek a land application opportunity has a small effect on the overall project cost. The cost estimate for the land application alternative has a larger degree of uncertainty due to costs related to transport and market forces. If there is a nutrient need/benefit for the land selected, or if an application area is found closer than 40 miles from Markham Pond, the cost for this alternative could be less than estimated. However, the converse is also true. If dredging is pursued for Markham Pond the alternative of land application should be further evaluated for a specific site location, spreading, and land cost.

4.2 Flow Diversion

Flow through Markham Pond averages approximately 5.2 cubic feet per second (cfs) with annual peak flows due to storm events ranging from 25 to 40 cfs. Currently the inflows through Markham Pond take the shortest route to the pond's outlet structure. For most of the water flowing through the pond that means a travel distance of about 1,000 feet. If flow were to take the longest route through the pond this distance could more than double. **Appendix D** describes 2010 modeling of the pond that suggests the phosphorus-removal capacity of the pond could be improved by approximately 20 percent by increasing the flow length to increase the time available for particle settlement. Modeling estimates that diverting flow in this way could allow the pond to remove an additional 156 pounds of phosphorus from its inflows per year.

Two options are recommended for flow diversion. The first option would include installation of a diversion surface as part of a dock or pier structure made of wood and metal. This structure would also provide public access to the pond for passive recreation, such as walking and viewing. The pier could be built with a section below the walkway, open to water flow, and a section with a diverter or solid surface in the water to re-direct flow. The pier would connect to the trail system at Hazelwood Park including regional trail connections.

A second option would be to install the diversion surface only. This would require driving posts into the sediment and installing a timber diversion surface. This structure would serve only as a flow diverter. It would not provide public access but would provide the same assimilative enhancement as the pier option.

Table 3. Opinion of Cost for Two Options for Diverting Flow within Markham Pond

	Length	Pier Structure Cost	Paved Access Cost	20% Contingency	Total Cost	Phosphorus removal cost over 20 years ($/lb)
Pier option 1	720 ft.	$288,000	$10,000	$60,000	$358,000	$115/lb.
Diverter only	450 ft.	$135,000	—	$27,000	$162,000	$55/lb.

4.3 Periphyton Contaminant Assimilation System

Periphyton-stormwater-assimilation areas (PSAAs), sometimes referred to as submergent-aquatic-vegetation constructed wetlands (SAVs), utilize algal/vegetative uptake of dissolved phosphorus to remove phosphorus from water. Periphyton is algae that grow on a submerged substrate such as rock, aquatic vegetation, woody debris, or soil. These systems require pretreatment and are best used as “polishing” units at the end of assimilative trains for stormwater runoff (Appendix E). Improved removal of phosphorus attached to particles would be achieved by dredging and diversion, as described above. The periphyton system would increase removal of dissolved phosphorus.

Periphyton mats have been found to grow optimally in water that contains less than 50 μg/L of total phosphorus (TP). When combined with submerged aquatic vegetation, the periphyton mats perform better in waters with higher concentrations of phosphorus. Because Markham Pond has a TP concentration greater than 50 μg/L, a system combining periphyton mats and submerged aquatic vegetation for phosphorus uptake may be most effective (Everglades Report 2006b).

Limestone could be installed and vegetation planted in the western end of Markham Pond (**Figure 4**). Because of the large volume of flow moving through Markham Pond, assimilative efficiency is not expected to be as high as other experimental systems with longer residence times (such as in the Everglades where these systems have been used with success). However, phosphorus removal should increase significantly compared to existing conditions.

Table 4. Cost and Estimated Performance of a Periphyton Assimilation System at Markham Pond

	Cost
Construction and design	$1,004,000
Annual maintenance	$7,800
Estimated annual phosphorus removal = 162 lbs.	$358, per pound, over 20 years

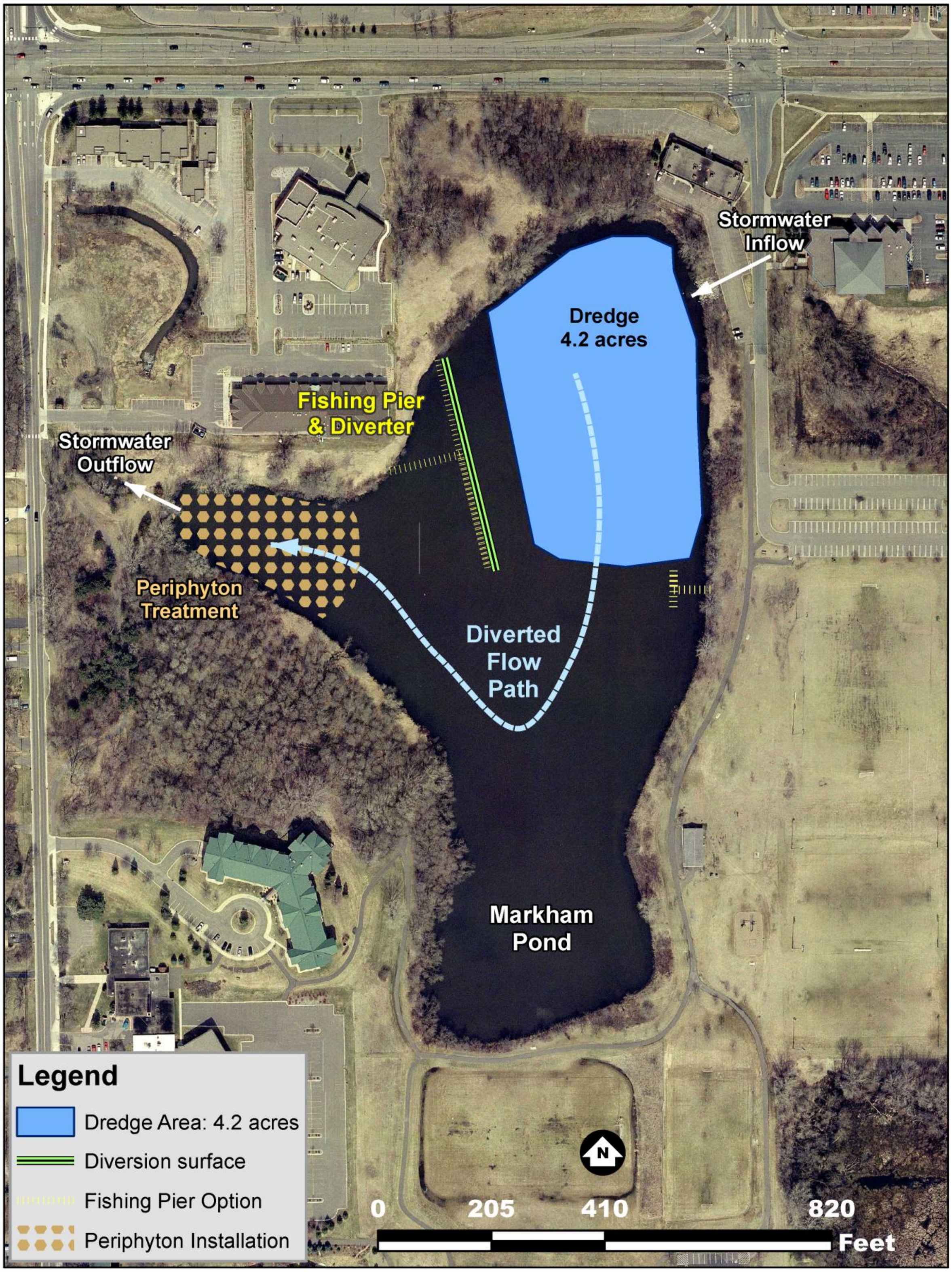


Figure 4. Proposed Contaminant Assimilation Capacity Improvements for Markham Pond

4.4 Summer Aeration

Summer aeration is often used in ponds and lakes in an attempt to improve water quality and habitat. If used in the appropriate environment and application it can provide benefits. Summer aeration was considered for this Plan but is not recommended based on the following considerations.

From May through August of 2010, temperature and dissolved oxygen were measured in Markham Pond at three depths. As expected, the data showed that Markham Pond did not stratify by temperature as a deeper lake would. This is due to the shallow depth of the pond. Because the long fetch of the pond makes mixing due to wind the dominant driver, increasing the pond depth to that proposed in **Section 4.1** would not likely lead to temperature stratification in the pond.

The data also showed the lowest dissolved oxygen concentration was 4.91 mg/L at the bottom of the pond. This indicates that there is probably a low level of sediment oxygen demand in Markham Pond. If dredging is conducted and the top organic layer is removed, sediment oxygen demand would likely be even less. Because of the high oxygen levels and low oxygen demand that exist in the pond during the summer, aeration is not likely to provide habitat or contaminant-assimilation benefit in the summer.

Installation of an aeration system in the summer might also reduce the assimilative efficiency of the pond as the bubbles moving upward through the water column entrain particles and promote their transport through the pond. This would inhibit particle setting and assimilative efficiency, and work against other measures.

Based on these analyses we concluded that summer aeration would likely provide no benefits to Markham Pond.

4.5 Reduction in Watershed Impervious Surface

The following pallet of runoff reduction measures represents actions that might be included along with other tasks in this Plan to further limit the contaminant loading from the surrounding park and other areas. This Plan does not specify any of these measures specifically for implementation. This list and descriptions of ways to reduce stormwater runoff provide examples for discussion and consideration as the stakeholder process proceeds and the Plan is implemented.

Table 4. Summary of Possible Runoff Reduction Techniques for Hazelwood Park and the Markham Pond Watershed

Stormwater BMP	Design Cost[1]	Construction Cost[1]	Maintenance Cost[1]	Assimilative Performance[2]	Aesthetics, Visibility, and Educational Opportunity[2]
Tree trenches	Medium	Medium	Low	Best	Better
Filtration trenches	Medium	Medium	Low	Better	Good
Tree rill system	Medium	Medium	Medium	Better	Best
Rainwater garden/ Bioretention	Low	Low	Medium	Best	Better
Permeable pavement	Low	Low	Medium	Better	Better
Dry detention	Medium	Medium	Medium	Good	Good
Turf conversion	Low	Low	Medium	Good	Better

1 Relative ranking: High, Medium, Low
2 Relative ranking: Good, Better, Best

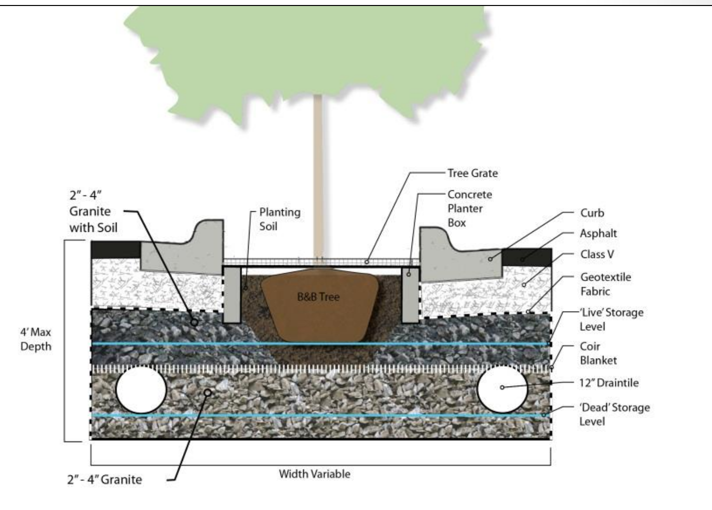
Dry Detention Ponds

Description: Dry detention ponds are dry stormwater basins incorporated into the stormwater system to temporarily detain runoff volumes before discharging downstream. These systems typically provide very limited water quality treatment through particle settling (unless designed for extended detention). They have little impact on runoff volume reduction but can provide volume storage and rate control. When not holding water, dry detention ponds are often used as informal recreation space.
Application: Open spaces collecting runoff from a variety of surfaces and open spaces that have the potential to accept flows from existing storm sewer systems

Tree Trenches

Description: Tree trenches are typically linear systems comprised of trees, tree grates (potentially in combination with other permeable surfaces such as permeable pavers), growing media, rock storage below the surface, and an underdrain system. These systems can provide water quality treatment through filtration and uptake by trees and can reduce runoff volumes through interception by the leaves, uptake by the trees, and infiltration into underlying soils. They can also provide flood volume storage and rate control by storing water in the void spaces in the subsurface rock storage. In addition to water quality benefits, trees in tree trenches live longer and are healthier than typical street trees, due to the amount of air and water they receive at their roots. This results in an aesthetically pleasing feature that enhances its surroundings.

Application: Linear corridors (e.g., street right-of-way, trails, other pathways) and parking lots.



Filtration Trenches

Description: Filtration trenches are typically linear systems comprised of rock storage below the surface and, potentially, an underdrain system, using either permeable surfaces or catchment structures to bring water to the subsurface storage. These systems can provide some water quality treatment through filtration and reduce runoff volumes through infiltration into underlying soils. They can also provide flood volume storage and rate control by storing water in the void spaces in the subsurface rock storage. **Application:** Linear corridors (e.g., street right-of-way, trails, other pathways) and parking lots.

Permeable Pavers and Pavements

Description: Permeable pavers and pavements (e.g., asphalt and concrete) are specially designed, load-bearing surfaces that allow water to pass through either the surfaces of the material or through spaces between the pavers into a rock subsurface storage layer. These systems can provide some water quality treatment through filtration and reduce runoff volumes through infiltration into underlying soils. They can also provide runoff volume storage and rate control by storing water in the void spaces in the subsurface rock. Permeable pavers and pavements come in a variety of sizes, shapes, and colors, which allows for a wide range of possibilities. **Application:** Parking lots, streets, parking lanes, trails, plaza areas.

Rainwater Gardens/Bioretention Systems

Description: Rainwater gardens/bioretention systems are shallow landscaped depressions that collect stormwater runoff. Some systems are more complex with engineered soil media, underdrain systems, and overflow structures, while others are simply vegetated depressions in native soils. These systems can provide water quality treatment and reduce runoff volumes through interception, filtration, and uptake by the vegetation and infiltration into underlying soils. They can also provide some runoff volume storage and rate control by storing water in the depressed area. In addition to being functional, these systems can be designed to match existing landscape features or even become focal points—catered to preferred aesthetics and maintenance capacities. **Application:** Linear corridors (e.g., street right-of-way, trails, other pathways), parking lots, and open spaces that collect roof runoff.

Turf Conversion

Description: From a stormwater management perspective, turf grass on a site is generally preferable to impervious surfaces. However, in terms of overall sustainability, there are significant benefits to converting turf grass areas to native plantings and vegetation including:

- Increased habitat for existing urban wildlife and creation of attractive habitat for marginally urban wildlife species.
- Increased diversity of vegetation on the landscape and aesthetic enhancement of the project area.
- Incremental reduction of water usage for irrigation, since native vegetation is better adapted to regional seasonal water stress.
- Natural improvement of soils through accumulation of organic material in the soil column.
- Incremental reduction of fertilizers and herbicides; native vegetation does not require these.
- Reduced stormwater runoff resulting from the improved porosity of the soils created by the deep-rooted nature of most native vegetation.

Application: Any areas that are currently turf grass that are not typically used in a way that requires turf grass.

5 Fishery Improvements

5.1 Fish Management

Part of this integrated strategy to improve water quality in Kohlman Lake and achieve the TMDL objective is to reduce the potential for high populations of benthic foraging fish in Markham Pond and Casey Lake to impact water quality in Kohlman Lake. Common carp (*Cyprinus carpio*) and other fishes with similar foraging habits can significantly increase turbidity, suspended solids concentrations, sedimentation rates, chlorophyll a concentrations, and reduce submerged macrophyte biomass and light penetration in small, shallow wetland basins (Badiou 2005).

High populations of common carp have been documented to occur seasonally in both Markham Pond and Casey Lake (Osborne 2012). Markham Pond also has high populations of goldfish (Osborne 2012). Goldfish are closely related to common carp and have similar food habitats and foraging behaviors that adversely impact water quality (Richardson et al. 1995).

Common carp and other benthic feeding fishes have been shown to increase water column nutrient concentrations through excretion (Lamarra 1975, Chumchal 2005) or indirectly via disturbance of surface sediments during foraging (Anderson et al. 1978, Cline et al. 1998, Persson 1997). Large numbers of common carp have also been implicated in reduced success of game fish populations as well as increased turbidity (Bernstein and Olson 2001, Koehn 2004).

Reduction of common carp and goldfish populations in Markham Pond and Casey Lake is expected to incrementally reduce in-lake nutrient cycling with subsequent benefits to water quality entering Kohlman Lake. Quantitative evaluation of nutrient cycling by benthic feeding fish in the Phalen Chain of Lakes is identified as part of research scheduled to be completed by the University of Minnesota (RWMWD 2012).

The specific fishery management approaches implemented at Markham Pond will be formulated in cooperation with the Minnesota Department of natural Resources and the University of Minnesota, subsequent to management activities at Casey Lake.

Part of this integrated strategy to improve water quality in Kohlman Lake and achieve the TMDL objective is to reduce potential carp impacts to water quality in Kohlman Lake.

5.1.1 Markham Pond

The populations of common carp and goldfish in Markham Pond were estimated in 2009-2011 by researchers at the University of Minnesota (Osborne 2012). Results of this research indicate that the pond functioned as nursery habitat for the Phalen Chain of Lakes. Elimination of nursery areas for common carp and goldfish is a critical piece in the overall carp management plan for the Phalen Chain of Lakes.

Potential management options and/or combinations include:

- Reduction of common carp and goldfish populations with a fall drawdown to intensify winter hypoxia with or without application of rotenone. Elimination of the resident populations is a crucial first step for carp control.
- Repetitive efforts using electrofishing or nets to remove resident common carp and goldfish during winter.
- Restriction of common carp access to Markham Pond by construction of a fish barrier at the Kohlman Creek outlet to Kohlman Lake.
- Winter aeration in an effort to overwinter game fish for increased common carp egg predation.
- Spring stocking of bluegills and northern pike for purposes of predation on common carp and goldfish eggs and juveniles and to provide recreational fisheries.

5.1.2 Casey Lake

Osborne (2012) found that ≈ 33% of age-0 common carp survived winter conditions in Casey Lake. Also surviving winter conditions were older common carp presumed to be sexually mature. Casey Lake functions as nursery habitat for common carp similarly to Markham Pond, but due to higher winter dissolved oxygen concentrations in some locations, provided refuge conditions for adult common carp.

Potential and completed management options and/or combinations:

- A fall/winter drawdown to intensify winter hypoxia was completed in 2012-2013 and was successful in eliminating common carp from Casey Lake.
- Bluegills and largemouth bass were stocked in the spring of 2013 for purposes of predation on common carp eggs and juveniles and to provide recreational fisheries.
- The District and the City of North St. Paul will install a winter aerator during the fall of 2013 in an effort to overwinter game fish for increased common carp egg predation.

5.1.3 Fish Passage through the Kohlman Basin, Markham Pond, and Casey Lake Connections

Fish species of interest utilizing the pathways upstream of Kohlman Lake are common carp and northern pike *(Esox lucius)* during spring spawning movements. Bluegill (*Leopmis macrochirus*) do not exhibit strong upstream spawning movements and primarily move within lake basins or flowages on a seasonal basis to find preferred habitat. **Appendix F** describes the fish passage analysis for pathways between Kohlman Lake and Markham Pond. The pathways from Kohlman Lake to Markham Pond are currently passable by common carp during conditions found during the 2-year storm event when tail water conditions eliminate depth or velocity barriers through the Bruce Vento Trail and Hazelwood Street culverts.

Northern pike can access Kohlman Basin via Kohlman Creek at flows below 5 cubic feet per second (cfs) at the State Highway 61 culvert. Pike movement in Kohlman Basin is impeded by the permeable weirs in Kohlman Basin at flows less than required for overtopping of the weir. Pike cannot successfully move into Markham Pond from downstream areas due to the 2-foot vertical barrier at the pond's outlet structure.

Based on the likelihood that Kohlman Lake and other downstream water bodies function as overwinter refuges for common carp, the crossing at Highway 61 (**Figure 5**) offers the best location to install a fish barrier or trap that would reduce the success of common carp reaching Kohlman Basin and Markham Pond from Kohlman Lake. The timing and design of barrier functionality can accommodate potential use of Kohlman Basin as a northern pike spawning area. Bluegill migration into Kohlman Basin is unlikely due to the life history of bluegill, therefore bluegill passage was not considered. Four types of fish passage barrier options are shown in **Table 5**, along with planning level opinions of their cost. A bubble barrier was installed during the spring of 2013.

Interruption of common carp movement from the overwinter refuges of Kohlman and Gervais lakes will reduce common carp utilization of winterkill-prone areas upstream of the barrier for spawning. If spawning migrations of common carp can be interrupted, a coordinated plan to remove age-0 and sexually mature resident common carp from Markham Pond and Casey Lake will reduce existing populations that contribute to lower water quality. Coordination with the Minnesota Department of Natural Resources (MNDNR) for potentially stocking bluegills in Markham Pond will further reduce common carp populations in the pond.

Table 5. Fish Passage Barrier Recommendation Options and Opinions of Cost

Location	Option	Cost Range ($)
Highway 61 Kohlman Creek outlet culvert	Williams trap	15,000–30,000
	Bubble/Sound barrier	145,000
	Physical	2,500–7,500
	Electric Barrier	250,000

5.2 Fish Stocking

Because game fish are known to feed on carp eggs and fry, a game fish population in Markham Pond might help control the carp population, thereby improving water quality and ecological integrity in Markham Pond and downstream.

5.3 Winter Aeration

Winter aeration might provide an over-winter refuge from depleted oxygen conditions for fish in Markham Pond. Once management of the fishery has commenced and common carp have been brought under control, an examination of the setting could help determine if winter aeration might be beneficial.

Most aeration systems are composed of an air pump and a bubbler head that force bubbles into the water column from the bottom of a pond or lake. Some systems cascade water in an above- or below-ground installation where the water picks up oxygen as it cascades down steps and is then delivered to the lake. The latter method is seldom used for small, shallow ponds such as Markham where there is a frequent risk of the pond freezing solid, and the expense of installing a permanent cascade aeration system is high.

Bubbler aeration generally increases oxygen in the water column by maintaining an open water area in a pond, thereby exposing pond water to the open air. Literature indicates that bubbles from aerators do not transfer much air by diffusion to the water column (Miller and Mackay 2003). Hence, the success of winter aeration using a bubbler depends upon keeping enough pond surface area open for oxygen transfer.

The following data collection would be important to determine whether winter aeration might be beneficial:

1. Measurement of dissolved oxygen levels in the winter.
2. Measurement of the winter sediment oxygen demand.
3. Evaluation of the potential for the pond to freeze solid in the winter.
4. Analyses to determine the size of the open water area to maintain, and consequential appropriate system size.

