Penn Lake Management Framework

Mission

The Lake known as Penn is located among the traditional, ancestral, and contemporary lands of tribal nations: the Dakota, Iowa, Ho-Chunk, Anishinaabe, and other tribal groups. This land continues to hold great historical, spiritual, and personal significance for the members of these tribes and will continue to do so for many generations to come. Since its foundation in 1843, the City of Bloomington has been the primary caretaker of Penn. The City of Bloomington affirms that Penn Lake is a member, a relative, and a resource of the land community of which we are all a part. The City's management will strive to be done with respect for the Lake and the past, present, and future communities sharing the land with it.

The mission of the Penn Lake Management Framework is to guide the restoration, rehabilitation, and reinforcement of the ecosystem structure of Penn Lake and its watershed into a desirable stable state, informed by regional reference systems, novel characteristics of urbanized waters, and desirable ecosystem services defined by community stakeholders.

Figure 1. Geese and a Great Blue Heron at Penn Lake in 2022. Photo credit: Stantec Inc.

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Penn Lake Management Framework

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Penn Lake Management Framework

Written by:
Jack Distel
Water Resources Specialist
City of Bloomington
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List of Acronyms

CEM – Conceptual Ecological Model

ERM – Ecological Results Map

FEMA –- Federal Emergency Management Agency

LGU – Local Governmental Unit

MDNR – Minnesota Department of Natural Resources

MNDOT – Minnesota Department of Transportation

MPCA – Minnesota Pollution Control Agency

MS4 – Municipal Separate Storm Sewer System

NGO – Non-Governmental Organization

NMCWD – Nine Mile Creek Watershed District

NPDES – National Pollutant Discharge Elimination System

TMDL – Total Maximum Daily Load

WCA – Wetland Conservation Act

µg/L – Micrograms per liter

Executive Summary

The City of Bloomington aims to work towards making Penn Lake healthier. The Penn Lake Management Framework will assist by setting clear goals and providing a process for adapting and improving management over time. The goals of the City's management of Penn Lake are:

1. **High-value Ecosystem Services**: This means understanding the benefits people get from the lake, like recreation and wildlife watching. People's perception, combined with scientific data, helps measure these benefits.
2. **Self-sustaining Species Diversity**: This focuses on the variety of plants and animals in and around the lake. The goal is to get these species healthy enough to thrive naturally without too much interference.
3. **Good Water Quality**: Penn Lake's water quality has a long history of too many nutrients. The Framework will work to reduce these nutrients, especially phosphorus, to healthier levels. Additionally, the Framework will address other pollutants, like de-icing salts.
4. **Resilient System Hydrology**: This means improving how water flows through Penn Lake and its watershed to prevent floods, keep water clean, and support the ecosystem.

The Penn Lake Management Framework is a procedure that helps to identify a list of management projects or initiatives over a five-year period. That list and some additional summary information will be written into a document called the Management Pathway. The Framwork's procedure is simple. It is based on four main criteria:

1. **Community inclusion** – Community input will be used to understand perceptions of management and to set community priorities for management.
2. **Infrastructure** – Bloomington has a lot of infrastructure that affects Penn Lake. Planning will help inform infrastructure construction, repair, retrofit, and improved maintenance.
3. **Regulations** – This will account for any regulations that affect management decisions. It will also help coordinate with partner agencies, like Nine Mile Creek Watershed District.
4. **Monitoring** – To manage Penn Lake successfully, it is important to understand what is going on with the lake and how it is changing. For example, to improve fishing in the lake you first need to know what kind of fish there are to start with.

Each of these four categories will provide the information needed to identify management priorities. There is no single thing that can be done to create a healthy Penn Lake. To ensure management is being completed in a strategic and efficient manner, the Framework utilizes a simplified process of ecological modeling. These models will be used by City staff to help navigate management.

Many actions and projects are going to be needed. The Management Framework is designed to allow the City of Bloomington to adapt management strategies to maximize impact in the pursuit of reaching a healthy Penn Lake. It is also designed to put an emphasis on community participation. The following document provides a detailed description of how this process is to be carried out.