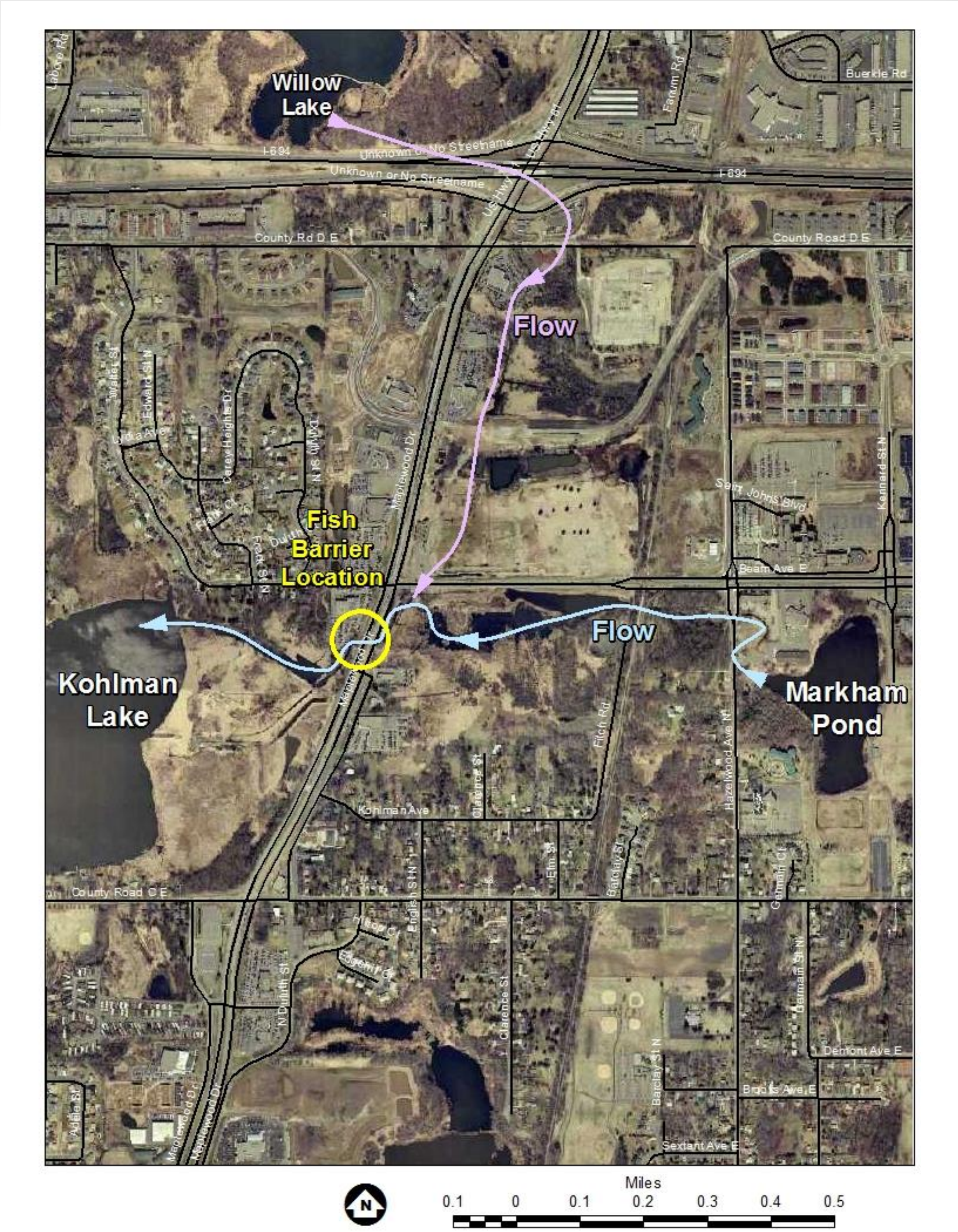


Figure 5. Recommended Fish Barrier Location

6 Habitat Improvements

6.1 Shoreline Habitat Restoration

Shoreline restoration around Markham Pond could benefit the pond and its upland habitat. Shoreline conditions around the 4,500-foot circumference of the pond range from stable to having a high potential for erosion. Many shoreline areas appear to have a low diversity of vegetation and could benefit from enhancement of the number of species present through intensive planting. Also, some restoration will be required in areas where construction work occurs as part of Plan implementation.

As implementation of this Plan commences, it would be advantageous to perform a vegetation and erosion-condition survey to identify areas where sensitive shoreline or desirable vegetative should be protected from construction activity, and areas where restoration could benefit the stability and quality of habitat adjacent to the pond.

For planning purposes it is estimated that approximately one-third of the pond shore, or 1,500 feet of shoreline, will be slated for restoration efforts.

Table 6. Opinion of Cost for Shoreline Restoration at Markham Pond

	Vegetation and erosion survey and design	Stabilization and planting	Total
Markham Pond shoreline restoration	$18,000	$225,000	$243,000

Many shoreline areas appear to have a low diversity of vegetation and could benefit from enhancement of the number of species present through intensive planting.

6.2 Macrophyte Control and Management

Macrophyte control and management in lakes and ponds can be very challenging, in part due to the difficulty of access to planting areas. It is also very difficult to control predation and other stresses to plants in open water.

Currently Markham Pond has very little submerged aquatic plant growth, probably due to the limited penetration of light through the murky water. As the measures and tasks in this Plan are implemented, it is expected that improved water clarity will promote the growth of increased aquatic plant densities.

The installation of a periphyton phosphorus assimilation system on the western embayment of Markham Pond (**Section 4.3**) provides an opportunity to develop an area of submerged vegetation in the pond which currently does not exist. The assimilation system installation will involve placement of assimilative materials and should provide an access to the lake bottom that would make planting of submerged vegetation efficient. Vegetation is typically planted with periphyton systems and will enhance the assimilative capacity of the installation. These plantings would need temporary protection from geese and other water birds that might eat young plants.

This Plan recommends submerged vegetation plantings with the periphyton system and ongoing monitoring of aquatic plant growth in Markham Pond to determine if future management activities will be required.

7 Recreational Improvements

7.1 Shore and Open Water Access Enhancements

Shore and open water access structures at Markham Pond would produce a viewing and appreciation opportunity that does not currently exist in Hazelwood Park. Access to the open water would provide passive recreation as well as education and outreach opportunities for the water quality and habitat enhancement work planned.

Shore and open water access would be provided as part of the proposed diversion structure (**Section 4.2**). This pier-like structure would be constructed with a walking surface and railing to accommodate shore and open-water viewing.

Shore and open water access would also be provided via a wooden pier located along the eastern shore at a location convenient from the parking area.

7.2 Trail System Integration

Existing trails within Hazelwood Park provide opportunities for pedestrians to enjoy the park. Regional trail systems exist within a short distance of the park; current and future linkages could provide regional trail opportunities to the west via the Vento state trail, north to Maplewood Mall, and east to Casey Lake.

In 2003 Brauer and Associates developed three concept plans for Hazelwood to connect the existing trails and create better access to the pond. Those three concept plans are attached as **Appendix G**.

Expansion of trails connecting to Hazelwood Park would provide an opportunity for regional access to Markham Pond and all the amenities and opportunities this Plan would establish. It would provide access to the regional trail and park system for the neighborhood. The development of trail connections is an important task for this Plan.

7.3 Amphitheater

The City of Maplewood envisions using the topography around "Hazelwood Field #2" as an amphitheater, with seating on the hill for spectators, and a stage or performance area in the lower part of the natural bowl. An amphitheater would provide an opportunity for educational and artistic programming that is currently not available in the park.

Recreation Improvements include viewing structures, trails, an amphitheater, improved soccer fields, and rest rooms.

7.4 Other General Park Improvements

The City of Maplewood is currently working to make improvements to the soccer fields partnering with a local soccer association and involving a large-scale turf restoration project at Hazelwood Park with the goal of increasing the turf quality. The City also hopes to develop restrooms at the site.

8 Community Outreach Enhancements

Community outreach enhancements can be used to educate the community and give individuals a sense of appreciation and involvement in work completed or being performed. Some overall objectives for public education include:

1) raising awareness that smaller localities are part of larger watersheds leading to high profile public waters,
2) stormwater carries pollutants from lawns and parking areas to other parts of the watershed,
3) watersheds can be reclaimed through the use of trees, plants, and other best management practice features,
4) the natural and cultural history of the site,
5) creating an awareness of the dynamics of natural processes,
6) creating a new sense of the norm as widespread water quality practice,
7) raising the level of awareness of work being done by water stewards.

8.1 Outdoor Classroom Development

Outdoor classrooms can provide an opportunity for kids and adults to learn, firsthand, the issues that face our waters, while providing an opportunity to see methods being used to deal with problems on-site. This plan will result in a set of features that will benefit water resources and wildlife habitat, providing a unique opportunity to educate the public.

Infrastructure needs for outdoor classroom activities are minimal. Gathering space with direct access to the water can serve as an area to perform sampling or other field activities and provide a place for lectures and talks. A plaza or open area suitable for 20-30 people to gather, with an adjoining wooden pier over the water that includes a work surface, would provide an ideal setting for outdoor instruction. Benches or other seating in the plaza would add comfort and establish the classroom space. The classroom area should be located on the east side of Markham Pond near the parking area and future restrooms.

Outreach enhancements take advantage of improvements to educate the public.

8.2 Interpretive Signage

Attractive signage that explains the features and their function in and around Markham Pond would enhance the outdoor classroom function and provide valuable information for neighborhood and regional visitors.

Five or six colorful placards at key points within reading distance of a trail would provide a self-guided tour of all the work completed toward improving the pond and park.

Signage should be coordinated with trails so as to avoid directing people onto vegetated areas.

8.3 Public Art

Public art can provide a center of interest and attraction for a park, while also interpreting park features and educating the public. This Plan provides a handful of opportunities for public art that intermingles with nature and water quality education. Artistic enhancements could be part of: the outdoor classroom area, the viewing piers, the amphitheater, interpretive signage, and the trail experience. Opportunities for freestanding artwork exist in the park space as well.

Some themes that might be explored for artwork integrated with water quality and park projects include:

1. making invisible systems (buried, temporal) visible or audible,
2. creating features that educate and inspire individuals and commercial owners to implement their own water quality features,
3. acknowledging historic waters and cultural connections,
4. translating data into comprehensible and aesthetic experiences,
5. creating an aesthetic interface between the natural and built environment, and
6. creating innovative approaches to BMPs that have an aesthetic, and possibly an interpretive dimension (art as functional infrastructure, example: viewing pier).

Some possible art features that might be considered include:

1. hardscape treatments that reflect water flow, water related species or text,
2. multi-sensory experiences through temporary or permanent artworks (sonification, performance, interactive media),
3. artwork or interactive media that responds to data collection or temporary events
4. aesthetic water management features: scuppers, cisterns, basins, channels,
5. features that involve public participation with artists,
6. design that incorporates emerging green technologies and materials, and
7. art that connects youth to water quality issues.

9 Project Monitoring and Evaluation

9.1 Monitoring Plan

Monitoring the project progress toward the Plan goals will guide adjustments in the Plan that might be needed to maximize progress toward those goals. Upon completion of the Plan implementation tasks, detailed processes for the following monitoring activities should be developed and implemented.

Water quality monitoring and fish population surveys will be used to determine if the Plan's goals are being met.

Water Quality Monitoring. Markham Pond should be monitored a minimum of once per month between ice-off and ice-on during the open water season. Properties measured each sampling should include:

- Water level
- Temperature
- Transparency tube measurement for clarity
- Turbidity
- pH
- Conductivity
- Hardness
- Chlorophyll-a
- Total phosphorus
- Soluble reactive phosphorus
- Dissolved oxygen

These constituents would provide insight into the effectiveness of the nutrient assimilation methods in place and indicate improvements in habitat quality.

Markham Pond is shallow, generally around 3-5 feet deep and will require the use of a transparency tube to measure transparency when clarity is deeper than the water depth. A sampling point for this list of constituents at mid-point in the pond flow should be chosen and used for all sampling. The use of an integrated water column sampling tube would allow sampling the full depth in a single sample. When a sampling plan is set, sampling near the major stormwater inflow point and near the outflow point to compare water quality before "assimilation" and as it leaves the pond should be considered.

Markham Pond has a large volume of stormwater flow-through and so provides an opportunity to sample for contaminants of concern in stormwater. Some additional constituents that may be of interest in this regard include: chloride, E coli, total Kjeldahl nitrogen, ammonia, and metals (lead, copper, zinc).

Fish Population Surveys. Surveys of fish population will provide information regarding the effectiveness of the fish-management program. The fish population should be sampled every 2-4 years, with populations indicated by species and numbers. Fish-stocking and fish-control measures can be adjusted accordingly.

Aquatic Plant Surveys. An annual plant survey will help to analyze the level of success of the Plan and the quality of the fish habitat in Markham Pond. Currently there are very few aquatic plants in Markham Pond. Informal survey of plant annual populations will help to determine if water quality in the pond is improving and if habitat for fish is developing.

Park User Surveys. In order to test the effectiveness of recreational, outreach, and aesthetic improvements to Hazelwood Park, a user survey should be developed and made available to the public. This could be in the form of a survey available in paper format at the park shelter and electronically on the City of Maplewood's website. Residents could offer their opinions regarding improvements and their experience in the park.

9.2 Evaluation of Results

A brief annual summary of the results from the water quality monitoring, fish population survey, aquatic plant survey, and park user surveys should be prepared and analyzed in comparison to the goals outlined in **Section 2** of this Plan. This summary could also be available to the public on the City of Maplewood and Ramsey Washington Metro Watershed District's websites.

Water quality monitoring, aquatic plant monitoring, and fish population surveys will be used to determine if the Plan's implementation tasks are leading to fulfillment of water quality, fisheries, and wildlife habitat goals. Park user surveys will be used to determine if the Plan's recreational, education, and aesthetic goals are being met.

Where goals of the Plan are not being met adjustments may be made to methods or operations of the Plan implementation tasks toward improving their performance.

10 Pre and Post Project Wetland Functional Assessment

An assessment of ecological and other wetland functions was performed for Markham Pond in order to estimate the expected impact on the wetland due to improvements proposed in this plan, as compared to the existing conditions. The Minnesota Routine Assessment Method (MNRAM) was applied during the summer of 2012 to existing conditions, and the components of this Plan were used to estimate future conditions.

The MNRAM assessment showed that improvement in the overall Minnesota Board of Soil and Water Resources (BWSR) wetland management classification of Markham Pond would be achieved under this Plan. With completion of the tasks in this Plan, Markham Pond would move from Manage 2 (existing conditions) to Manage 1 (future conditions) in the MNRAM classification. Highlights of the comparison between the existing conditions and proposed improvements for each wetland function include:

- Flood and stormwater attenuation ratings increase with proposed improvements (from a numeric rating of 0.43 to 0.54) due to an increase in storage capacity and sediment removal.
- Downstream water quality numeric ratings increase from 0.42 to 0.55 due to the proposed sediment and nutrient reductions delivered to downstream waters.
- Maintenance of *Wetland Water Quality* numeric ratings increase from 0.33 to 0.61 due to the proposed improvements to vegetative diversity and integrity, stormwater detention, sediment delivery, and nutrient loading.
- Maintenance of *Characteristic Wildlife Habitat Structure* numeric ratings increase from 0.38 to 0.67 which results in an increase from "Moderate" to "High" category rating for this function; improvement to vegetative diversity and integrity, upland area management, and wetland community interspersion are the variables that increase this functional rating.
- Maintenance of *Characteristic Fish Habitat* numeric ratings increase from 0.38 to 0.58 due to an increase in fish habitat as well as sediment delivery improvements and nutrient load reductions.
- Maintenance of *Characteristic Amphibian Habitat* numeric ratings increase from 0.22 to 0.26 due to upland land use and stormwater runoff pretreatment and detention.

Functional Assessment: Minnesota Routine Assessment Method

- The *Aesthetics/Recreation/Education/Cultural* rating increases from "High" to "Exceptional" due to proposed increased opportunities for education and recreational activities.
- *Wetland Sensitivity to Stormwater and Urban Development* ratings increase from "Moderate" to "High" due to the improvements in vegetative integrity. High quality vegetation is more sensitive to stormwater and urban development.
- *Additional Stormwater Treatment Needs* numeric ratings increase from 0.33 to 0.61 due to the increase in the *Maintenance of Wetland Water Quality* rating. A high-quality wetland is less sustainable with inputs of stormwater.
- *Vegetative Diversity and Integrity* ratings increase from "Low" to "High" due to the proposed native seeding and buckthorn removal in the floodplain forest community, decrease in curlyleaf pondweed in the shallow open water community, and the additional shallow marsh community, which will likely develop in the western portion of the pond.

Detailed summaries of the assessments are provided in **Appendix H**.

10.1 Minnesota Routine Assessment Method (MNRAM)

The MNRAM tool for evaluating wetland functions was developed as a way to regulate and protect wetlands based on wetland functions. The MNRAM assesses wetlands based on the answers to 72 questions to determine how well the functions and values are performed within each wetland. It is intended to provide detailed wetland resource data to watershed districts, municipalities within watershed districts, landowners, developers, and other parties to guide future development and redevelopment with the goal of protecting and managing wetland resources for overall public benefit.

The MNRAM evaluates the following functions/value characteristics:

Ecological Wetland Functions

1. Vegetative Diversity/Integrity
2. Hydrologic Regime
3. Wetland Water Quality
4. Wildlife Habitat Structure
5. Fish Habitat
6. Amphibian Habitat

Wetland Values

1. Flood/Stormwater Attenuation
2. Downstream Water Quality Protection
3. Shoreline Protection
4. Aesthetics/Recreation/Education/Cultural
5. Commercial Uses
6. Ground Water Interaction

Additional Evaluation Information

1. Restoration Potential
2. Sensitivity to Stormwater and Urban Development

Numeric scores are computed for each wetland function/value based on established formulas in the methodology. Those numeric scores are then converted to quality ratings — exceptional, high, medium, and low — which are entered into the Wetland Management Classification System to determine the overall management class. The corresponding wetland management standards and guidelines govern future activities that would affect wetlands.

The MNRAM wetland management classification system was developed by the Board of Water and Soil Resources (BWSR) to standardize wetland protection. The wetland management classification system determines the class into which each wetland will be placed based on the assessed wetland functions/values.

The wetland management classification system includes four categories with the following general goals:

Preserve: Avoid and preserve wetland if at all possible. No change in wetland hydrology. No increase in nutrient load.

Manage 1: Minimize impacts to the wetland. Control change in wetland hydrology. Remove sediment and pretreat water entering the wetland.

Manage 2: Minimize impacts to the wetland. Control change in wetland hydrology. Remove sediment from water entering the wetland.

Manage 3: Consider for restoration or enhancement. Where necessary, allow use of wetland for flood storage and pretreatment of water entering other, higher-quality wetlands.

11 Project Sequencing

A general sequence of restoration tasks for the project is shown below in the order of most efficient implementation. The expected duration of each task is shown with each task.

Dredging is suggested first due to the high level of disruption to the pond and surroundings. Installation of the periphyton should also occur early on. The final phase would involve park improvements, trail work, and restoration of the shoreline after other work has been completed and in-pond construction activities have ended.

Table 7 presents a possible sequence of Plan tasks that maximizes efficiency and minimizes costs. In most cases task duration could overlap with other tasks. Tasks with the same sequence number might be coincident or ahead of other tasks with the same sequence number.

Table 7. Projects Sequencing

Plan Tasks	Sequence #	Duration Estimate (Months)
Long-term carp control	1	2
Fish stocking	2	ongoing
Dredging	3	14
Periphyton system and vegetation	4	10
Public art installation scoping	5	1
Flow diverter	5	3
Reduction in impervious area	6	2
Public art installation	7	2
Shore & water access enhancement	7	1
Shoreline habitat restoration	7	4
Interpretive signage	7	1
Monitoring	8	ongoing
Trail system improvements	9	2
Restrooms	9	2
Outdoor classroom area	10	1
Amphitheatre	10	3

Table 7 presents a possible sequence of Plan tasks that maximizes efficiency and minimizes costs. In most cases, task duration could overlap.

12 Permitting

Permits for some of the tasks proposed in this plan will likely be required from the following agencies. **Table 8** shows expected permitting required for each task.

Army Corp of Engineers (USACOE)

Discussions with the Army Corps of Engineers indicate that an individual USACOE permit would be required for impacts over 3 acres, and that actions requiring a permit might include: dredging, shoreline restoration, installing a diversion structure, and excavation that requires placement of fill (or mats) for a haul road in the pond. Due to the size of Markham Pond, it is possible that a haul road - also requiring a Corps permit - would be needed to access the dredge site.

The USACOE also indicated that deeper dredging of the pond would be allowed if the functions and values of the pond improve with dredging activities.

Minnesota Department of Natural Resources (MNDNR)

The MNDNR has jurisdiction over fisheries issues in Minnesota; installation of fish barriers and other fish-management activities would require MNDNR review and permitting. The MNDNR may also require a permit for the installation of a viewing pier/diversion structure.

Because Markham Pond is a protected wetland (62-141W), dredging activity may require mitigation, depending on how the MNDNR and USACOE view the associated impacts to wildlife habitat and fisheries. Dredging of Markham Pond and installation of a periphyton system would also require a MNDNR public waters permit. Removal of stormwater deposited material (maintenance) is much easier to get permission for.

The MNDNR has also indicated that an EAW would be needed for in-lake impacts larger than 1 acre.

Minnesota Pollution Control Agency (MPCA)

Material excavated below the MNDNR's ordinary high-water level is considered to be dredged material, which is defined as waste and regulated by the MPCA. A guidance document for managing dredged material is available on the MPCA website at: http://www.pca.state.mn.us/water/dredgedmaterials.html.

Permits for some of the tasks proposed in this plan will likely be required from the Army Corp of Engineers, Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, and the city of Maplewood.

The MPCA's guidance document provides assistance in determining the type(s) of regulatory oversight and/or permit(s) required for projects and sites involving the removal and management (storage, treatment, disposal, and/or reuse) of dredged materials—once excavated—as well as requirements related to discharges from the project site and/or management control site(s), including stormwater.

Permits required to dispose of the material depend on the quality of the material and the disposal option selected. Due to the volume of dredging proposed and the grain-size distribution of the pond sediments, it is expected that approvals from the MPCA will be required. Testing of both the sediment and runoff from dewatering activities will likely be required.

If not disposed of in a landfill, the dredged material needs to be characterized according to the relevant soil reference values (SRV). A Level 1 SRV is required for the material to be re-used on residential/recreational lands; a Level 2 SRV means the material must be re-used on industrial sites.

If a permit is required, it needs to be submitted at least 180 days before the anticipated date of dredging. All sediment analysis work would need to be completed before the submission of any permit requests. Testing and reporting related to sediment characterization has budget implications and is considered as part of the project design cost estimation.

City of Maplewood

The city of Maplewood should be consulted for permitting requirements for each task. Work in Hazelwood Park and on other city property will likely require permits or other permission.

Table 8. List of Possible Permitting Agencies for Implementation of this Plan

Plan Task	Possible Permits Needed
Dredging	USACOE, MnDNR, MPCA, City
Periphyton system	USACOE, MnDNR, MPCA, City
Pier/Diversion structure	USACOE, MnDNR, City
Fish barrier	MnDNR, City
Shoreline restoration	USACOE, MnDNR, City

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Appendices

Appendix A. Markham Pond Water Quality Data and Treatment Efficiency Analyses

A water quality monitoring study was conducted in 2010 to evaluate the water quality treatment performance of the pond and better understand how the pond functions. Monitoring at Markham Pond consisted of the following:

- The outlet at Hazelwood, the Kohlman Creek inlet, and the Beam Avenue inlet which drains Maplewood Mall was monitored for total phosphorus, soluble reactive phosphorus, total suspended solids, volatile suspended solids, particle size, and flow.
- Within Markham Pond monitoring was done at two locations for temperature, conductivity, pH, dissolved oxygen, total suspended solids, total phosphorus, soluble reactive phosphorus, total suspended solids, volatile suspended solids, chloride, turbidity, and chlorophyll a.

Based on the data collected in 2010, the following stormwater treatment performance data was derived for Markham Pond:

- total suspended solids removal: 89 %
- organic solids removal: 74 %
- total phosphorus removal: 45%

The data collection and analyses showed that 1) most of the phosphorus entering Markham pond is in the organic form, and 2) Kohlman Creek is the more significant contributor of phosphorus by a factor of about 1.7.

The finding that phosphorus is mostly in the organic form is important because organic phosphorus (e.g., decomposed leaves, grasses, etc.) settles more slowly than inorganic phosphorus. Therefore improvement of the pond's treatment efficiency will require that settlement times are sufficiently longer to remove organic particles from the water column.

The water quality data collected in Markham Pond also indicate that the pond may often have adequate levels of dissolved oxygen for fish during the ice out season (greater than 5.0 mg/L), the pH is relatively stable, the conductivity is somewhat elevated, and chlorophyll a (phytoplankton) is somewhat high. Overall, the pond water quality is supportive of aquatic life.

On June 21, 2010, an aquatic macrophyte survey was conducted at Markham Pond. Twenty points were surveyed and all points had vegetation spanning seven different taxa. The most abundant macrophyte species in Markham Pond were small pondweed, elodea, and sago pondweed. Curly-leaf pondweed was present at 20 percent of the surveyed sites. No Eurasian watermilfoil was found.

Modeling Results and Discussion

Ponds can remove phosphorus by settling solid particles that carry phosphorus. Large particles tend to settle faster than small particles, and inorganic particles (e.g., sand and silt) tend to settle faster than lower density organic particles (e.g., decomposed leaves, grasses, etc.).

Particle size was sampled in the 2 stormwater inlets and the outlet of Markham Pond. The results showed that:

1. more large particles flow in at the Kennard (Kohlman Creek) inlet than at the Beam inlet, and,
2. most of the large particles are removed by Markham Pond leaving small particles suspended that are harder to remove.

This latter observation means that improving Markham Pond's water quality treatment performance is largely dependent upon improving the removal of the smaller particles. For example, during the June 9 storm, nearly 97 percent of the particles in the Beam Avenue flow were 100 um in diameter or smaller. In Kohlman Creek, only 80 percent of the particles were 100 μm or smaller while the remaining 20 percent were larger than 100 μm. At the pond outlet most of the particles (92 percent to 97 percent) are less than 100 um, indicating that most of the large particles had settled out in Markham Pond.

To explore the potential to increase the settlement of small particles in Markham Pond, a three-dimensional hydrodynamic and water quality model (Delft3D) was used. This model was needed to review the changes in flow-path in the pond from wind effects, and on particle settling for different pond dredging depths and for flow diversion. These effects are difficult to predict without a hydrodynamic three dimensional model.

Using the water quality monitoring data, particle size data, and the three dimensional model, it was determined that phosphorus removal could be improved by changing the flow through characteristics of Markham Pond (**Figure A-1**). The reconfigured scenarios included the construction of a flow diverter that redirects flow in Markham Pond and several different dredging scenarios that cover the spectrum of limited dredging to more extensive dredging (**Figure A-2**).

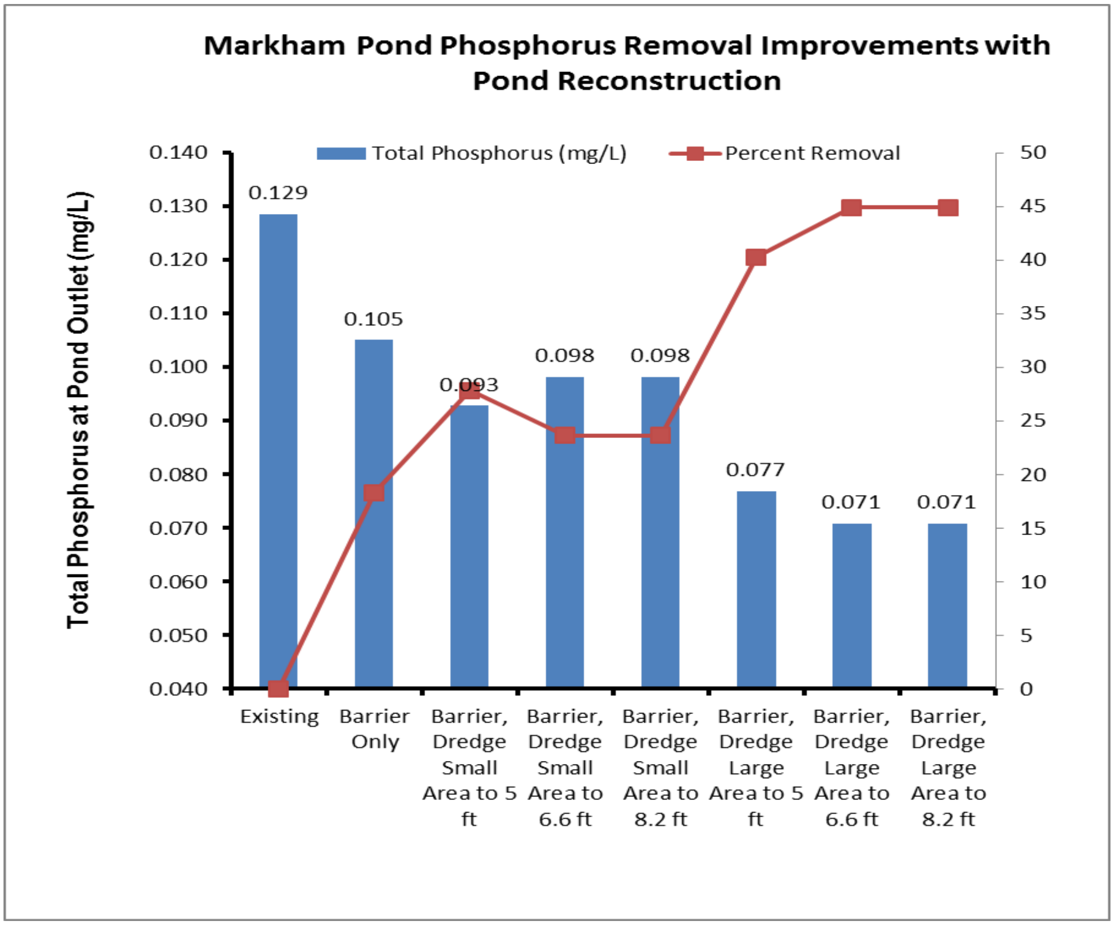

Figure A-1. Modeled Scenarios for Improving Particle Settlement and Phosphorus Removal at Markham Pond.

Figure A-1 shows that phosphorus removal is expected to improve by about 18 percent with the installation of a diverter alone that forces pond inflows to travel around the entire pond length rather than short circuiting to the outlet. This would increase the phosphorus removal performance of the pond by about 56 percent. If, in addition to the diverter, a 4-acre area directly east of the pond is dredged to a depth of 5 to 8 feet, phosphorus removal is expected to improve by 24 percent to 28 percent. If about 11 acres of the pond were dredged to a depth of 5 to 8 feet, phosphorus removal is expected to improve by 40 percent to 45 percent.

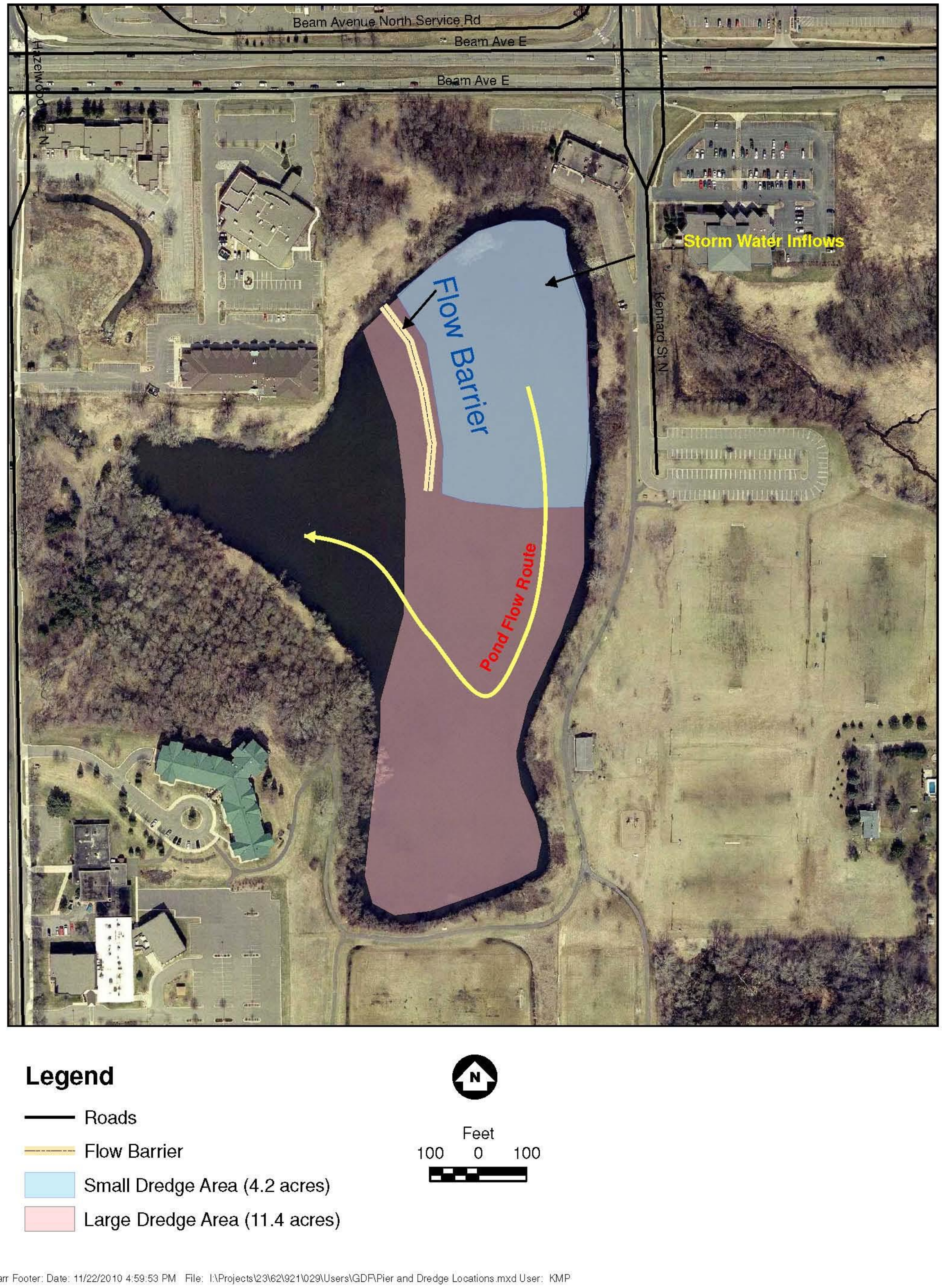

Figure A-2. Markham Pond Flow-through Modeling Scenarios.

Appendix B. Dredging Alternatives

This appendix reviews the alternatives for dredging Markham Pond. First, the alternatives for the magnitude, or volume of dredging are presented. These alternatives can be viewed in terms of cost per treatment improvement or phosphorus removal expected to be achieved. Second, the alternatives with regard to methods and disposal are presented. These alternatives are viewed in the context of overall cost and logistics.

Dredging Volume

Dredging volume scenarios are developed from the modeling work described in **Appendix A**. **Table B-1** shows all of the scenarios with the associated phosphorus removal improvement and dredging volume for each.

The modeling work showed that there are several optimal levels of dredging. Alternative 1 maximizes the ratio of dredging volume, and therefore cost, to treatment improvement for dredging a 4 acre section of Markham Pond. Alternatives 4 and 5 also show improved treatment with a larger 11 acres of dredged area.

Table B-1. Modeled Treatment Effectiveness for 6 Dredging Scenarios Based on the Delft3D Modeling Described in Section 2.2. Blue Highlight Marks Selected Alternatives.

#	Dredging Alternative	Volume of Dredging (yd^3)	Phosphorus Removal Improvement	Phosphorus Removal Improvement (lbs/year)
1	4 acre area to depth 4.9 feet	3,704	9%	81
2	4 acre area to depth 6.6 feet	13,749	5%	46
3	4 acre area to depth 8.2 feet	23,794	5%	46
4	11 acre area to depth 4.9 feet	23,493	22%	188
5	11 acre area to depth 6.6 feet	53,092	26%	227
6	11 acre area to depth 8.2 feet	83,044	26%	227
	Flow diverter	0	19%	156

Model alternatives 2, 3 and 6 show little or no benefit to increased dredging. This is due to the increased distance that particles must travel before settling for greater depths, compared to the reduction in flow velocity gained for these alternatives.

Based on the modeled results, Alternatives 1, 4, and 5 were selected for further study (shown highlighted in yellow above). Alternatives 2, 3, and 6 were deemed much less efficient in increasing treatment effectiveness with increased dredging.

Dredging Methods

Based on discussions with contractors and experienced engineering staff, mechanical and hydraulic dredging are the most likely methods for dredging Markham Pond. A brief description of each method follows.

Mechanical Dredging

Mechanical dredging consists of removing material by excavating or scooping sediment from the channel or lake bottom and placing the material on a barge, truck, or directly on a disposal area. Mechanical dredging equipment includes clamshells, draglines, backhoes or other mechanical equipment for excavating bottom sediments. Typically, mechanical dredging equipment is mounted on a large barge, towed to the dredge site, and secured with vertical anchor piling called spuds. Excavated material is then placed and transported by shuttle barges or off-road trucks to the disposal area. Dredge spoils can be placed directly in trucks and hauled to the identified disposal areas. Mechanical dredges work best in consolidated material and can be used to remove rocks, timbers, stumps and other debris that may exist at the identified sites. Mechanical dredges have difficulty retaining loose fine material that can wash out of the bucket as it is raised. Typical removal rates of sediment are on the order of 60 to 120 cubic yards (CY) per hour.

For the Markham Pond project, this method of dredging presents the advantage of generally being less expensive for the overall process of removal, dewatering and disposal. This is partly due to the relatively low level of contamination in the sediments (**Appendix C**) which facilitates flexible disposal or placement.

Hydraulic Dredging

Hydraulic dredging includes the use of pumps and piping to remove a mixture of dredged material and water from a channel or lake bottom. A typical pipeline hydraulic dredge sucks the mixture of sediment and water through one end and pumps the material through the discharge pipeline directly to the final disposal or dewatering area. A mechanical cutting head consisting of rotating blades is often included at the intake pipe to agitate and loosen bottom sediments so they can be pumped through the system. Hydraulic dredging equipment is typically mounted on a large barge, towed to the dredge site, and secured with spuds during dredging operations. Typical removal rates of sediment are on the order of 120-240 CY per hour. Hydraulic pipeline dredges can be relatively cost efficient since they can operate continuously and pump directly to the disposal site, if one is located nearby. However, if there is a lot of debris in the dredging site, the pumps can clog and impair efficiency.

The dredge spoils may contain between < 5% to 20% solids depending on characteristics of the sediment and whether polymers or additives have been introduced to increase the solids content of the slurry. Hydraulic dredging generally requires larger spoils disposal areas than mechanical dredging due to the high volume of water that must be handled to minimize environmental impacts from return water. For Markham Pond dredging this way would require a large land area for equipment staging and spoils drainage which may not be available. The addition of expensive polymers can greatly improve drying and decrease that volume.

Both dredging methods (hydraulic and mechanical) are considered in developing the opinion of costs in this report.

Sediment Dewatering

The necessary degree of sediment dewatering depends on the disposal location selected for either dredging method. The water content of the sediment will range from approximately 70 percent to 95 percent (most likely 90 percent to 95 percent using hydraulic dredging). Two dewatering methods were considered in this study:

- Settlement on-site or near-site using settling ponds and chemical additives to decrease settling time. The maximum horizontal and vertical distances that dredge spoils may be piped are approximately 1 mile and 200 feet, respectively.
- Mechanical dewatering on-site or nearby. These methods include special machinery and the addition of chemical additives to make dewatering more effective. The machinery includes separators for trash and large particles such as sand, chemical thickeners, and a centrifuge or filter press for dewatering the prepared sludge.

A cursory analysis of the cost of trucking the dredged material to an off-site location for dewatering revealed substantially higher costs than other methods listed here; therefore, this option was not considered viable.

Because of the silty nature of the sediment in Markham Pond it is likely that dewatering without chemical additives could take a year or longer and require several acres of land to achieve the required dewatering for disposal off site. Therefore chemical additives are assumed to be needed for both the settlement and mechanical dewatering alternatives. For both dewatering methods, a substantial area for either geotextile fabric tubing or excavation and berm construction is a necessary part of the dewatering process. A staging area is also required to treat and manage the return water removed from the sediment. Less area would be needed for mechanical dewatering. Through the addition of chemical additives (coagulant polymers) and use of geo-textile tubes or mechanical dewatering, the necessary dewatering site area could be reduced and dewatering time could be shortened to approximately 4-6 months.

There is one potential site available for dewatering operations of dredged sediments at Markham Pond. Hazelwood Park along the southern and eastern margins of Markham Pond could provide several acres of ready space for work. The site is dominated by soccer fields, and the City of Maplewood would require that they be restored and ready for play with the next soccer season leaving a limited time frame for sediment drainage.

Disposal Options

There are a number of options for disposing of dredged materials. Options depend on the nutrient, grain size and pollutant content of the sediment. The MPCA defines three tiers of sediment and disposal options (Managing Dredged Materials in the State of Minnesota, MPCA, 2009):

- **Tier 1** Dredged Material is suitable for use or reuse on properties with a residential or agricultural use category. It is the most restrictive category and assumes human exposure to contaminants is long term (chronic).

- **Tier 2** Dredged Material is suitable for use or reuse on properties with an industrial or recreational use category. This category is less restrictive and is based on the human exposure scenario that fits the intended use. Examples can be road fill, beach sand, fill on parkland, etc.

- **Tier 3** Dredged Material is characterized as having significant contamination, as demonstrated by one or more monitored parameter concentrations being greater than Tier 2 requirements. Tier 3 Dredged Material is considered to be significantly contaminated and must be managed specifically for the contaminants present.

In 2006 the Metropolitan Council completed an in-depth study of the character of stormwater pond sediments in the Twin Cities metropolitan area (**Appendix C**). The ponds studied included Markham

Pond. The data samples collected and published in the study are used here to scope the feasibility of dredging in Markham Pond. Classification of the sediment character and contamination are important for determining the level of care and management taken for the dredged material.

The Metropolitan Council data shows that Markham Pond dredged material would likely meet the Tier 1 criteria. The silty nature of the sediment indicates that road or other construction fill will not be suitable. This leaves direct land application, landfill cover, or direct landfill disposal. For the purposes of this study, costs are included for the three likely disposal scenarios including: land application, landfill cover, and direct landfill disposal.

Disposal Sites

Facilities for disposal of dredged materials must be designed by a professional engineer registered in the state of Minnesota. Based on the *Managing Dredged Materials in the State of Minnesota* (MPCA, 2009), and previous projects conducted by Barr Engineering, two landfills (**Table B-2**) were identified that will accept dredge spoils. Land application was assumed to occur within 40 miles of Markham Pond but a specific site was not determined.

Table B-2. Landfill Facilities Located Nearest Markham Pond.

Facility Name	Location	Road mileage from Markham Pond
SKB	Rosemount, MN 55068	24
Pine Bend	Inver Grove Heights, MN 55077	23

Cost of Dredging

Because a number of options exist for disposal and dredging techniques, a range of costs were developed for the dredging of Markham Pond. Opinion of costs were broken down into the following categories:

- sediment removal costs
- dewatering costs
- disposal costs
- bidding and contract activities
- quality control and monitoring

Sediment removal cost

Based on discussions with contractors, hydraulic dredging of pond sediment at Markham Pond is estimated to average approximately $5.50 per cubic yard. Mechanical dredging is expected to average $8 per cubic yard. Opinions of costs for three dredging options are shown in **Table B-3**.

Table B-3. Opinions of Cost for Dredging Markham Pond Sediment.

Dredging Alternative	Volume of Dredging (YD^3)	Hydraulic Method ($5.50/$yd^3$)	Mechanical Method ($8/$yd^3$)
4 acre area to depth 5 ft	3,704	$20,000	$30,000
11 acre area to depth 5 ft	23,493	$129,000	$188,000
11 acre area to depth 6.6 ft	53,092	$292,000	$425,000

Dewatering cost

For the purposes of estimating the costs associated with the dewatering portion of this study, two scenarios were considered:

- Settlement dewatering near Markham Pond using chemical additives to shorten the dewatering time.
- Mechanical dewatering on-site or nearby. These methods require special machinery and the addition of chemical additives to make dewatering more effective. The machinery includes separators for trash and large particles such as sand, chemical thickeners, and a centrifuge or filter press for dewatering the prepared sludge.

In both methods listed above, dredged sediment would need to be temporarily stored in Hazelwood Park during the dewatering process. Because the soccer fields must be available for play during the soccer season, the project timing should be maximized outside the soccer season and the addition of chemical additives (coagulant polymers) considered.

To reduce the dewatering time and space necessary for both settling and mechanical dewatering of sediment, the addition of a polymer is recommended. Using chemical additives, dewatering is estimated to cost between $25 and $35 per CY. Chemical (polymer) additives alone can cost up to $18 per gallon with approximately 1 gallon required per cubic yard, or 200 gallons of dredged spoils. Both methods of dewatering – settlement and mechanical – have approximately the same cost when the chemical additive is included.

For the settlement dewatering method, approximately two to four acres would be needed for staging and the use of geotextile bags and/or ponding, if a polymer is used. For mechanical dewatering, approximately two acres are needed. For restoration of the area after the dewatering process, approximately $20,000 per acre to $35,000 per acre restoration cost of the dewatering area was assumed. Total estimated costs for dewatering of sediment dredged from Markham Pond are presented in **Table B-4**. Dewatering costs include set-up and operations with chemical additive for both dewatering methods.

It should also be noted that hydraulic dredging will likely increase the total volume of material dredged from the lake due to the incorporation of water during the process. Dredged volume could increase by 20% or more over the initial estimates presented here.

Table B-4. Opinion of Costs for Settlement or Mechanical Dewatering of the Dredged Sediment.