Introduction

Penn Lake is a shallow-water lake in Bloomington, Minnesota (figure 2). It is comprised of two main lobes: Upper Penn and Lower Penn. These are separated by a water control structure that directs water under 86th Street West. That structure also establishes the normal water surface elevation for Upper Penn Lake. The majority of Penn's 1,245-acre watershed is within Bloomington. However, the northern tip of the watershed extends into the City of Richfield (figure 4).

In 2018, the Minnesota Pollution Control Agency (MPCA) listed Penn Lake as an impaired water body due to high nutrient pollution. The MPCA's 2020 Total Maximum Daily Load (TMDL) study set a 40% phosphorus load reduction requirement for the City of Bloomington. The Minnesota Department of Transportation (MNDOT) and the City of Richfield were assigned their own reduction requirements. While only officially listed as impaired in 2018, there has been a long history of poor lake conditions observed at Penn Lake. As noted in the 1976 Penn Lake Management initiative, "Penn Lake … [has] low water transparency and relatively high concentrations of algae."

The path to improving the health of Penn Lake is long. Management will need to be flexible and efficient. To accomplish this, the City of Bloomington has created this document, the Penn Lake Management Framework (Framework). Its purpose is to create a standardized procedure for collecting information that will be used to come up with a short-term strategy for management. To ensure the strategy remains adaptive, this process will occur every five years. Figure 2 shows the simplified process of adaptive management. The Framework's procedure is shown in figure 5.

The Framework is mainly a tool for City staff. The strategies for management will be written into a document called the Management Pathway. That document will be more similar to a classic management plan and is likely to be of more interest to the community at large. City staff should follow the procedure of the Framework (figure 5) and reference the rest of this document for more details as they work to create management pathways or other management decisions.

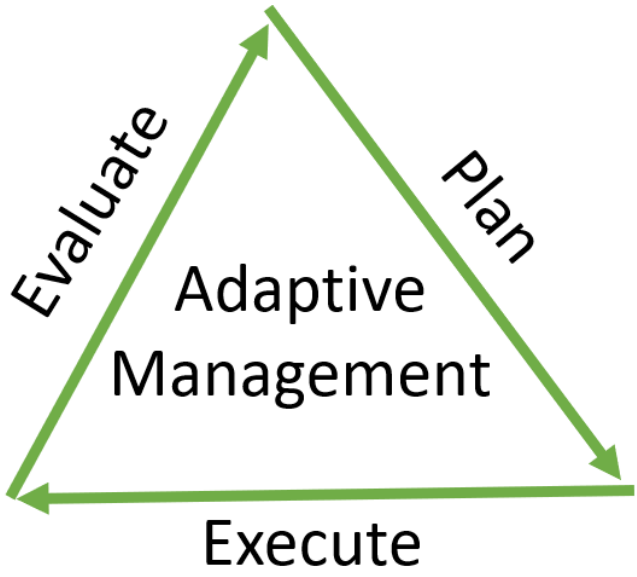

Figure 2. The steps of adaptive management. Adaptive management is a repetitive process that aims to continually adjust management strategies to the changing conditions of the real world. The Penn Lake Management Framework is designed around the principles of adaptive management.

While the Framework is mainly a procedural document, the point of management is to improve and sustain Penn Lake's health. Therefore, the Framework also defines management's goals of what a healthy Penn Lake is. Health will be defined through four categories: high-value ecosystem services, self-sustaining species diversity, good water quality, and resilient system hydrology. These are described in further detail below.

I. **High-value ecosystems services** –

Ecosystem services are the goods, functions, and processes that humans receive from the ecosystems around us (*Matlock & Morgan, 2011). Ecosystem services will be defined primarily by community perception, which is a subjective interpretation. However, perception paired with the objective data from the other categories will create a full measure of ecosystem service's value. For example, birding as a recreational activity can be subjectively defined by the community's perception of it – do they find birding accessible and/or rewarding? Is the local bird species diversity acceptable? Then these perceptions can be compared to bird surveys or other objective data points that come out of the central goal of self-sustaining species diversity.