Dredging Alternative	Volume of Dredging (YD^3)	Dewatering w/Additive ($30/$yd^3$)	Restoration ($35,000)	Total Cost
4 acre area to depth 5 ft	3,704	$111,000	$30,000	$141,000
11 acre area to depth 5 ft	23,493	$705,000	$35,000	$740,000
11 acre area to depth 6.6 ft	53,092	$1,593,000	$45,000	$1,638,000

Disposal cost

<u>Land Application</u>

Existing sediment analyses suggest that the dredge spoils would meet the MPCA's Tier 1 specifications for pollutants, and may be disposed at a landfill or land applied. Land application and distribution of the material will be dependent upon the nitrogen content of the sediment. If mineralization tests show that minimal amounts of organic nitrogen are released during testing (5%-10%), approximately 40-800 acres could be needed for application of the dredge spoils. This is based on an expected uptake rate for nitrogen of 100 lbs per acre and the minimum value for mineralization. The 100 lbs per acre uptake rate was chosen so that flexibility would be available for different types of crop land application.

Table C-5 details the costs of land application for the three scenarios including hauling and spreading. Distance from Markham Pond was estimated at 40 miles based upon the amount and type of land needed and conversations with dredge spoil brokers. Spreading includes all handling, application and equipment costs associated with the activity. Land rental fees are based on the assumption of expected land cost 40 miles from Markham Pond. A bio-solids broker would determine marketability of the dredge spoils and potential rental sites and/or use as crop fertilizer if the project were to proceed.

Overall cost is relatively high for land application due to transportation and spreading costs. Land application is usually best when sediment can be directly applied from the lake to available land. The generally high nitrogen content of productive lake sediments requires that a large amount of land be used to protect both surface and ground water from contamination. It is estimated that Markham Pond sediment will need to spread over 40 to 800 acres of land. Land rental fees may be avoided if there is a need for sediment of this type at the time of dredging. Because this cost is comparatively small however, it will not substantially impact the overall cost of land application. A change in distance will impact overall cost greatly. This cost estimate assumes no onsite dewatering. On site dewatering will lower transportation and spreading costs but the savings will be offset by the need for faster dewatering activity on-site.

If distance to the selected application site or sites is shorter than 40 miles, transport cost will decrease. If mineralization of nitrogen in the sediment is greater than expected, spreading and land cost will increase due to additional acreage needed for application and additional spreading time.

Table B-5. Estimated Costs for Land Application of Dredge Spoils.

Dredging Alternative	Volume of Dredging (CY)	Transport ($30/CY)	Spreading ($20/CY)	Land Cost ($2/CY)	Total Cost
4 acre area to depth 5 ft	3,704	$111,000	$74,000	$7,000	$192,000
11 acre area to depth 5 ft	23,493	$705,000	$470,000	$47,000	$1,222,000
11 acre area to depth 6.6 ft	53,092	$1,593,000	$1,062,000	$106,000	$2,761,000

Sanitary Landfill

If the dredged material does not meet Tier 1 requirements by the MPCA or other options are deemed unsuitable, disposal within a sanitary landfill is a likely option. After sufficient dewatering that dries the sediment enough to meet the Paint Test (a test used to ensure sufficient water has been removed for landfill disposal of wet sediment), dredge spoils from Markham Pond could be disposed of in a landfill. It is expected that the Markham Pond sediments would qualify as landfill cover. There is a 50% cost difference between spoils being placed within the landfill itself and spoils used as landfill cover, ranging from approximately $10 per cubic yard for cover use to $15 for disposal within the landfill. Below are the estimated costs for landfill disposal. Volume is based on a 40% reduction from dewatering activities. The distance of transport assumed is based on **Table B-6**.

Table B-6. Estimated Costs for Landfill Transportation and Disposal.

Dredging Alternative	Volume of Dry Material (CY)	Transport ($10/CY)	Landfill Cover ($10/CY)	Total Cost
4 acre area to depth 5 ft	1,482	$15,000	$15,000	$30,000
11 acre area to depth 5 ft	9,397	$94,000	$94,000	$188,000
11 acre area to depth 6.6 ft	21,237	$212,000	$212,000	$424,000

Factors that might increase dredging costs include limited site access for barge and dredging equipment and the distance to potential disposal locations. If Hazelwood Park is not available for temporary dewatering, transportation costs will increase by up to twice as much as the figure here, mainly due to the increased volume of the high water content sediment.

Fixed Costs

Fixed costs for a dredging project at Markham Pond would include project design, project bidding, and construction observation and administration. These costs are most often a function of the total physical work itself. A typical effort on a job of this magnitude would be approximately 5 percent to 10 percent of the total cost. For this study the more conservative 10 percent is used.

Depth sounding surveys should be completed before and after dredging activities have been completed. The cost for soundings and mapping is expected to cost less than $20,000. Monitoring during the dredging may also be required to ensure water quality limits are not severely impacted in downstream water bodies. Costs associated for monitoring are estimated at $10,000. If heavy metals are found in the lake sediment, monitoring costs could increase due to additional laboratory analyses needed.

For the project alternatives opinion of costs, the fixed costs are calculated as 10 percent of the site work plus $30,000 for soundings and monitoring.

Comparison of Dredging Alternatives

Combining all of the information from the sections above, a comparison of alternatives in terms of total cost and cost per pound of increased treatment capacity for Markham Pond can be done. **Tables B-7 and B-8** below compare the two most efficient options. These cost tables include the following assumptions:

- It is assumed that the sediment analyses presented in **Appendix C** accurately represents the pond’s sediment character.
- It is assumed that a limited area of the south side of Hazelwood Park would be available for 3-4 months for sediment dewatering.
- Mechanical dewatering is selected to minimize time needed for dewatering.
- Hydraulic dredging is selected to minimize cost.
- For the purpose of phosphorus mass removal costs, it is assumed that the life of the improvements would be at least 20 years.
- Fixed costs for design and construction administration are estimated as 10% of the physical work plus $30,000 for soundings and monitoring.
- A 20% contingency is included to cover unexpected obstacles for all project components.

Table B-7. Opinion of Costs for 3 Dredging Scenarios with Landfill Disposal of Sediments.

Dredging Alternative	**4 acre area to depth 5 ft ($)**	**11 acre area to depth 5 ft ($)**	**11 acre area to depth 6.6 ft ($)**
Hydraulic Dredging	20,000	129,000	292,000
Dewatering	141,000	740,000	1,638,000
Landfill disposal	30,000	188,000	424,000
Design, planning, monitoring (10% + 30,000)	49,000	136,000	265,000
Contingency (20%)	48,000	238,000	524,000
TOTAL COST	**288,000**	**1,431,000**	**3,143,000**
Estimated annual phosphorus removal improvement (lbs/year)	**81**	**188**	**227**
Cost per pound phosphorus removal improvement (prorated for 20 years)	**178**	**381**	**692**

Table B-8. Opinion of Costs for 3 Dredging Scenarios with Land Application Disposal of Sediments.

Dredging Alternative	**4 acre area to depth 5 ft ($)**	**11 acre area to depth 5 ft ($)**	**11 acre area to depth 6.6 ft ($)**
Hydraulic Dredging	20,000	129,000	292,000
Land application	192,000	1,222,000	2,761,000
Design, planning, monitoring (10% + 30,000)	51,000	165,000	335,000
Contingency (20%)	53,000	303,000	678,000
TOTAL COST	**316,000**	**1,819,000**	**4,066,000**
Estimated annual phosphorus removal improvement (lbs/year)	**81**	**188**	**227**
Cost per pound phosphorus removal improvement (prorated for 20 years)	**195**	**484**	**896**

Dredging Recommendation

Dredging to a depth of 5 feet in the smaller 4 acre area is recommended because it has the most efficient cost per pound of phosphorus removal rate by 2-3 times. Two disposal options are presented in **Table B-9**. They include a landfill disposal option and a land spreading option. Both have similar costs, differing by 10 percent to 30 percent. There is a higher uncertainty inherent in the land application alternative because a site must be found and the cost of the land application may depend on various market conditions.

Table B-9. Recommended Work and Opinion of Cost for Markham Pond Dredging.

Dredging Alternative	Landfilled 4 acre area to depth 5 ft ($)	Land application 4 acre area to depth 5 ft ($)
Hydraulic Dredging	20,000	20,000
Dewatering	141,000	-
Landfill disposal	30,000	-
Land application	-	192,000
Design, planning, monitoring (10% + 30,000)	49,000	51,000
Contingency (20%)	48,000	53,000
TOTAL COST	**288,000**	**316,000**
Estimated annual phosphorus removal improvement (lbs/year)	**81**	**81**
Cost per pound phosphorus removal improvement prorated for 20 years	**178**	**195**

It is estimated to take about 14 months from initiation of the project to completion of the dredging work if there are no unexpected delays. The dredging process would take approximately 1 month and on-site dewatering may take 2 to 6 months with chemical additives and mechanical dewatering. Dredge time may also be affected by land availability if land application is pursued for disposal and dredge spoil storage availability is limited.

Appendix C. Existing Sediment Sampling Data for Markham Pond

In 2006 the Metropolitan Council completed an in depth study of the character of stormwater pond sediments in the Twin Cities metropolitan area (Polta, 2006). The ponds studied included Markham Pond. The data samples collected and published in the study are used here to scope the feasibility of dredging in Markham Pond. Classification of the sediment character and contamination are important for determining the level of care and management taken for the dredged material

Figure C-1 shows the sampling locations for the study. The samples for the study were analyzed for grain size distribution, metal concentrations, and selected organic compounds.

Figure C-1. Sediment sampling locations at Markham Pond from the Metropolitan Council Study (Polta, 2006).

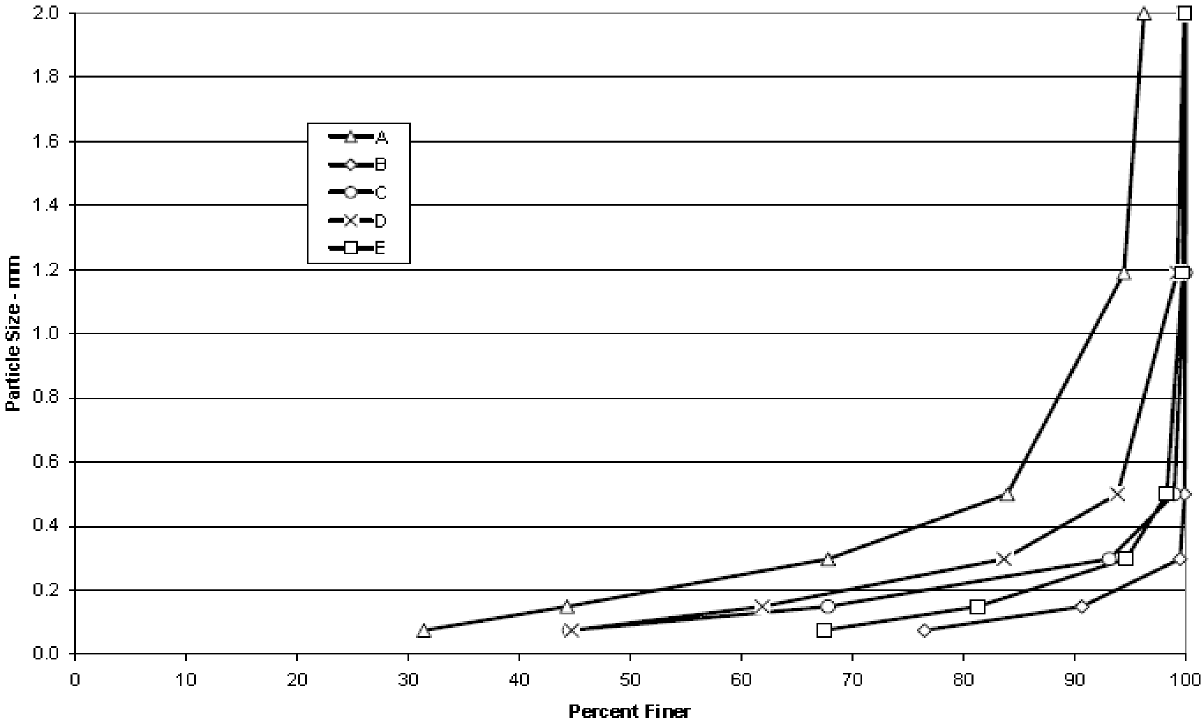

Figure C-2. Grain size distributions for sediments at Markham Pond from the Metropolitan Council Study (Polta, 2006).

The grain size distribution measurements are shown in **Figure C-2**. The Minnesota Pollution Control Agency (MPCA) classifies sediments with 7% or less of grains finer than 0.075 mm as sand. The figure shows that the sediments for Markham Pond do not meet these criteria and would be classed as silt for the purposes of managing the dredged material according to the *MPCA Managing Dredged Material* guidance document (MPCA, 2009).

Metal concentration measurements are show below in **Table C-1**. None of the metal measurements at Markham Pond showed levels above the MPCA Tier 1 management threshold. This result would indicate that the Markham Pond sediments would likely be classified as meeting the Tier 1 criteria under the MPCA dredging management guidance.

Organic compound concentration measurements are show below in **Table C-2**. None of the organic measurements at Markham Pond showed levels above the MPCA Tier 1 management threshold. This result would further indicate that the Markham Pond sediments would likely be classified as meeting the Tier 1 criteria under the MPCA dredging management criteria and therefore be suitable for the maximum flexibility in location and use for final placement.

Table C-1. Metal analysis on sediments for Markham Pond from the Metropolitan Council Study (Polta, 2006).

Core	1A1	1A2	1B1	1B2	1C1	1C2	1D1	1D2	1E1	1E2	Average
Equivalent B(a)P (mg/kg)***		1.08		0.53		1.63		1.18		1.24	1.13
GRO (mg/kg)							19.7				19.7
Total Hg (ng/g)*	20.2	48.1	43.1	28.0	51.1	44.4	37.9	41.6	67.8	56.4	46.5
TCLP metals	all values below limits established for classification as hazardous waste										
Copper (mg/kg)*	24.5		21.0	16.0	21.0	25.0	25.5	21.0	31.0	28.5	23.6
Nickel (mg/kg)*	16.0		15.5	10.5	13.0	15.0	15.5	12.5	21.0	19.5	15.3
Lead (mg/kg)*	34.5		34.0	19.5	55.5	90.0	57.0	51.3	57.0	57.5	52.7
Zinc (mg/kg)*	96.5		88.0	65.0	102.4	119.7	115.5	85.0	131.5	121.0	103.5
Cadmium (mg/kg)*	0.90		0.95	1.20	0.90	1.03	0.95	0.75	1.30	1.20	1.04
Chromium (mg/kg)*	16.0		17.5	12.0	15.0	20.0	18.5	14.3	23.5	21.0	17.7
Aluminum (mg/kg)*	7,126		7,184	4,934	4,775	6,289	6,554	5,084	9,107	8,243	6,521
Arsenic (mg/kg)*	4.0		3.2	<2.0	2.8	3.9	4.0	2.9	5.4	5.5	3.9
Iron (mg/kg)*	13,907		11,402	7,583	22,571	18,754	15,155	11,271	18,485	17,712	15,367
Manganese (mg/kg)*	382		314	189	1338	804	826	539	686	664	670
Molybdenum (mg/kg)*	0.60		0.47	<0.4	0.73	0.65	0.90	0.55	1.75	1.85	0.99
Selenium (mg/kg)*	<2.0		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (mg/kg)*	383		429	287	307	358	368	314	501	432	374
Vanadium (mg/kg)*	27.5		27.0	19.7	21.0	25.5	26.5	21.0	33.5	30.7	25.6

* average of duplicates

** pH meter was not working correctly; results suspect

*** Equivalent B(a)P = equivalent concentration of Benzo(a)pyrene using relative potency factors suggested by MPCA

When duplicates were both reported < x, the highest x was reported as the average

For averages, if one duplicate was < detection limit and one was > detection limit, the average of the value > detection limit and half of the detection limit was reported. (eg. Duplicates = 14 and <5.0; average = (14 + 5/2)/2 = 8.2).

The data collected in the Metropolitan Council Study (Polta, 2006), are used here for the purpose of scoping feasibility and cost. Additional sampling may be required for the MPCA before project approvals are granted.

This data provides a very good indication of the character and quality of the sediments at Markham Pond. The results suggest that the dredged material from the pond would be classified as silt by the MPCA, but would meet the Tier 1 criteria for contamination. According to the MPCA guidance for managing dredged materials the sediments dredged from Markham Pond would be “suitable for use or reuse on properties with a residential or recreational use category.” This is the least restrictive management category and could have significant cost implications for a dredging project.

Table C-2. Organic compound analysis on sediments for Markham Pond from the Metropolitan Council Study (Polta, 2006).

Compound	1A2	1B2	1C2	1D2	1E2	2A2	2B2	2C2	2D2	2E2
Napthalene	14	6	20	15	21	38	28	42	9	18
1-Methylnapthalene	14	5	16	13	16	34	< 0.55	< 0.55	< 0.55	< 0.55
2-Methylnapthalene	7	2	8	7	8	17	14	15	3	8
1,5-Dimethylnapthalene	15	5	18	15	14	58	27	51	4	15
1,2-Dimethylnapthalene	8	3	10	8	8	28	11	11	3	5
Acenapthylene	19	4	87	28	18	98	50	94	13	45
2,6-Dimethylnaphthalene	4	1	5	4	5	17	12	11	2	6
Acenaphthene	16	8	31	20	23	105	6	7	21	3
2,3,5-Trimethylnaphthalene	12	5	15	13	16	47	24	39	5	14
Fluorene	32	16	53	42	49	137	4	5	22	2
1-Methylfluorene	12	8	19	20	30	68	9	16	4	9
Dibenzothiophene	16	6	32	19	21	49	0	1	0	1
Phenanthrene	289	166	719	356	438	1097	59	125	27	53
Anthracene	48	12	101	38	35	106	9	8	2	4
2-Methylphenanthrene	31	15	73	34	39	81	16	31	7	24
4,5-Methylenephenanthrene	46	26	107	55	63	136	81	137	43	80
1-Methylphenanthrene	23	11	60	28	39	55	16	32	7	24
4,6-Dimethyldibenzothiophene	16	6	31	19	18	5	10	15	4	8
3,6-Dimethylphenanthrene	11	5	25	14	15	29	16	29	5	11
Fluoranthene	716	390	1592	572	843	2322	5	1916	462	771
Pyrene	794	383	1313	566	978	2459	1096	1817	400	743
2-Methylfluoranthene	33	17	67	26	38	107	47	85	22	38
Retene	16	8	22	3	1	6	10	19	4	7
1-Methylpyrene	62	9	35	27	34	85	0	48	0	20
Benzo(b)naptho(2,1-d)thiophene	55	36	131	51	78	211	93	151	32	60
Benzo(a)anthracene	240	125	540	150	213	873	679	1147	277	477
Chrysene	448	268	916	295	550	1451	605	1025	247	425
1-Methylbenz(a)anthracene	17	6	15	4	6	174	85	24	35	62
5-Methylbenz(a)anthracene	15	5	19	22	27	79	18	28	7	12
10-Methylbenz(a)anthracene	27	4	19	23	20	56	42	66	20	36
6,8-Dimethylbenz(a)anthracene	96	14	65	66	3	5	46	82	6	12
3,9-Dimethylbenz(a)anthracene	14	3	9	7	29	43	14	30	5	9
Benzo(b)fluoranthene	832	564	1703	634	1070	2375	1155	3424	660	1200
7,12-Dimethylbenz(a)anthracene	14	6	17	24	17	32	21	34	5	13
Benzo(k)fluoranthene	250	158	452	236	373	701	931	2759	29	964
Benzo(e)pyrene	505	219	625	261	384	756	378	805	156	282
Benzo(a)pyrene	376	200	637	243	413	989	475	1001	205	345
8,9,11-Trimethylbenz(a)anthracene	65	9	26	37	38	10	5	11	2	4
Perylene	88	41	136	69	104	187	95	185	19	30
Indeno(cd-)pyrene	384	207	674	41	130	166	431	1235	162	325
Dibenzo(a,h)anthracene	98	42	140	17	96	47	77	215	32	58
Benzo(g,h,i)perylene	592	210	747	218	567	884	439	1266	181	334
Coronene	114	58	201	71	131	218	80	240	31	58
Total PAH – 43	6485	3294	11533	4412	7020	16442	7216	18282	3179	6616
Total PAH – 13	3121	1635	6222	2377	3717	9804	3107	7433	1724	2969

Appendix D. Flow Diversion Alternatives

Currently the inflows through Markham Pond take the shortest route to the pond's outlet structure. For most of the water flowing through the pond that means a travel distance of about 1000 feet. If flow were to take the longest route through the pond this distance could more than double. Modeling of the pond performed in 2010 that suggested that the phosphorus removal capacity of the pond could be improved by about 20 percent by increasing the flow length to increase the time available for particle settlement. Modeling estimated that diverting flow in this way could allow the pond to remove an additional 156 pounds of phosphorus per year from its inflows.

Diverting the flow through Markham Pond to increase this flow length could be achieved by several methods. Because the flow velocity of water through the pond is low, a flow diverter does not need heavy duty structural integrity. Based on monitoring, a peak flow of approximately 35 cubic feet per second (cfs) can be expected through the pond. The force exerted on the full length of a 350 foot surface deflecting this flow would amount to less than 10 pounds. The choice of options should consider permitting issues, cost, and potential for multiple uses.

One option for diverting the prevailing westerly flow to the south would be the construction of an underwater berm from dredged or other granular material or rip-rap. This alternative has the disadvantage of requiring mitigation for fill in a wetland due to the resulting degradation of habitat and other functions of the existing open water. Wetland mitigation is expensive due to requirements of space, construction, and ongoing maintenance and monitoring. Because of the clear disadvantages of the berm options they were not considered further in this analysis.

Two options are recommended for consideration for diverting flow (**Figure D-1**). The first option would include installation of a dock or pier structure made of wood and metal that would include a diversion surface. The pier could be built to have a section below the walkway that is open to water flow and a section with a diverter, or solid surface, in the water that blocks flow and changes its direction. The pier would connect to the trails and parking at Hazelwood Park and provide both treatment enhancement and public access to the pond.

The second option would be to install the diversion surface only. This would require driving posts into the sediment and installing a timber diversion surface. This structure would serve only as a flow diverter. It would not provide public access but would provide the same treatment enhancement as the pier option.

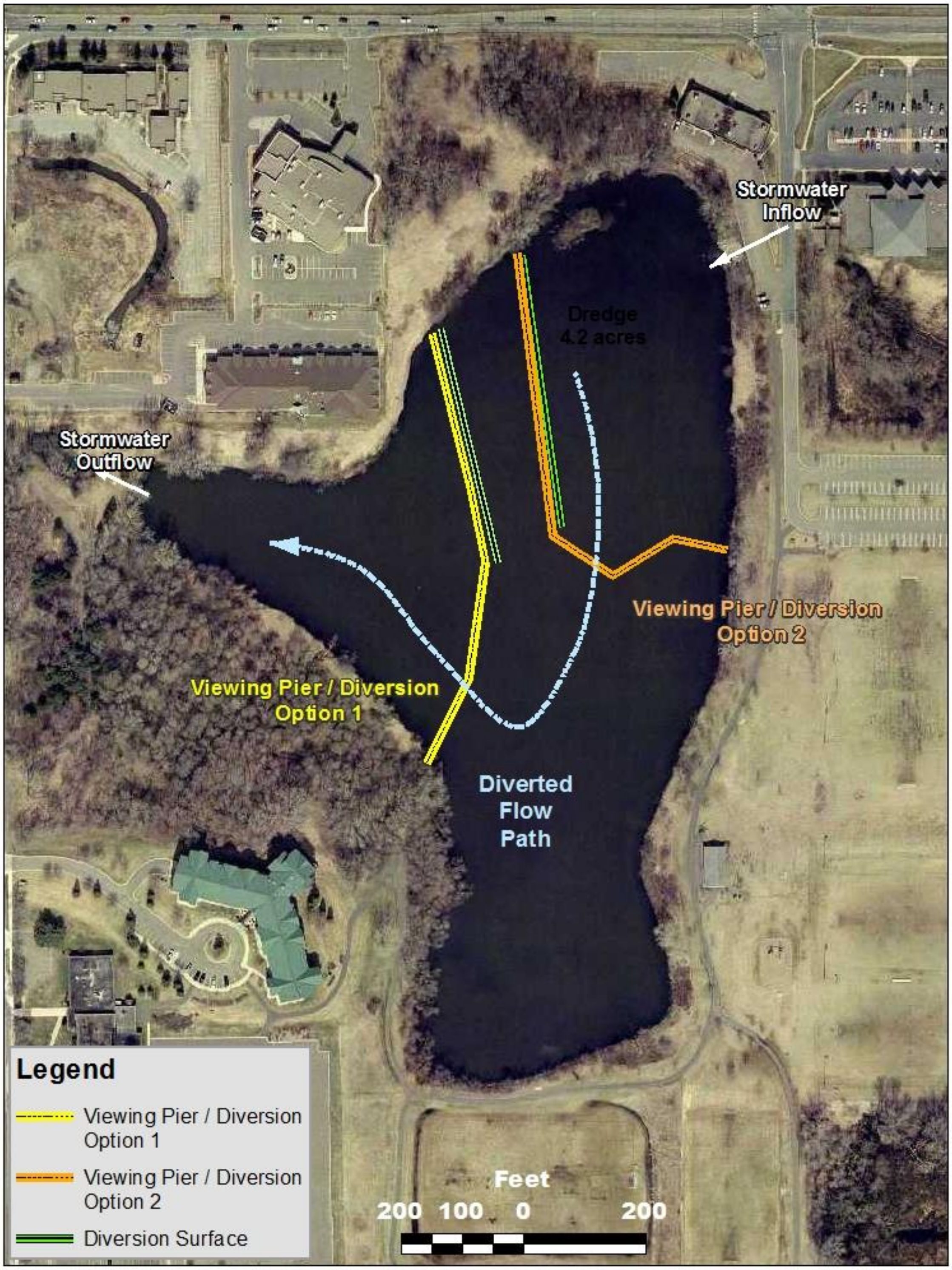

Figure D-1. Options for a Viewing Pier / Flow Diverter Structure on Markham Pond.

Flow Diversion Structure Opinion of Cost

Table D-1 below shows opinions of cost for three options for flow diversion in Markham Pond. Options 1 and 2 also provide public access to the Pond from Hazelwood Park. The opinions of cost include treated timber structures with driven posts for support in 3 feet of water. The pier would have a timber walkway and railings. A timber diversion surface would be attached to a portion of the structure to block flow and move it southward. The piers would be accessed with additional bituminous trail to connect with existing trails. The opinions of cost are based on information provided by contractors and project managers for similar projects.

Table D-1. Opinions of Cost for Two Options for Installing a Pier/diversion Structure on Markham Pond.

	Length (ft)	Pier Structure ($)	Paved Access ($)	20% Contingency ($)	Total ($)	Phosphorus Removal $/lb over 20 years
Pier Option 1	720	288,000	10,000	60,000	358,000	115
Pier Option 2	790	316,000	5,000	65,000	386,000	125
Diverter only	450	135,000	-	27,000	162,000	55

Appendix E. Limestone and Submerged Aquatic Vegetation Periphyton Treatment Wetlands

General Description

Periphyton Stormwater Treatment Areas (PSTAs) and Submergent Aquatic Vegetation constructed wetlands (SAVs) utilize the concept of algal/vegetative uptake of dissolved phosphorus to remove phosphorus from water. Periphyton are algae that grow on a submerged substrate such as rocks, aquatic vegetation, woody debris, or soil. Periphytic algae differ from planktonic algae that float in the water column of a water body. Planktonic algae are what limnologists are typically referring to when discussing transparency issues caused by algal growth in a pond or lake. Periphytic algae are often associated with nuisance scums along shorelines (making rocks slippery) and in shallow parts of lakes and wetlands.

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. 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 E-1** shows an aerial view of an operating PSTA system.

Figure E-1. A PSTA System in Southern Florida.

Site Specific Considerations

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 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 % or more.
- Leakage control is necessary in multiple cell systems to avoid short-circuiting of the treatment train.
- PSTAs and SAVs target soluble phosphorus and should be used at the end of a treatment train that removes most particulate matter and floating debris.

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.

Limestone

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

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.

Literature Review of Performance Data

A Florida treatment train consisting of wetlands in a series – floating and emergent aquatic vegetation followed by 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 cubic meters /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 percent to 33 percent of the phosphorus was bound with calcium, while the remaining portion was bound with organic material (67 percent to 70 percent). Another study on PSTAs in the Everglades showed that approximately 5 percent of total phosphorus (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 E-1. Relative Reliability, P Removal, Maintenance and Cost for PSTA/SAV Systems, Based on Review of Available Literature

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

Markham Pond SAV

Because Markham Pond likely has a TP concentration that is greater than 50 μg/L, an SAV system for phosphorus uptake may be more suitable than a PSTA. Improvements including limestone installation and vegetation planting could be made to the western end of Markham Pond to increase phosphorus removal from flow moving through the system. Dredging the accumulated sediment from the north lobe of the pond would increase the treatment of the flows coming into the pond from Kohlman Creek on the east side and provide pretreatment for the SAV wetland part of the pond.

Because of the large volume of flow through Markham 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 the Markham Pond are summarized below:

Construction and Design	$1,004,000
Annual Maintenance	$7,800
Estimated Annual Phosphorus Removal = 162 lbs.	$358 per pound over 20 years

All project capital costs include a basic cost estimate plus a 20% increase for engineering and a 40% increase for contingency.

Appendix F. Fisheries Evaluation

The water quality role that common carp play relative to increased turbidity, chlorophyll a concentrations, reductions in submerged macrophyte biomass, and in-lake nutrient cycling has been discussed by RWMWD since the inception of the 1997 Plan. Research since 1997 has further quantified how benthic feeding fish such as carp can contribute to increased levels of in-lake phosphorus levels (Parkos et al 2003, Badiou 2005). High populations of carp have also been implicated for reduced success of game fish populations and lake aesthetics due to turbidity caused by lake-bottom sediment disturbance (Bernstein and Olson 2001, Koehn 2004). Winterkill prone waters such as Markham Pond and Casey Lake are sought out by carp during spring migrations as highly desirable spawning areas (Bajer and Sorenson 2009).

Part of an integrated strategy to improve water quality in Kohlman Lake and achieve the TMDL objective (Barr, 2010) is to reduce the potential for carp and other benthic feeding fish to have adverse impacts to water quality in Kohlman Lake. Kohlman Basin, Markham Pond, and Casey Lake are viewed as likely spawning and nursery areas for carp and goldfish which could contribute to populations in Kohlman Lake (Osborne 2012) as well as contributing to lowered water quality as a result of their feeding habits.

The objectives of this fisheries evaluation to: 1) identify fish passage routes located between Kohlman Lake and Casey Lake; 2) identify potential locations and options for fish barriers to reduce carp access upstream of Kohlman Lake; and 3) identify potential integrated strategies to reduce impacts of carp and goldfish on water quality.

Passage Evaluation

Fish species of interest utilizing the existing routes upstream of Kohlman Lake are common carp and northern pike *(Esox lucius*) during spring spawning movements. Bluegill (*Leopmis macrochirus*) do not exhibit strong upstream spawning movements but primarily move within lake basins or warm water flowages on a seasonal basis to find preferred habitat. **Table F-1** shows the criteria used to determine whether common carp and northern pike could pass velocity barriers between Kohlman Lake and Markham Pond.

Table F-1. Passage Criteria for Common Carp and Northern Pike.

Species	Fish size	Max burst* speed	Prolonged swim speed	Source
Common carp (Cyprinus carpio)	adult	13 fps	4fps	Bell 1991
Northern pike (Esox lucius)	Sub-adult (14 inch)	3 fps	NA	Bell 1991

* burst speed for 7.5 seconds

Structures identified as potential barriers to fish movement from Kohlman Lake to Markham Pond are shown on **Figure F-1**. The inlet to Kohlman Lake from Kohlman Basin is the channel flowing to the west at the Hwy 61 culvert. Passage evaluation of the structures between Kohlman Lake and Casey Lake was conducted using a combination of XP-SWMM modeling to evaluate water surface elevations, audit of flow and velocity monitoring data from the RWMWD, direct observation of structures for potential passage routes at flows of 10 and 79 cfs and use of FishXing, the public domain software that compares known fish swim, burst, and leaping abilities to structure dimensions, headwater and tailwater conditions, slope, and material type under a specified flow range.

Figure F-2 shows the details of the elevations of the structures. Water surface elevation determined by XP-SWMM modeling conducted by Barr is also shown on the elevation plot for the 2-yr (171 cfs) and 100-yr (264 cfs) recurrence peak flows.

Northern Pike Passage

Passage by northern pike seeking to move from Kohlman Lake to use Kohlman Basin as a spawning area is possible at the Hwy 61 culvert and stop log weir at flows below 5 cfs when Kohlman Lake is at or near the OHW elevation of 859.5. Flows above 5 cfs create a velocity barrier to pike. Movement may be impeded at the permeable weirs at flows below overtopping as pike do not leap. Velocity barriers are present at culverts under the Bruce Vento Trail and Hazelwood Street. Northern pike are unable able to access Markham Pond due to the 2-foot vertical drop at the outlet culvert should they be present upstream of the Hazelwood St. culvert. Efforts to lower the permeable weirs where they tie into natural ground at either end would improve conditions for pike movement within Kohlman Basin.

Carp Passage

The system from Kohlman Lake to Markham Pond is currently passable by common carp. The elevation plot in **Figure F-2** suggests that fish passage could be impeded at each structure due to the normal water elevation (NWE) in relation to the structure heights, however, based on field observations, flow monitoring data from RWMWD (2008-2009), and use of FishXing software to evaluate structures, passage is possible by carp under specific flow conditions. Annual passage is most likely possible at some time during the May-June spawning period at all locations except for the Bruce Vento and Hazelwood culverts where a 2-yr flow event is required.

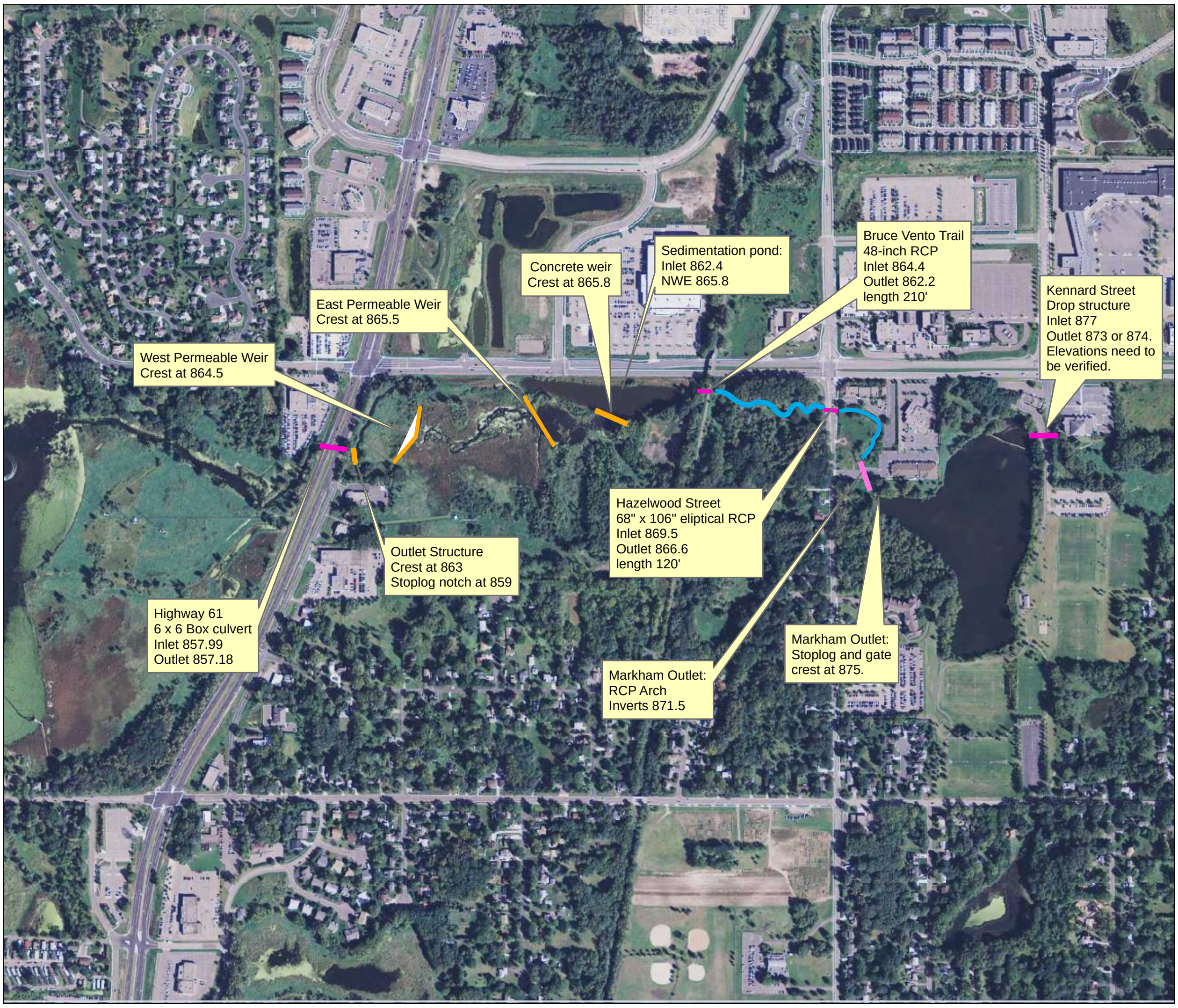

Figure F-1. Project Location Map with Structures

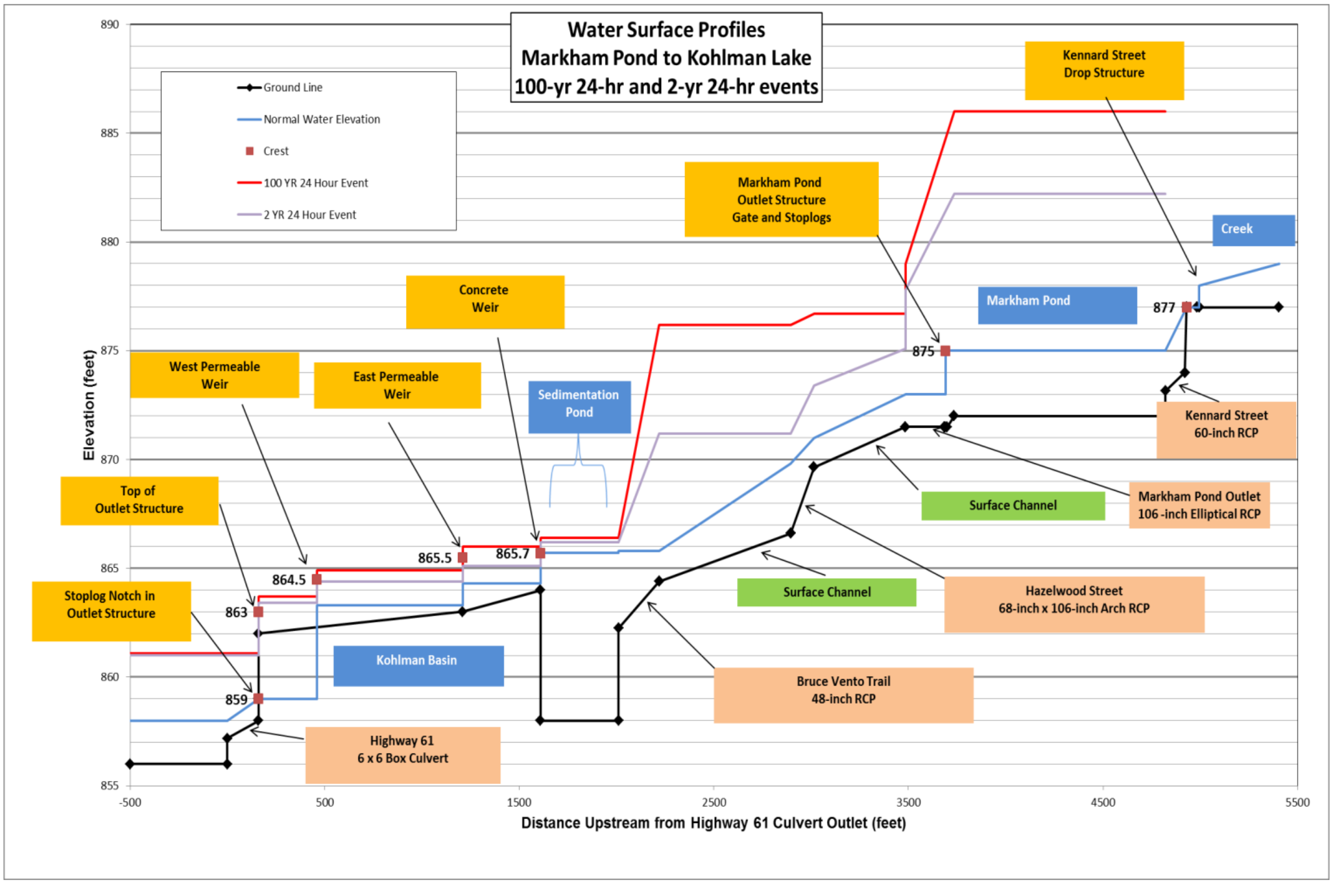

Figure F-2. Structures and Associated Elevations from Hwy 61 to Markham Pond.

Note: "Normal Water Elevation" corresponds to the top of the controlling structure, or invert, of the controlling pipe immediately downstream from that water surface. In the case of the permeable weirs, the normal water elevation was set to the invert of the lowest "gap" in the timber portion of the weir. Markham Pond water levels reach 886 ft in the case of the 100-year, 12-hour event, and 882.2 ft in the case of the 2-year, 24-hour event.

The backwater from Kohlman Lake (OHW 859.5) at the Hwy 61 stop log weir (**Figure F-3**) allows passage of fish during periods when velocities do not exceed the maximum burst speed of adult carp. Passage at the west permeable weir (**Figure F-4**) is more restrictive at flows lower than overtopping. Flow through the west permeable weir is higher than at the east permeable weir or sediment pond weir making passage more difficult until overtopping occurs.

The east permeable weir and sedimentation pond weir are also passable at specific locations at flows as low as 10 cfs based on observations made on April 11, 2011 (**Figures E-5 and E-6**). Passage would be improved with flows greater than the 10 cfs observed on April 11. 2011.

Carp passage through the 210-foot long, 48-inch diameter culvert under the Bruce Vento Trail and the 120-foot long, 68-inch diameter culvert under Hazelwood Street is possible when tailwater conditions at each culvert found during the receding limb of the 2-yr hydrograph create a backwater into the culverts. Passage at the Bruce Vento Trail culvert is possible between flows of 5.0 cfs to 11.3 cfs. Passage at the Hazelwood St. culvert is possible between flows of 5.0 cfs to 11.9 cfs. The FishXing input file used 6 inch carp with a critical flow depth in each culvert of 0.3 feet. Passage is only possible during the 2-yr event when backwater conditions are present at each culvert. Under other flow conditions a velocity and/or depth barrier precludes carp movement at these culverts.

Passage into Markham Pond via the pond outlet culvert is possible by carp. Photos taken on April 11, 2011 show the conditions at a flow of approximately 10 cfs (**Figure F-7**). Passage evaluation using the public domain software “Fish-Xing” also confirms the potential for passage of carp between 8 cfs and 75 cfs. Data supplied by RWMWD for the automated flow monitor on Kohlman Creek at the Hwy 61 culvert during 2008 and 2009 do not show any periods when velocities exceeded maximum adult carp burst speeds as developed by Bell (1991). The jumping abilities of carp are well known, and no barriers exist between Kohlman Lake and Markham Pond high enough to preclude upstream carp movement (Stuart 2006).

Figure F-3. Hwy 61 Stop Log Structure at Approximately 10 cfs, April 11, 2011.

Figure F-4. West Permeable Weir at Approximately 79 cfs, April 26, 2011.

Figure F-5. East Permeable Weir at Approximately 10 cfs, April 11, 2011.

Figure F-6. Sedimentation Pond Weir at Approximately 10 cfs, April 11, 2011.

Figure F-7. Markham Pond Outlet at Approximately 10 cfs, April 11, 2011.

Kohlman Basin Barrier Alternatives

Hwy 61 Culvert

This location provides the greatest potential for precluding carp seeking to use upstream locations in Kohlman Basin as spawning and nursery areas. The site offers the potential for installation of four different types of barriers or traps. The outlet of this culvert could be retrofitted in several ways to accommodate preclusion of fish movement.

Electric Weir Option

Installation of an electric barrier retrofitted to the outlet of the culvert carrying Kohlman Creek under Hwy 61 offers the chance to preclude all fish movement from Kohlman Lake to upstream areas. If northern pike access to Kohlman Basin is desirable; activation of the barrier could be keyed to water temperature as northern pike seek spawning areas earlier in the year at lower water temperatures (33-45 degrees F) than those that trigger carp spawning movements (60-78 degrees F).

Physical Screen Option

Physical screening of the culvert under Hwy 61 would allow preclusion of all fish larger than the bar/or screen mesh size chosen when fixed over the outlet of the culvert as it enters Kohlman Lake. A trash rack would be necessary on the inlet to preclude the fish screen on the outlet from becoming clogged with debris. A vertical bar screen with 2.0 inch spacing between vertical bar elements has been successful in precluding common carp approximately 14 inch and larger from accessing structures. Bajer and Sorenson (2009) found all female carp sampled in Lakes Susan and Echo in the Riley Creek watershed of central Minnesota to be sexually mature at length of 13.4 inches and larger. Operation of the screen could be timed to allow pike movement into Kohlman Basin for spawning while precluding the bulk of the carp movement due to the earlier spawning movements of pike in relation to carp.

Williams Trap Option

The Williams Trap offers the potential to retrofit the outlet of the Hwy 61 culvert to allow placement a device that functions as physical barrier and selective trap for common carp based on their tendency to jump when encountering a vertical barrier (Stuart 2006). Operation of the trap would allow for incremental reduction in adult carp populations as they congregate and seek to move from Kohlman Lake to Kohlman Basin/Markham Pond. Northern pike or other fishes seeking to move from Kohlman Lake would be able to pass through the trap due to its design. A conceptual diagram of the Williams Trap is shown in **Figure F-8**.

Bubble/Sound Barrier Option

A bubble sound barrier could be installed in Kohlman Lake downstream from the Hwy 61 culvert. Bubble/sound barriers with appropriate frequencies and bubble patterns are effective in deterring common carp movements as carp have specialized hearing development. Bubble/sound barriers are currently being investigated for use in Minnesota by the University of Minnesota, Saint Anthony Falls Laboratory. An experimental bubble-only barrier was installed by the University in May 2012 upstream of the Hwy 61 culvert. Research findings should be used to guide design of a bubble/sound barrier.

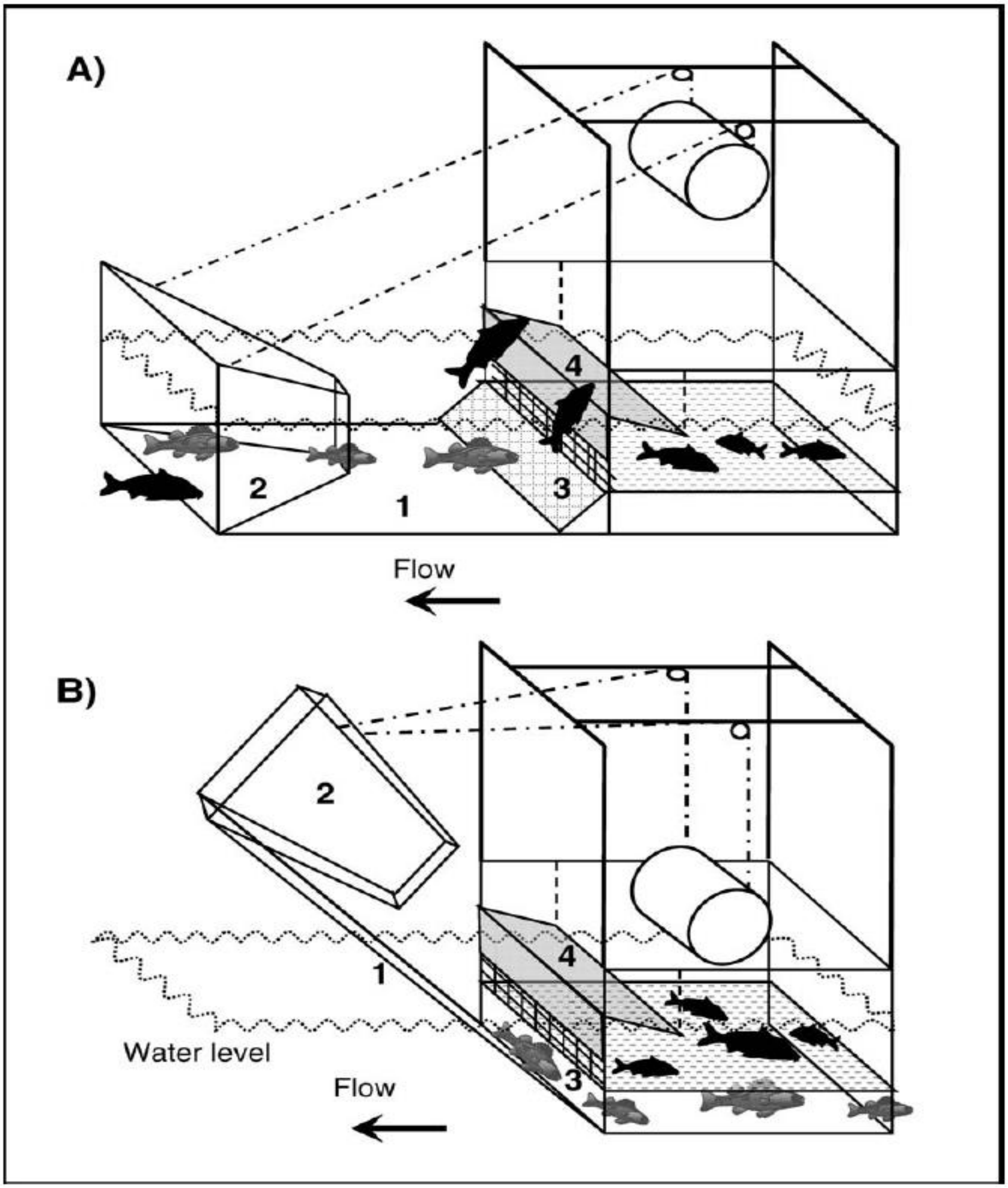

FIGURE 1.—Illustration of the Williams cage, showing (A) the operating position used to catch and separate jumping common carp (black fish symbols) and nonjumping Australian native fishes (gray fish symbols), and (B) the raised position. The following elements are indicated in each panel: (1) false lifting floor; (2) cone trap; (3) native-fish exit gate; and (4) nonreturn slide. For clarity, the mesh covering is excluded and all measurements are given in the main text.

Figure F-8. The Williams Cage from Stuart et al (2006).

Hwy 61 Stop Log Weir

This site is potentially conducive to a physical screen or Williams trap. The site is more confined due to the upstream entrance to the Hwy 61 culvert, road right-of-way and the stop log weir. Fish moving through the Hwy 61 culvert and then stopped at the stop log weir could potentially become very numerous and cause a nuisance situation. A barrier at this location also could be subject to debris jams and associated upstream water surface elevation increases that would be undesirable. A structure or barrier at this location is not recommended.

West Permeable Weir

The west permeable weir currently creates conditions that impede northern pike movement through Kohlman Basin but does not present a barrier to carp movement. Field observation of the west weir during April 2011 indicates that flow through the weir structure is sufficient at flows up to approximately 79 cfs that overtopping does not occur. Carp are likely to have little difficulty in negotiating the approximate 1 foot (at 79 cfs) jump necessary to pass the weir. Northern pike will not be successful in moving upstream beyond this weir until flows overtop the weir. Lowering a section of the weir to the NWE to 863.3 as it ties into natural ground at either end would allow passage of northern pike at flows less than overtopping. This effort could, however, compromise some of the effectiveness of the nutrient treatment of the weir as flows are routed around rather than through the structure. Increasing the weir height with vertical bar mesh panels or additional weir boards placed similarly to those already in place could potentially preclude fish movement at flows greater than overtopping but could also create unanticipated problems due to increases in upstream water surface elevation as more water is temporarily impounded during events > 2-yr recurrence. Additional modeling to evaluate projected increases in water surface elevations corresponding to an increase in the top height of the weir would be necessary. Flow through the weir may also change over time as fines and organic materials begin to plug the spaces between the weir boards creating an increasing likelihood for unanticipated upstream water surface level increases and regular maintenance. Debris management on vertical bar mesh panels would likely be frequent. The visual impact of increasing the top elevation of the weir by 3-4+ feet necessary to impede carp movement may also be unacceptable.

East Permeable Weir

The east permeable weir currently creates conditions that impede northern pike movement through Kohlman Basin but does not present a barrier to carp movement. Fish passage at the east weir is possible at flows as low as 10 cfs as observed in April 2011. Passage is possible at selected locations where minor variations in the top elevation and downstream rock armor have created flow paths that are suitable for fish. During the April 2011 field visit when flows were approximately 10 cfs the elevation difference between the top of the weir and upstream water surface was less than 0.2 feet in some locations. The rock armor on the downstream face of the weir had adequate natural variation to allow fish passage. A similar situation exists at this weir as the west weir as it was evaluated to impede carp movement. A substantial effort is needed to raise the jump height at the weir to preclude carp movement at the 2-yr or 100-yr event. Debris management, upstream water surface elevation increases and aesthetics are all areas of concern at this location, just as they were for the west weir. Northern pike are impeded by this structure due to the downstream rock face and potential velocity barriers where flows are concentrated. Northern pike movement can be improved by lowering sections of the weir to the NWE of 864.3 where it ties into natural ground.

Sedimentation Pond Weir

The concrete weir at the sedimentation pond was overtopped at flows of approximately 10 cfs as observed on April 11, 2011. The downstream rock armor associated had enough variability that flow paths had developed adequately to allow fish passage by both northern pike and common carp. This location presents logistical issues for barrier installation, similar to the east and west permeable weirs. Increases in upstream water surface elevations associated with an increase in weir height or barriers that could clog with debris could be a larger issue due to the weir proximity to Beam Avenue.

Culverts under the Bruce Vento Trail and Hazelwood Street

These culverts both have velocity and/or depth barriers that preclude northern pike passage under all flow conditions modeled. Under certain flow conditions found on the receding limb of the 2-yr event, carp can pass these structures. Passage is only possible at either structure a maximum of 3.5% of time under flow conditions modeled. Efforts to modify the structures to preclude all carp passage may be possible but was not evaluated.

Markham Pond Outlet

The Markham Pond outlet as shown in **Figure F-7** presents a barrier to northern pike movement due to the 2 foot vertical drop from the culvert as well as a velocity/depth barrier through the culvert.

Northern pike passage could potentially be improved by construction of a series of rock ramps with 6 inch or less elevation changes between ramps and installation of baffles in the culvert. Resting pool areas approximately two feet deep between the rock ramps would be needed to allow pike adequate low velocity water to recover from efforts to navigate the structure. Modeling to determine the optimum depths and lengths of pools at the desired range of design flows is necessary if this option is pursued. Access to Markham Pond by northern pike will be limited in any circumstance by velocity or depth barriers through the existing culvert as determined by use of "Fish-Xing" software. Installation of a vertical bar/screen with 2.0 inch bar spacing at the outlet would impede most carp larger than 14 inches from accessing Markham Pond via the outlet culvert. The trash rack at the Markham Pond inlet would need modification to preclude debris from entering the culvert and clogging the barrier at the outlet. Barriers and trash racks of this type would likely impact culvert conveyance and the time for Markham Pond to return to normal water surface elevations following a precipitation event.

Kennard St. Drop Structure

Fish movement through the Kennard St. drop structure upstream to Kohlman Creek/Casey Lake is impeded by the 2 foot elevation change inside the drop structure. Observation of the structure indicates inadequate pool depth (< 3 inches on April 11, 2011) to allow fish to jump; however, carp are known to navigate structures that do not readily appear to be passable. The pool depth will also increase when flows are higher than those observed on April 11, 2011. Downstream movements from Casey Lake into Markham Pond via Kohlman Creek may be slowed by seasonal debris on the trash rack located on the upstream inlet to the drop structure; however passage into the drop structure is possible. Placement of a vertical bar screen at the Markham Pond inlet to the drop structure would impede upstream carp movement. This structure is not passable by northern pike due to the 2 foot vertical drop. Downstream movement or drift of juvenile carp into Markham Pond from upstream locations is possible but has not been documented (Chizinkski, *unpublished*).

Table F-2 summarizes alternatives for impeding carp movement considered in this evaluation. Planning level cost estimates for the alternatives described above are provided in **Table F-3**.

Table F-2. Summary of Locations and Alternatives Considered for Barrier Installations.

Location	Alternative	Advantage	Disadvantage
Hwy 61 culvert downstream of Hwy 61	Physical screen	Low cost	High maintenance
	Electric barrier	Efficacy	Cost/Safety
	Bubble and sound* barrier	Safety	Cost/Specific design TBD
	Williams Trap	Adult carp removal	Seasonal High maintenance
Hwy 61 stop log weir upstream of Hwy 61	Physical screen	Low cost	High maintenance
	Williams Trap	Adult carp removal	High maintenance
Markham Pond outlet culvert	Physical screen	Low cost	High maintenance

*Experimental bubble barrier installed upstream of Hwy 61 in May 2012 by the Univ. of Minn.

Table F-3. Barrier Summary of Range of Expected Installation Costs.

Location	Alternative	Cost Range
Hwy 61 Kohlman Creek outlet culvert	Electric	$260,000
	Bubble/Sound	$200,000
	Williams Trap	$15,000-$30,000
	Physical	$2,500-$7,500
Hwy 61 stop log weir	Williams Trap	Not recommended
	Physical	Not recommended
West permeable weir	Pike passage improvement	$2,500-$7,500
East permeable weir	Pike passage improvement	$2,500-$7,500
Sedimentation pond weir	Pike passage improvement	$2,500-$7,500
Culverts at Bruce Vento Trail and Hazelwood St.	Not evaluated	Not determined
Markham Pond outlet	Physical	$2,500-$7,500
Kennard Street drop	Physical	$2,500-$7,500

Potential Integrated Strategies in Kohlman Basin

Background

Recent research confirms that Markham Pond and Casey Lake are nursery areas for common carp, and that Markham Pond has a population of goldfish (*Carassius auratus*) (Osborne 2012), a benthic feeding fish that contributes to internal nutrient cycling and turbidity (Richardson 1995). Osborne (2012) documented overwinter survival of age-0 carp in Markham Pond at ≈ 4% while ≈ 33% survived in Casey Lake; however, he suggested that adequate numbers of carp remained as residents to generate annual spring reproduction. Additionally, Osborne (2012) only documented minor downstream emigration from Markham Pond during seasonal periods in 2010 and 2011. Casey Lake carp populations are less subject to winterkill but have not been documented to date to contribute to downstream populations. Based on the passage evaluation, carp can only irregularly access Markham Pond and Casey Lake from downstream locations, however, due to the resilience of carp and goldfish to winterkill conditions and the potential for a very irregular reproductive success to maintain populations (Bajer and Sorenson 2009) carp and goldfish reproductive success will continue in both ponds with subsequent impacts to lowered water quality.

Potential Strategies

Reduce potential for carp to access Markham Pond and Kohlman Basin by constructing a barrier at Kohlman Lake inlet

A barrier to preclude the potential for carp to access waters upstream of Kohlman Lake would limit the likelihood that carp could irregularly gain access to Markham Pond and set up conditions for continued annual reproductive success.

Reduce success of annual reproduction in Markham Pond and Casey Lake by conducting a fall drawdown coupled with removal and/or fish toxicant application

Annual reproduction of carp and goldfish is likely to continue in Markham Pond and Casey Lake as long as adequate numbers of sexually mature fish survive overwinter conditions. Markham Pond currently depresses the annual reproductive success due to anoxic conditions and/or complete freeze out. Casey Lake allows for more successful overwintering of fish populations in general based on research conducted by Osborne (2012). An approach to further depress the current poor overwinter survival in Markham could be a first step. Boat electro-fishing removal of carp and goldfish, coupled with fall drawdown and/or application of a fish toxicant such as rotenone would further reduce success of carp and goldfish reproduction. Rotenone is typically applied at approximately 1 gallon (5% active) per acre foot to achieve a concentration 3 ppm. Degradation is light and temperature dependent, typically taking place within 4 weeks even at cooler water temperatures. Rotenone costs to treat Markham Pond at full pool (approximately 48 acre feet) would be approximately $3800 at $80 per gallon. Treatment of Casey Lake at full pool (approximately 28 acre feet) would be approximately $2200. Removal of carp in Casey Lake by boat electrofishing, drawdown and netting would reduce carp populations incrementally and could improve chances for existing gamefish populations to be more effective predators on carp eggs and/or early juveniles. Boat electrofishing removal or under ice netting of carp if conducted for two day periods with a crew of 4 persons (8 man days each gear type) could be conducted for under $7,000 for each effort.

Improve success for gamefish survival in Casey Lake and/or Markham Pond

Installation of aeration in one or both ponds with or without selective deepening of Markham Pond could potentially improve overwinter survival of gamefish. Water quality benefits from aeration in Markham Pond or Casey Lake are unknown at this time, however, in general aeration has been shown to improve overwintering conditions for fish by maintaining open water areas and creation of localized zones of adequate dissolved oxygen concentrations. Aeration has the potential to improve overwintering conditions for carp and goldfish as well as the desirable gamefish populations. Further investigation is required to determine the potential for success and type of aeration system most applicable.

Willow Creek and Gervais Mill Pond

Willow Creek

Fish passage into and out of Willow Lake (located on the H.B. Fuller property) is impacted by structures at the outlet, the culvert junction and inlet to the culvert under Hwy 61, the length of the culvert under Hwy 61, and the flow path of Willow Creek upstream of Kohlman Basin.

The Willow Lake outlet to Willow Creek is currently fitted with a flap gate on a 42-inch CMP (Barr 2007). This flap gate (**Figure F-9**) currently has a fixed opening of approximately 2.5 inches (est.) at the widest point. This opening is close to the 2 inches recommendation for vertical bar barriers to preclude carp of 14 inches or larger from upstream access.

Figure F-9. Flap Gate at Willow Lake Outlet to Willow Creek.

The culvert junction and upstream inlet to the culvert under Hwy 61 (**Figure F-10**) currently does not impede movement of carp within Willow Creek or wetlands downstream, however, the length of the culvert under Hwy 61, estimated at approximately 150 feet measured from aerial photos, likely creates a depth and/or velocity barrier for carp movement under some flow conditions. Northern pike cannot likely pass through this culvert due to velocity or depth barriers during the spring when movements would be anticipated. Use of “Fish-Xing” software to confirm a flow range for passage is possible but was not conducted. No direct connections to allowing fish passage from Kohlman Basin upstream to Willow Creek were located during the field visit on April 11, 2011. The flow from Willow Lake is routed through the series of ponds north of Beam Ave, which are connected to the sedimentation pond of Kohlman Basin by a submerged culvert under Beam Ave.

Figure F-10. Culvert Junction and Upstream Inlet to the Culvert under Hwy 61.

Gervais Mill Pond

Fish passage from Gervais Lake into the Gervais Mill Pond complex is not impeded by the culverts or trash racks now in place under Edgerton Street as shown in **Figure F-11**. Installation of vertical bar barriers or an electric or bubble/sound weir depending on the need would impede fish movement from Gervais Lake to Gervais Mill Ponds. MNDNR records indicate regular fall stocking of bluegill to Gervais Mill Ponds suggesting that winterkill conditions do not typically occur. Further coordination with MNDNR and the University of Minnesota is desirable to determine whether or not a fish barrier is viewed as necessary.

Figure F-11. Culverts from Gervais Lake to Gervais Mill Pond Complex.

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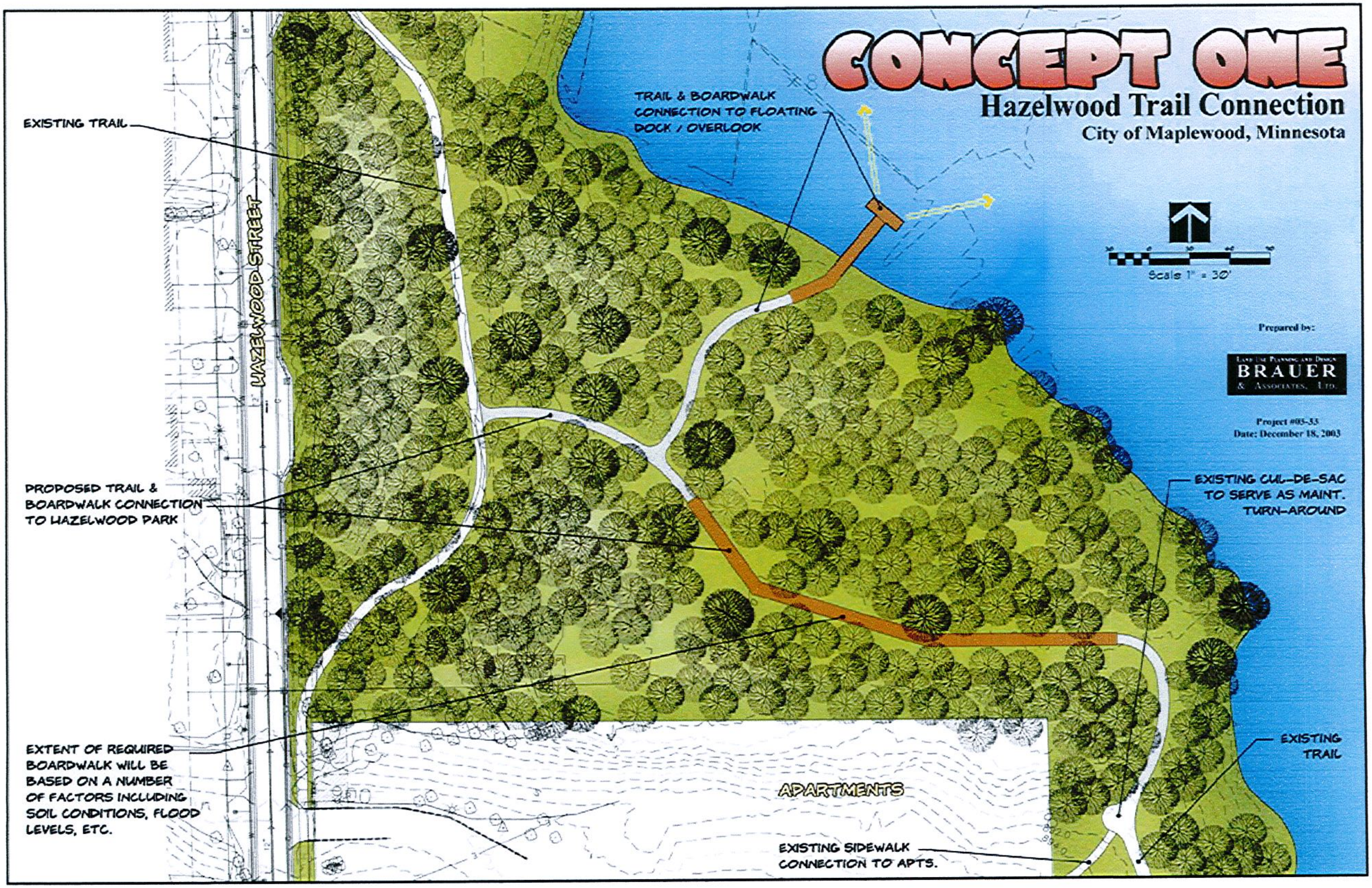
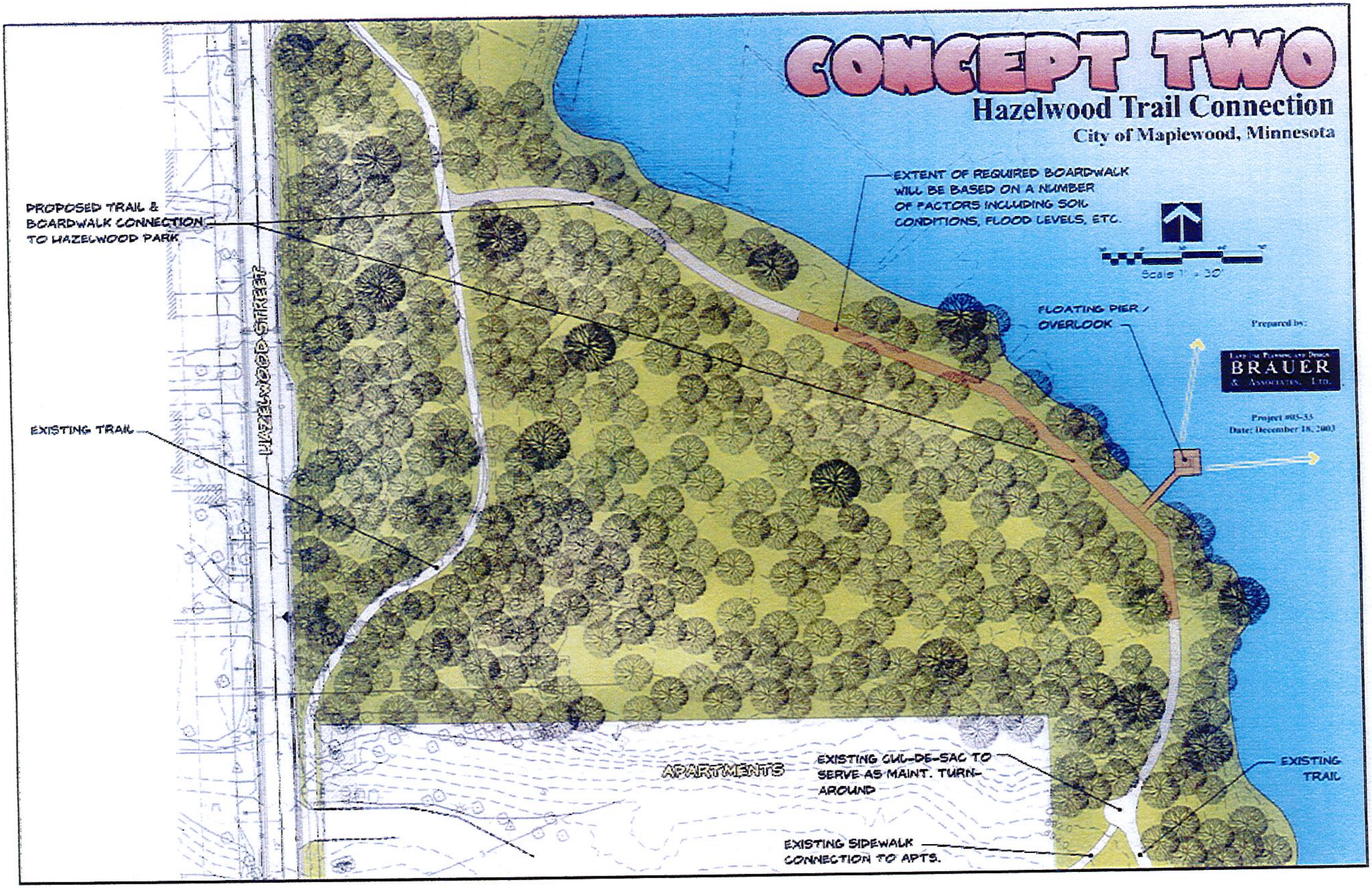
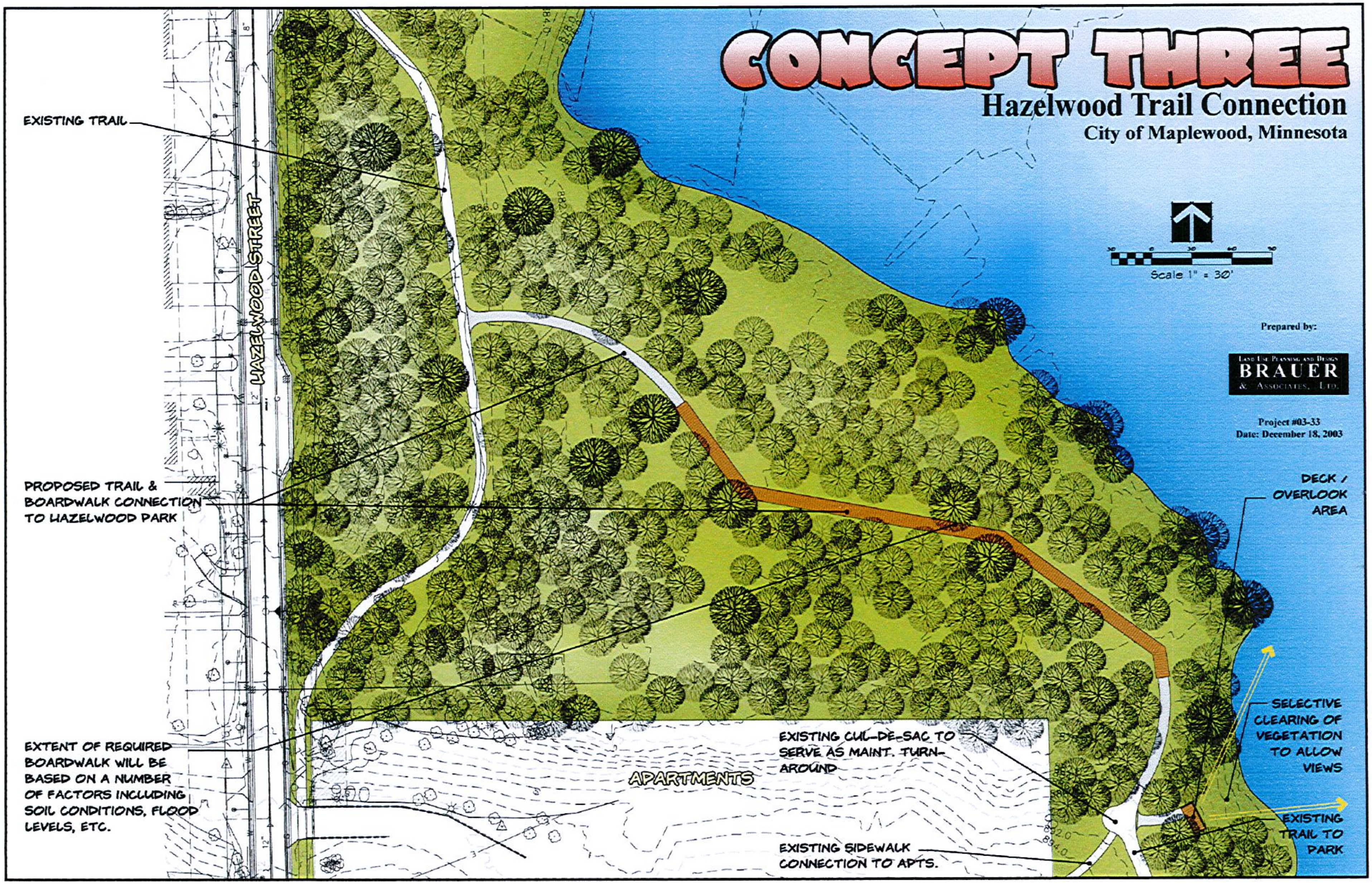
Appendix G. Hazelwood Park Trail Concepts


CONCEPT ONE
Hazelwood Trail Connection
City of Maplewood, Minnesota
EXISTING TRAIL
HAZELWOOD STREET
TRAIL & BOARDWALK CONNECTION TO FLOATING DOCK / OVERLOOK
Scale 1" = 30'
Prepared by:
BRAUER & ASSOCIATES, LTD.
Project #03-33
Date: December 18, 2003
PROPOSED TRAIL & BOARDWALK CONNECTION TO HAZELWOOD PARK
EXISTING CUL-DE-SAC TO SERVE AS MAINT. TURN-AROUND
EXTENT OF REQUIRED BOARDWALK WILL BE BASED ON A NUMBER OF FACTORS INCLUDING SOIL CONDITIONS, FLOOD LEVELS, ETC.
APARTMENTS
EXISTING TRAIL
EXISTING SIDEWALK CONNECTION TO APTS.


CONCEPT TWO
Hazelwood Trail Connection
City of Maplewood, Minnesota
EXTENT OF REQUIRED BOARDWALK WILL BE BASED ON A NUMBER OF FACTORS INCLUDING SOIL CONDITIONS, FLOOD LEVELS, ETC.
Scale 1" = 30'
FLOATING PIER / OVERLOOK
Prepared by:
BRAUER & Associates, Ltd.
Project #03-33
Date: December 18, 2003
PROPOSED TRAIL & BOARDWALK CONNECTION TO HAZELWOOD PARK
HAZELWOOD STREET
EXISTING TRAIL
APARTMENTS
EXISTING CUL-DE-SAC TO SERVE AS MAINT. TURN-AROUND
EXISTING TRAIL
EXISTING SIDEWALK CONNECTION TO APTS.



CONCEPT THREE
Hazelwood Trail Connection
City of Maplewood, Minnesota
Scale 1" = 30'
Prepared by:
Land Use Planning and Design
BRAUER
& Associates, Ltd.
Project #03-33
Date: December 18, 2003
EXISTING TRAIL
HAZELWOOD STREET
PROPOSED TRAIL & BOARDWALK CONNECTION TO HAZELWOOD PARK
EXTENT OF REQUIRED BOARDWALK WILL BE BASED ON A NUMBER OF FACTORS INCLUDING SOIL CONDITIONS, FLOOD LEVELS, ETC.
APARTMENTS
EXISTING CUL-DE-SAC TO SERVE AS MAINT. TURN-AROUND
EXISTING SIDEWALK CONNECTION TO APTS.
DECK / OVERLOOK AREA
SELECTIVE CLEARING OF VEGETATION TO ALLOW VIEWS
EXISTING TRAIL TO PARK

Appendix H. Minnesota Routine Wetland Assessment Method Results

The Minnesota Routine Assessment Method (MNRAM) for Evaluating Wetland Functions was developed as a way to regulate and protect wetlands based on wetland functions. The MNRAM assesses wetlands based on the answers to 72 questions to determine how well the functions and values are performed within each wetland. It is intended to provide detailed wetland resource data to watershed districts, municipalities within watershed districts, landowners, developers, and other parties to guide future development and redevelopment with the goal of protecting and managing wetland resources for overall public benefit

The MNRAM evaluates the following functions/value characteristics:

Ecological Wetland Functions

1. Vegetative Diversity/Integrity
2. Hydrologic Regime
3. Wetland Water Quality
4. Wildlife Habitat Structure
5. Fish Habitat
6. Amphibian Habitat

Wetland Values

7. Flood/Stormwater Attenuation
8. Downstream Water Quality Protection
9. Shoreline Protection
10. Aesthetics/Recreation/Education/Cultural
11. Commercial Uses
12. Ground Water Interaction

Additional Evaluation Information

1. Restoration Potential
2. Sensitivity to Stormwater & Urban Development

Numeric scores are computed for each wetland function/value based on established formulas in the methodology. Those numeric scores are then converted to quality ratings – exceptional, high, medium, and low – which are entered into the Wetland Management Classification System to determine the overall management class. The corresponding wetland management standards and guidelines govern future activities that would affect wetlands.

The MNRAM wetland management classification system was developed by the Board of Water and Soil Resources (BWSR) for standard wetland protection. The wetland management classification system determines the class into which each wetland will be placed based on the assessed wetland functions/values. The wetland management classification system includes four categories with the following general goals:

Preserve

Avoid and preserve wetland if at all possible. No change in wetland hydrology. No increase in nutrient load.

Manage 1

Minimize impacts to the wetland. Control change in wetland hydrology. Remove sediment and pretreat water entering the wetland.

Manage 2

Minimize impacts to the wetland. Control change in wetland hydrology. Remove sediment from water entering the wetland.

Manage 3

Consider for restoration or enhancement. Where necessary, allow use of wetland for flood storage and pretreatment of water entering other, higher quality wetlands.

The RWMWD adopted the BWSR calculations for wetland management classification, however, the naming convention was changed to Manage A (equivalent to Preserve), Manage B (equivalent to Manage 1), Manage C (equivalent to Manage 2), and Water Quality Pond (equivalent to Manage3).

A MNRAM was completed for the current conditions at Markham Pond and also for the proposed Markham Pond improvements. Summary scoring sheets are provided below. These assessments provide a way to compare existing conditions and proposed conditions for wetland functions and values as a result of the proposed improvements. The overall BWSR wetland management classification of Markham Pond would change from Manage 2 to Manage 1 with the proposed improvements. Comparison between the existing conditions and proposed improvements for each wetland function are as follows:

- Flood and stormwater attenuation ratings increase with proposed improvements (from a numeric rating of 0.43 to 0.54) due to an increase in storage capacity and sediment removal. However, both of these numeric ratings fall within the “Moderate” rating for this function.
- Downstream water quality numeric ratings increase from 0.42 to 0.55 due to the proposed sediment and nutrient reductions delivered to downstream waters. However, both of the numeric ratings fall within the “Moderate” rating for this function.

- Maintenance of Wetland Water Quality numeric ratings increase from 0.28 to 0.61 which translates to an increase from “Low” to “Moderate” rating for this wetland function. Improvements to vegetative diversity and integrity, stormwater detention, sediment delivery, and nutrient loading are the variables that increase this functional rating.
- Maintenance of Characteristic Wildlife Habitat Structure numeric ratings increase from 0.38 to 0.67 which results in an increase from “Moderate” to “High” category rating for this function. Improvement to vegetative diversity and integrity, upland area management, and wetland community interspersion are the variables that increase this functional rating.
- Maintenance of Characteristic Fish Habitat ratings increase from “Low” to “Moderate” due to an increase in fish habitat as well as sediment delivery improvements and nutrient load reductions.
- Maintenance of Characteristic Amphibian Habitat numeric ratings increase from 0.22 to 0.26 due to upland land use and stormwater runoff pretreatment and detention. However, both of the numeric ratings fall within the “Low” rating for this function.
- The Aesthetics/Recreation/Education/Cultural rating increases from “High” to “Exceptional” due to proposed increased opportunities for education and recreational activities.
- Wetland Sensitivity to Stormwater and Urban Development ratings increase from “Moderate” to “High” due to the improvements in vegetative integrity. High quality vegetation is more sensitive to stormwater and urban development.
- Additional Stormwater Treatment Needs ratings increase from “Low” to “Moderate” due to the increase in the Maintenance of Wetland Water Quality rating. A high quality wetland is less sustainable with inputs of stormwater.
- Vegetative Diversity and Integrity ratings increase from “Low” to “High” due to the proposed native seeding and buckthorn removal in the floodplain forest community, decrease in Curly-leaf pondweed in the shallow open water community, and the additional shallow marsh community which will likely develop in the western portion of the pond.

Management Classification Report for MarkhamPond_current **Markham Pond**

ID: 1

RAMSEY County
Watershed, #
Corps Bank Service Area

Based on the MnRAM data input from field and office review and using the classification settings as shown below, this wetland is classified as Manage 2

Functional rank of this wetland based on MnRAM data	Functional Category	Self-defined classification value settings for this management level
Low	Vegetative Diversity/Integrity	Moderate
Moderate	Habitat Structure (wildlife)	Moderate
Low	Amphibian Habitat	Low
Low	Fish Habitat	Moderate
Not Applicable	Shoreline Protection	Low
High	Aesthetic/Cultural/Rec/Ed and Habitat	Moderate / Low
Moderate	Stormwater/Urban Sensitivity and Vegetative Diversity	- / -
Low	Wetland Water Quality and Vegetative Diversity	- / -
Low	Characteristic Hydrology and Vegetative Diversity	- / -
Moderate	Flood/Stormwater Attenuation*	-
Not Applicable	Commericial use*	-
Moderate	Downstream Water Quality*	-

The critical function that caused this wetland to rank as **Manage 2** was
Vegetative Diversity

Details of the formula for this action are shown below:

Aesthetics/Recreation/Education/Cultural **(Q49+Q50+Q51+Q52+Q53+Q54+Q55+Q56)/8**

Question	*Value*	*Description*
49	1	Wetland visibility
50	1	Proximity to population
51	1	Public ownership
52	1	Public access
53	0.5	Human influence on wetland
54	0.1	Human influence on viewshed
55	0.5	Spatial buffer
56	1	Recreational activity potential

* The classification value settings for these functions are not adjustable

Management Classification Report for MarkhamPond_current **Markham Pond**

ID: 1

RAMSEY County
Watershed, #
Corps Bank Service Area

Maintenance of Characteristic Wildlife Habitat Str (Q3e*2+Q39+Q37+Q38+Q40+Q41+(Q23+Q24+Q25)/3+Q13+Q20)/10

Question	*Value*	*Description*
13	0.5	Outlet: hydrologic regime
20	0.5	Stormwater runoff
23	0.5	Buffer width
24	1	Adjacent area Management
25	0.5	Adjacent area diversity
37	0.1	Vegetation cover interspersion
38	0.1	Community interspersion
39	0.5	Detritus
3e	0.195	<No Description Found>
40	0.5	Wetland interspersion/landscape
41	0.5	Wildlife barriers

This report was printed on: Thursday, September 06, 2012

* The classification value settings for these functions are not adjustable

Wetland Functional Assessment Summary

Wetland Name	Hydrogeomorphology	Maintenance of Hydrologic Regime	Flood/ Stormwater/ Attenuation	Downstream Water Quality	Maintenance of Wetland Water Quality	Shoreline Protection
MarkhamPond_current	Depressional/Flow-through (apparent inlet and outlet), Depressional/Flow-through (apparent inlet and outlet)	0.30	0.43	0.42	0.28	0.00
		Low	Moderate	Moderate	Low	Not Applicable

Wetland Name	Maintenance of Characteristic Wildlife Habitat Structure	Maintenance of Characteristic Fish Habitat	Maintenance of Characteristic Amphibian Habitat	Aesthetics/ Recreation/ Education/ Cultural	Commercial Uses	Ground-Water Interaction	Additional Information: Wetland Restoration Potential	Additional Information: Wetland Sensitivity to Stormwater and Urban Development	Additional Information: Additional Stormwater Treatment Needs
MarkhamPond_current	0.38	0.32	0.22	0.76	0.00	Recharge	0.00	0.50	0.28
	Moderate	Low	Low	High	Not Applicable		Not Applicable	Moderate	Low

Wetland Community Summary

Wetland Name	Location	Community: Cowardin Classification	Community: Circular 39	Community: Plant Community	Vegetative Diversity/Integrity: Wetland Proportion	Individual Community Rating	Highest Wetland Rating	Average Wetland Rating	Weighted Average Wetland Rating
MarkhamPond_current	62-029-22-03-009	PUBG	Type 5	Shallow, Open Water Communities	70	0.1	0.50	0.30	0.19
							Moderate	Low	Low
		PFO1A	Type 1	Floodplain Forest	25	0.5	0.50	0.30	0.19
							Moderate	Low	Low
					95		0.50	0.30	0.19

☑ *Denotes incomplete calculation data.*

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Management Classification Report for MarkhamPond_proposed **Markham Pond**

ID: 2

RAMSEY County
Watershed, #
Corps Bank Service Area

Based on the MnRAM data input from field and office review and using the classification settings as shown below, this wetland is classified as Manage 1

Functional rank of this wetland based on MnRAM data	**Functional Category**	**Self-defined classification value settings for this management level**
High	Vegetative Diversity/Integrity	High
High	Habitat Structure (wildlife)	High
Low	Amphibian Habitat	Moderate
Moderate	Fish Habitat	High
Not Applicable	Shoreline Protection	Moderate
Exceptional	Aesthetic/Cultural/Rec/Ed and Habitat	High / Moderate
High	Stormwater/Urban Sensitivity and Vegetative Diversity	High / Moderate
Moderate	Wetland Water Quality and Vegetative Diversity	High / Moderate
Low	Characteristic Hydrology and Vegetative Diversity	High / Moderate
Moderate	Flood/Stormwater Attenuation*	-
Not Applicable	Commericial use*	High
Moderate	Downstream Water Quality*	-

The critical function that caused this wetland to rank as **Manage 1** was
Vegetative Diversity

Details of the formula for this action are shown below:

Aesthetics/Recreation/Education/Cultural **Exceptional for unique or rare opportunity**

Question	*Value*	*Description*
48	1	Unique/rare educ./cultural/rec.opportunity

Maintenance of Characteristic Wildlife Habitat Str **(Q3e*2+Q39+Q37+Q38+Q40+Q41+(Q23+Q24+Q25)/3+Q13+Q20)/10**

Question	*Value*	*Description*
13	0.5	Outlet: hydrologic regime
20	0.5	Stormwater runoff
23	0.5	Buffer width
24	1	Adjacent area Management
25	1	Adjacent area diversity

* The classification value settings for these functions are not adjustable

Management Classification Report for MarkhamPond_proposed **Markham Pond**

ID: 2

RAMSEY County
Watershed, #
Corps Bank Service Area

37	1	Vegetation cover interspersion
38	0.5	Community interspersion
39	0.5	Detritus
3e	0.95	<No Description Found>
40	0.5	Wetland interspersion/landscape
41	0.5	Wildlife barriers

This report was printed on: Thursday, September 06, 2012

* The classification value settings for these functions are not adjustable

Wetland Functional Assessment Summary

Wetland Name	Hydrogeomorphology	Maintenance of Hydrologic Regime	Flood/ Stormwater/ Attenuation	Downstream Water Quality	Maintenance of Wetland Water Quality	Shoreline Protection
MarkhamPond_proposed	Depressional/Flow-through (apparent inlet and outlet), Depressional/Flow-through (apparent inlet and outlet)	0.30	0.54	0.55	0.61	0.00
		Low	Moderate	Moderate	Moderate	Not Applicable

							Additional Information		
Wetland Name	Maintenance of Characteristic Wildlife Habitat Structure	Maintenance of Characteristic Fish Habitat	Maintenance of Characteristic Amphibian Habitat	Aesthetics/ Recreation/ Education/ Cultural	Commercial Uses	Ground-Water Interaction	Wetland Restoration Potential	Wetland Sensitivity to Stormwater and Urban Development	Additional Stormwater Treatment Needs
MarkhamPond_propose	0.67	0.58	0.26	2.00	0.00	Recharge	0.00	1.00	0.61
	High	Moderate	Low	Exceptional	Not Applicable		Not Applicable	High	Moderate

Wetland Community Summary

		Vegetative Diversity/Integrity							
		Community							
Wetland Name	Location	Cowardin Classification	Circular 39	Plant Community	Wetland Proportion	Individual Community Rating	Highest Wetland Rating	Average Wetland Rating	Weighted Average Wetland Rating
MarkhamPond_proposed	62-029-22-03-009	PUBG	Type 5	Shallow, Open Water Communities	60	1	1.00	1.00	0.95
							High	High	High
		PFO1A	Type 1	Floodplain Forest	25	1	1.00	1.00	0.95
							High	High	High
		PEMC	Type 3	Shallow Marsh	10	1	1.00	1.00	0.95
							High	High	High
					95		1.00	1.00	0.95

☑ *Denotes incomplete calculation data.*

Thursday, September 06, 2012 Page 1 of 1

Appendix I. Stakeholder Meeting Minutes

resourceful. naturally.
engineering and environmental consultants

Memorandum

To: Meeting Attendees

From: Tim P. Brown

Subject: September 26, 2011 Meeting Minutes

Project: Markham Pond Restoration Project

Date: October 6, 2011

On September 26, 2011 a meeting of stakeholders was held at the Maplewood Community Center to discuss opportunities for collaboration and cooperation toward rehabilitating Markham Pond and the surrounding green space considering regional linkages and opportunities.

Agenda Item 1: Introductions. Attendees introduced themselves and noted the organization they represent. A list of attendees is presented at the end of these minutes.

Agenda Item 2: Introduction and Background. Brad Lindaman (Barr Engineering) presented the context and background for the project. He described the TMDL Implementation Plan for Kohlman Lake and how Markham Pond plays an important role in that. He described a goal of developing a holistic approach to improving the water quality treatment capacity, the habitat and fishery, along with the regional recreation and educational opportunities that exist. He asked the group for suggestions of additional stakeholders to invite to future meetings, to make sure we have the right people at the table for this effort. Brad invited attendees to think about and bring forward ideas and suggestions during this meeting, or after, regarding concepts or projects that could build toward these goals.

Cliff Aichinger (Ramsey Washington Metro Watershed District, RWMWD) stated the importance of collaboration to realize the full potential of a holistic plan. He explained that it will take all of those here to be a part of either helping shape the idea, giving approvals, permits, or land. Some tremendous opportunities to have a multifaceted project that has a lot of benefits for different people is envisioned and we want to proceed in the context of more than just strictly water quality improvement.

Tim Brown (Barr Engineering) presented background relating to projects being scoped toward water quality and habitat improvement for Markham Pond. Projects described included:

- Potential dredging of the Markham Pond to improve treatment capacity and fishery habitat.

- Providing flow Diversion (reducing flow velocity through the pond).

- Building an in pond periphyton (calcareous bed) treatment system.

Peter Sorenson (University of Minnesota) described the fisheries study he is leading focusing on carp populations in the Kohlman Lake system. Carp are a big problem in the lakes uprooting plants. Markham Pond and Casey Lake are the primary nursery areas for carp in the upper Kohlman Lake basin. He has counted 34,000 young of the year carp in Markham Pond (2010) with a total pond biomass of 200kg/ha of carp. Carp are likely flushed downstream from these waters during high flows. Controlling carp in these areas would benefit water quality. He described a bubble barrier system that his research team would like to try at Markham Pond.

Cliff Aichinger (Ramsey Washington Metro Watershed District, RWMWD) reinforced the concern and evidence that carp are a key aspect of the water quality problems in Kohlman Lake. He explained the role bluegills may play in controlling carp.

Brad Lindaman (Barr Engineering) outlined the master planning level of this process and the timing of possible implementation.

Cliff Aichinger (Ramsey Washington Metro Watershed District, RWMWD) discussed the grant opportunities and timing that he sees potentially available for this group of project ideas. Grants might include Clean Water Fund grants and MPCA TMDL Implementation Grants.

<u>Agenda Item 3 and 4: Goals and Opportunities Feedback</u>. Discussion of stakeholder ideas was invited and preceded around the table.

Project opportunities cited by the group included:

- Wildlife corridor from Casey Lake through Markham to Kohlman Lake (City of Maplewood).
- Education opportunities (City of Maplewood).
- Amphitheatre (City of Maplewood).
- Hazelwood Park improvements (City of Maplewood).
- Trail around Markham Pond (City of Maplewood).
- Greenway and canoe passage from Casey Lake to Markham (City of Maplewood). This is part of the City’s Comprehensive Plan for future implementation.
- Extending trails west from Markham Pond (City of Maplewood).

- Neighborhood fishing program for Markham Pond (Minnesota Department of Natural Resources, DNR).
- Fishing access improvements (Minnesota Department of Natural Resources, DNR).
- Regional Park connections to the south (Ramsey County Parks).
- Creating a high quality fishery (Ramsey County Parks).
- Installing aeration and pan fish stocking (University of Minnesota).
- Trail connection to Maplewood Mall (RWMWD).
- Restoration of buffer areas (City of Maplewood).

The group then discussed ideas for funding projects within the plan. Some ideas discussed included:

- Bringing in regionally significant aspects of projects to attract regional level funds.
- The City of Maplewood could provide in-kind matching for funds.
- Legacy funds for trails or canoe routes, especially regional.
- DNR Shoreland Restoration Grants.
- Metropolitan Council Grants.
- MPCA Clean Water Grants.
- LCCMR Grants, especially for sustainable natural systems projects.
- And of course RWMWD grants.

The DNR briefly discussed permit considerations for potential dredging and diversion/pier installation. It would be beneficial to find coincident benefits for both projects and navigation function should be maintained if a pier is installed. An Environmental Assessment Worksheet would likely be required for the dredging as proposed.

The City of Maplewood suggested adding the Lakelands Trail along County Road D and a city owned parcel that is green space to project maps.

The City expressed a need for fill and cover for the "Gladstone Savanna" project northeast of Beaver Lake that might be generated with a dredging project. This use would lower the costs of both projects.

Peter Sorenson (University of Minnesota) discussed carp barriers and removal and how that might work in this setting. He suggested removal and possible Rotenone (piscicide) treatment due to a lack of quality game fish and that it might be most effective to undertake that upon completion of other project tasks. Maintenance of carp depletion may be needed over time.

The City of Maplewood suggested that a representative from North St. Paul be invited to future meetings. It was also suggested that contact be made with the businesses adjacent to Markham Pond including the Church, the Senior Housing and the medical offices on the north and west sides of the Pond.

Peter Sorenson (University of Minnesota) suggested bringing in the managers of Willow Lake to the discussions.

The group also suggested adding John Moriarty of Ramsey County Parks, and a Metropolitan Council representative to the stakeholder group.

Agenda Item 5: Next Steps.

Brad Lindaman (Barr Engineering) suggested a second meeting for November. Stakeholders could return with additional input and more information.

Meeting was then adjourned.

LIST OF ATTENDEES

NAME	ORGANIZATION	CONTACT
Jim Taylor	City of Maplewood	651-249-2121
Michael Thompson	City of Maplewood	651-249-2403
Bill Bartodziej	RWMWD	612-730-1542
Molly Shodeen	DNR Eco-waters	651-259-5802
Jim Levitt	DNR Fisheries	651-259-5819
Jerry Johnson	DNR Fisheries	651-259-5770
DuWayne Konewko	City of Maplewood	651-249-2330
Ginny Gaynor	City of Maplewood	651-249-2416
Ron Koth	Barr Engineering	952-832-2815
Pete Sorensen	University of Minnesota	612-624-4997
Tim Brown	Barr Engineering	952-832-2901
Cliff Aichinger	RWMWD	651-792-7957
Scott Yonke	Ramsey County Parks	651-748-2500
Brad Lindaman	Barr Engineering	952-832-2808
Tina Carstens	RWMWD	651-792-7960
Shann Finwall	City of Maplewood	651-249-2304

Memorandum

To: Meeting Attendees

From: Tim P. Brown & Dan Petrik

Subject: February 13, 2012 Meeting Minutes

Project: Markham Pond Restoration Project

Date: February 24, 2012

On February 13, 2012 a second stakeholder meeting was held at the Maplewood Community Center to discuss project opportunities for rehabilitating and improving Markham Pond and the surrounding area, and planning the next steps for developing a plan of action.

Introductions Attendees introduced themselves and the organizations they represent. A list of attendees is included at the end of these minutes.

Project Background Tim Brown (Barr Engineering) presented the context and background for the project. He described a project goal of creating a master plan that integrates the rehabilitation of Markham Pond and flowages with improvements to Hazelwood Park. A holistic planning process is also desired that would include diverse stakeholders and address habitat, water quality and recreation improvement goals. An illustrative master plan would describe a vision for the pond and park and detail the individual projects needed to achieve the vision. The master plan would provide guidance for improvements, identify project costs, create a shared sense of excitement, and provide the basis for seeking grants to implement projects.

Tim provided a quick review of the major water quality and habitat improvement activities being considered for Markham Pond:

- Dredging to improve water quality treatment capacity and fishery habitat.
- Providing flow diversion to reduce flow velocity through the pond thus increasing settlement and removal of sediments from the outflow.
- Building an in pond periphyton (calcareous bed) phosphorus removal treatment system.
- Fisheries improvements.
- Restoring shoreline habitat.

Steve Kummer (City of Maplewood) inquired about whether any benchmark monitoring has been completed of upstream flows to Markham Pond to understand the amount of phosphorus reduction needed to achieve water quality goals for the pond. Cliff Aichinger (Ramsey Washington Metro Watershed District, RWMWD) stated that the Kohlmann TMDL looked at a variety of upstream factors and included sampling throughout the Kohlman Lake system. Even with recent improvements (e.g. Maplewood Mall), the system still needs significant reductions. Dissolved Phosphorus is a major issue in Markham Pond and thus the periphyton system, and other improvements, are still needed.

In regard to the dredging project Molly Shodeen (DNR) indicated that securing Public Waters permits is facilitated when habitat improvement is the primary goal. Cliff indicated that improving habitat and water quality are highly related in this environment. He would like to see the project constructed around habitat improvements. He stated that the District is interested in a broad based or holistic solution to water quality problems in Markham Pond and desires a collaborative effort that addresses the needs of community stakeholders.

Peter Sorenson (University of Minnesota) described the fisheries study he is leading focusing on carp populations in the Kohlman Lake system. Carp are a big problem in the lakes uprooting plants and disturbing sediment, which re-suspends phosphorus. This activity decreases habitat for game fish. He also described Markham Pond and Casey Lake as the primary nursery areas for carp in the upper Kohlman Lake basin. Carp eggs are susceptible to game fish predation and there are no young carp in the larger lakes where there are stable populations of game fish. With no game fish in Markham Pond and Casey Lake, these water bodies are ideal nurseries for young carp. Carp are likely flushed downstream from these waters during high flows. Controlling carp in Markham Pond will be an important part of reducing phosphorus and improving water quality downstream in Kohlman Lake.

Discussion and Critique of Ideas

Discussion turned to a review of ideas raised at the last meeting including an initial assessment of the ideas.

Maplewood City staff discussed the project from a broad level of departmental perspectives. Staff noted that there are no current projects planned in or around the pond. The most recent work included repairs to the retaining wall on the north side of the pond. The City has a flowage easement around the north part of the pond.

Discussion identified a wide range of project ideas and related issues:

- Irrigation of the soccer fields through the reuse of stormwater runoff. This would align well with the City's sustainable turf management initiative, which includes soil decompaction.
- Using material dredged from the pond for fill – possibly in the area of soccer field #2 which could be converted into an amphitheater. Part of the field is in the 100-year flood plain. Filling

would require an analysis to identify the impact on other properties. Cliff did not think this would be an issue.

- The City is open to repurposing Hazelwood Park to include the amphitheater element. The City doesn't currently have any funding in the CIP for the park, but this could change with a solid master plan.
- The City has four natural area greenways. The section from Casey Lake to Markham pond is not feasible for canoe passage.
- Participants were not aware of any neighborhood issues that could affect development of a master plan. However, the City would work to include neighborhood interests through a public process involving the Parks Commission. This process would also likely engage the Environmental and Natural Resources Commission and would include two to three public hearings. The City is willing to drive this process and contribute staff resources for managing it.
- Peggy Arne from the Walker Methodist facility identified specific needs requested by residents of the Walker Methodist Hazel Ridge senior facility. These include:
  - Walking paths to connect to other paths in the park.
  - Access to the water's edge.
  - Fishing access via a dock or some other facility.
- City staff indicated that it doesn't get many citizen requests for park improvements other than complaints over soccer field conditions and water access.
- Nathan Greenwalt from the First Evangelical Free Church commented on issues related to park improvements:
  - The church's existing parking lot is in good shape.
  - The church needs more capacity than the lot provides. However, the City has made the parking lot on the south edge of Hazelwood Park available for church event parking.
  - The church likes the amphitheater idea; it could be used for church events.

In response to these issues Molly Shodeen (DNR) said she will check on the pond's history and to see whether soccer field #2 was ever part of a wetland. Jim Levitt (DNR) stated that with the above proposed improvements, the pond may qualify for the Fishing in Neighborhood (FIN) program. This could include DNR support for providing fishing access and stocking the pond with bluegills. Fishing piers are a cost share item in the FIN program. Aeration might also be an option.

John Moriarty (Ramsey County Parks) stated that Hazelwood Park is not part of a regional park system and is very unlikely to ever be part of the regional park system. The County is interested in partnering on some activities such as installing fish barriers.

Next Steps

Before adjourning, Tim sought feedback on what the next steps should be and what role each organization wanted to play.

- The City reiterated that the City's Park Commission will be a good sounding board on the planning effort after there is a draft master plan to react to. The City's normal process would include two to three meetings with the Commission. Typically, at the first meeting, the Commission will listen and suggest ideas. The second meeting would include presenting the draft master plan and getting feedback from the Commission. The third meeting would include presenting a final master plan and gathering any final feedback.
- In developing the master plan, the City will take the lead on park and trail issues as well as on managing the public process.
- It was identified that the planning process must include an opportunity to collaborate on fish and ecological issues to address improvements for shoreland, trails, pond access and fishing facilities.
- Key environmental review and permitting would be needed for dredging and for wetland impacts under WCA.
- The RWMWD agreed to begin drafting a master plan with a preliminary draft for discussion at the next meeting in April.

The meeting was then adjourned.

LIST OF ATTENDEES

NAME	ORGANIZATION	CONTACT
Jim Taylor	City of Maplewood	651-249-2121
Steve Kummer	City of Maplewood	651-249-2418
Bill Bartodziej	RWMWD	612-730-1542
Molly Shodeen	DNR Eco-waters	651-259-5802
Jim Levitt	DNR Fisheries	651-259-5819
Jerry Johnson	DNR Fisheries	651-259-5770
DuWayne Konewko	City of Maplewood	651-249-2330
Ginny Gaynor	City of Maplewood	651-249-2416
Dan Petrik	Barr Engineering	952-832-2846
Peter Sorensen	University of Minnesota	612-624-4997
Tim Brown	Barr Engineering	952-832-2901
Cliff Aichinger	RWMWD	651-792-7957
John Moriarty	Ramsey County Parks	651-748-2500
Peggy Arne	Walker Methodist Hazel Ridge	651-779-9779
Tina Carstens	RWMWD	651-792-7960
Shann Finwall	City of Maplewood	651-249-2304
Justine Koch	University of Minnesota	651-587-3496
Nathan Greenwalt	First Evangelical Free Church	651-777-5180
Dana Larsen-Ramsey	H.B. Fuller	651-236-5535
Keith Stachowski	City of North St. Paul	651-747-2431

Table 1. A Summary of Markham Pond Ecological Restoration Projects

Project Opportunities	Cost Range ($1,000's)	Phosphorus Reduction	Other Benefits	Lead Agency*
Dredging: Removal of sediments from the pond bottom at strategic locations to enhance particulate settling	290-320	81 lb/yr	Fishery	RWMWD
Flow diverter: Installation of a flow diverter that also serves as fishing pier	160-360	156 lb/yr	Access	RWMWD
Periphyton System: Installation of a calcareous based treatment cell	920	162 lb/yr	Education	RWMWD
Long Term Carp Control and possible removals	5-260	Yes	Fishery	RWMWD
Shoreline Habitat Restoration	250	Yes	Habitat & Aesthetics	RWMWD
Macrophyte Control and Management		Yes	Habitat	RWMWD
Monitoring toward adaptive management.			Water Quality & Education	RWMWD
Fishery Stocking and diversity improvements, neighborhood fishing program.		Yes	Fishery	MDNR
Shore Fishing Enhancements:			Recreation & Education	City
Trail system integration: extend trails west, connection to Vento trail and Casey Lake, Maplewood Mall			Recreation & Education	City
Outdoor classroom area establishment: Demonstrations and hands-on learning.			Recreation & Education	City
Interpretive signage			Recreation & Education	City
Green Corridors Establishment or drainage spines.		Yes	Habitat & Aesthetics	City
Reduction in impervious area: maintain or increase parking capacity and explore shared parking, and alternative parking surfaces.		Yes	Education	City
Bring public art to improvements made.			Aesthetics	City
Amphitheatre			Recreation & Entertainment	City
General Park Improvements (including trail around Markham)			Recreation, Habitat & Aesthetics	City

*City of Maplewood (City)
*Department of Natural Resources (MDNR)
*Ramsey-Washington Metro Watershed District (RWMWD)

Memorandum

To: Project File

From: Greg Fransen

Subject: April 23, 2012 Meeting Minutes

Project: Markham Pond Restoration Project

Date: August 13, 2013

On April 23, 2012 a third stakeholder meeting was held at the Maplewood Community Center to discuss comments and next steps for the draft plan for rehabilitating and improving Markham Pond and the surrounding area.

The format of the meeting was an open discussion of the most-recent version of the draft plan. An attendance list is not available and formal notes were not recorded at the meeting. Comments from the meeting were incorporated into the draft plan.

Markham Pond/Hazelwood Park
Stakeholder Meeting Agenda

Monday, April 23, 10:00-11:30 am

Maplewood Community Center, 2100 White Bear Ave, Maplewood

1. Introductions

2. Background
    - Context
    - Last meeting

3. DRAFT Master Plan
    - What we have so far
    - Comments on DRAFT document

4. Information needed
    - Recreational facilities
    - Fish stocking
    - Aesthetics and art
    - Other

5. Recommendations and Next Steps
    - Information development
    - Next Meeting
    - Maplewood Parks public process

Memorandum

To: Meeting Attendees

From: Tim P. Brown

Subject: October 24, 2012 Meeting Summary

Project: Markham Pond Restoration Plan

Date: November 29, 2012

On October 24, 2012 a fourth stakeholder meeting was held at the Maplewood Public Works Building to discuss the Draft Markham Pond Ecological Restoration Plan, and the next steps for finalizing the plan. A list of attendees is included at the end of these minutes.

Background

Tim Brown (Barr Engineering) presented the context and background for the Plan and the stakeholder process to this point. He described a project goal of creating a master plan that integrates the rehabilitation of Markham Pond and flowages with improvements to Hazelwood Park. The Plan describes a vision for the pond and park and describes the individual projects needed to achieve the vision. The Plan provides guidance for improvements, identifying project costs, and provides the basis for seeking grants to implement projects.

Tim provided a quick review of the major water quality and habitat improvement activities being proposed in the Plan:

- Water Quality improvements: dredging, flow diversion, and periphyton phosphorus assimilation; to improve contaminant assimilation capacity and improve habitat.
- Fisheries improvements: carp control and access improvements.
- Habitat improvements: shoreline restoration, macrophyte plantings.
- Recreational improvement: trail, water access, amphitheater, and other park improvements.
- Community Outreach improvements: outdoor classroom, interpretive signage, and public art.

The Plan also includes recommendations for monitoring and evaluating performance of measures taken.

Discussion of the Draft Plan

The City of Maplewood (the City) staff added some history of Markham Pond for inclusion in the Plan. Markham Pond was a gravel pit previous to 1972. The City constructed Markham Pond as a stormwater management basin around that time. The City acquired land adjacent Markham Pond in 1976.

The City also initiated a discussion of fishing in Markham Pond. Safety issues stemming from water quality were citied. Other parties also expressed concern, but it was noted that fishing already occurs and people will likely continue to do so. The group consensus was to leave access components in the Plan but to avoid promoting fishing or labeling access as specifically for fishing.

The City sees Markham Pond as a stormwater pond as opposed to an indigenous water body. They would prefer to manage Markham Pond as such. Discussion was held regarding the State of Minnesota's designation of Markham Pond as a Public Water. This designation makes internal work on the Pond much more difficult and is key to way the pond is viewed by regulators. Markham Pond may have been designated in error if the pond was built as a stormwater pond. The City and staff from the Ramsey-Washington Metro Watershed District (RWMWD) will meet directly, exclusive of the Markham project team, to determine whether to seek to re-classify Markham as not within the Public Waters category.

The Minnesota Pollution Control Agency (MPCA) staff present discussed implications for the plan tasks with regard to the applicable NPDES permit and TMDL implementation. Also discussed were the appropriateness of the Public Waters designation for Markham pond and regulatory designated use. Because of the Public Waters classification the MPCA sees the issue in the context of designated uses for public waters, some of which they feel may be counter to some of the Plan tasks.

MPCA staff also expressed concern about fishing in Markham Pond.

Dr. Peter Sorenson with the University of Minnesota stated that Markham Pond, as well as Kohlman Basin, are fisheries in a biological sense. Markham does winter kill periodically so the quality of the fishery is not high. Management of the fishery in Markham will need to evolve over the next few years based on results of the current sturdy and work upstream in Casey Lake. Dr. Sorenson also suggested that stocking would probably be necessary in Markham Pond to maintain a recreational fishery.

The RWMWD staff stated strong support for the public outreach components of the plan and discussed the workings and value of these tasks. RWMWD staff will work with City staff to decide whether the public waters designation is appropriate for Markham Pond.

RWMWD staff also felt that people will continue to fish and consideration should be given to that activity. The group discussed monitoring of fish toxicity assuming that people will continue to fish at Markham Pond. This would help to determine if eating fish from Markham is harmful.

Dana Larson-Ramsay with HB Fuller stated support for fishing access and for locations for people to gather.

Minnesota Department of Natural Resources staff discussed the process for changing the designation of a water body. It was also noted that under the current designation a Public Waters permit would be needed for tasks in the Plan. Further an EAW would be needed for in-lake impacts larger than 1 acre. Removal of stormwater deposited material (maintenance) is much easier to get permission for.

The US Army Corps of Engineers (USACOE) staff discussed federal permit requirements, including that impacts over 3 acres would require an individual permit from the USACOE, and that actions requiring a permit include: dredging, shoreline restoration, and installing a diversion structure. Regardless of the water body classification Permits for some of the Markham Pond Plan tasks will likely require a USACOE permit.

Next Steps

Next steps were discussed and it was agreed that the City and the RWMWD will meet outside the group to determine whether changing the Public Waters designation should be sought. Subsequent to that meeting, the Plan will be updated based on the meeting results and discussion here, and then a final stakeholder team meeting will be held.

Plan revisions coming from this discussion included:

1. Add history of the pond presented by the City.
2. Remove “Master Plan” from title.
3. Leave access components in the Plan but avoid promoting fishing or labeling access as specifically for fishing.
4. Quantify flow diverted by implementation of diverter flow structure.
5. Complete cost estimates on the implementation table.
6. Address Public Waters designation implications if needed.

The meeting was then adjourned.

Sign-in please *Markham Pond Team Meeting 10-24-12*

Name	Organization	Email	Phone
TIM BROWN	BARR	TBROWN@BARR.COM	952-832-2901
Tina Carstens	RWMWD	tina@rwmwd.org	651-792-7960
BRAD LINDAMAN	BARR	blindaman@barr.com	952-832-2808
Molly Shodeen	MnDNR	molly.shodeen@state.mn.us	651-259-5802
Andy Beaudet	USACE	Andrew.D.Beaudet@usace.army.mil	651-290-5642
Brian Livingston	MPCA	brian.livingston@state.mn.us	651-757-2532
Marni Karnowski	MPCA	marni.karnowski@state.mn.us	6517572495

Sign-in please *Markham Pond Team Meeting 10-24-12*

Name	Organization	Email	Phone
Ginny Gaynor	City of Maplewood	virginia.gaynor@ci.maplewood.mn.us	651-249-2416
WILLIAM BARTODZIEJ	RWMWD	BILL@RWMWD.ORG	612.730.1642
Peter Sorensen	U of MN	soren003@umn.edu	612 624-4997
Michael Thompson	City of Maplewood	michael.thompson@ci.maplewood.mn.us	651-249-2403
Steve Love	City of Maplewood	Steve.Love@ci.maplewood.mn.us	651-249-2404