II. **Self-sustaining species diversity** –

Species diversity is defined as the number of individual species that utilize the lake throughout their life cycle, like fish, or as part of their life cycle, like migratory birds. Self-sustaining signifies a species average annual population, in terms of the number of individuals of the same species, that persists year after year without the need for direct and specific management intervention. With that said, there will often be management overlap that influences the prevalence of a certain species, like carp harvests to prevent turbid lake conditions. While this impacts game fish populations, it is not as direct as something like stocking the actual game fish.

Specific management initiatives should define the measurement and monitoring of specific species or biotic functional groups (e.g., game fish or submerged aquatic vegetation).

III. **Good water quality** –

Eutrophication (e.g. lots of nutrients) is a top issue for Penn Lake. Management of eutrophication will focus on phosphorus reductions and will be managed by regulating external and internal nutrient loading. Good water quality is defined by internal concentrations of phosphorus that approach and are maintained at or lower than 60 µg/L, the regional shallow lake standard set by the MPCA. Progress can be measured based on this standard. External phosphorus load reductions aim to meet or exceed 40%. This is based on the 2020 MPCA TMDL requirement. Due to its outsized impact and ease of measurement, phosphorus reduction goals also serve as a proxy for other nutrient load reductions, like total suspended solids and nitrogen. Goals for specific nutrient management tasks will be defined under the respective initiative.

Chloride loading from winter de-icing is another priority concern. Management goals will aim to keep monthly maximum lake water concentrations of chloride less than 230 mg/L.

Other contaminant reduction goals will be defined in the management pathways. These will account for regulatory standards, scientific standards, and city goals.

*Matlock, Marty D., and Robert A. Morgan. *Ecological engineering design: restoring and conserving ecosystem services*. John Wiley & Sons, 2011.

IV. **Resilient system hydrology** –

Hydrology significantly influences water quality. However, due to the unique interventions required to manage the rate and quantity of water and to ensure the benefits of hydraulic management beyond water quality are represented, resilient system hydrology is a unique goal.

Resilient system hydrology is defined as decreased stormflow flashiness, increased residence time within Penn Lake, improved flood water storage capacity, and increased infiltration to groundwater across the watershed. Due to the need for advanced calculation and modeling to quantify impact, hydrology management projects should set specific and measurable goals.

The Framework focuses on the collection of information used in making management decisions. It also utilizes some ecosystem management tools, like conceptual ecological modeling, to ensure that these management decisions are working together for the greatest benefit. However, there is a lot of flexibility for managers to choose their own management style for any given list of projects. All of this, the information gathered, the strategy to maximize benefit, and other management priorities will be written into a management pathway.

A pathway provides a list of management opportunities and supporting narrative that describes the intention of management. Each pathway has a lifespan of five years. In the fifth year, they are reassessed and rewritten (Figure 3). The process of reassessment follows a standardized procedure described in the flow chart seen in Figure 4, which is basically the outline of the entire Framework. Each management pathway and its corresponding documentation will be added to the Framework's compendium. Over time, this will create a long-term narrative of management's efficacy and adaptation.

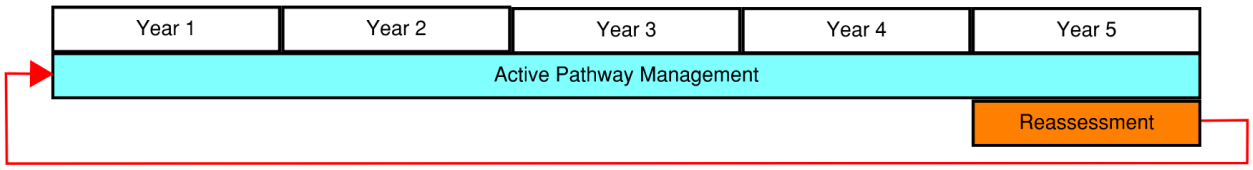

Figure 3. The life cycle of a management pathway. The reassessment in the fifth-year overlaps with continued management. The process repeats to create a series of management pathways.

The following document describes the four major sections of the Framework: infrastructure, community, regulation, and monitoring. It then describes the functionality and use of the conceptual ecological model and ecological results maps in choosing management interventions that optimize impact. From there, the remaining document describes the standardized process for creating management pathway and the function of the compendium.

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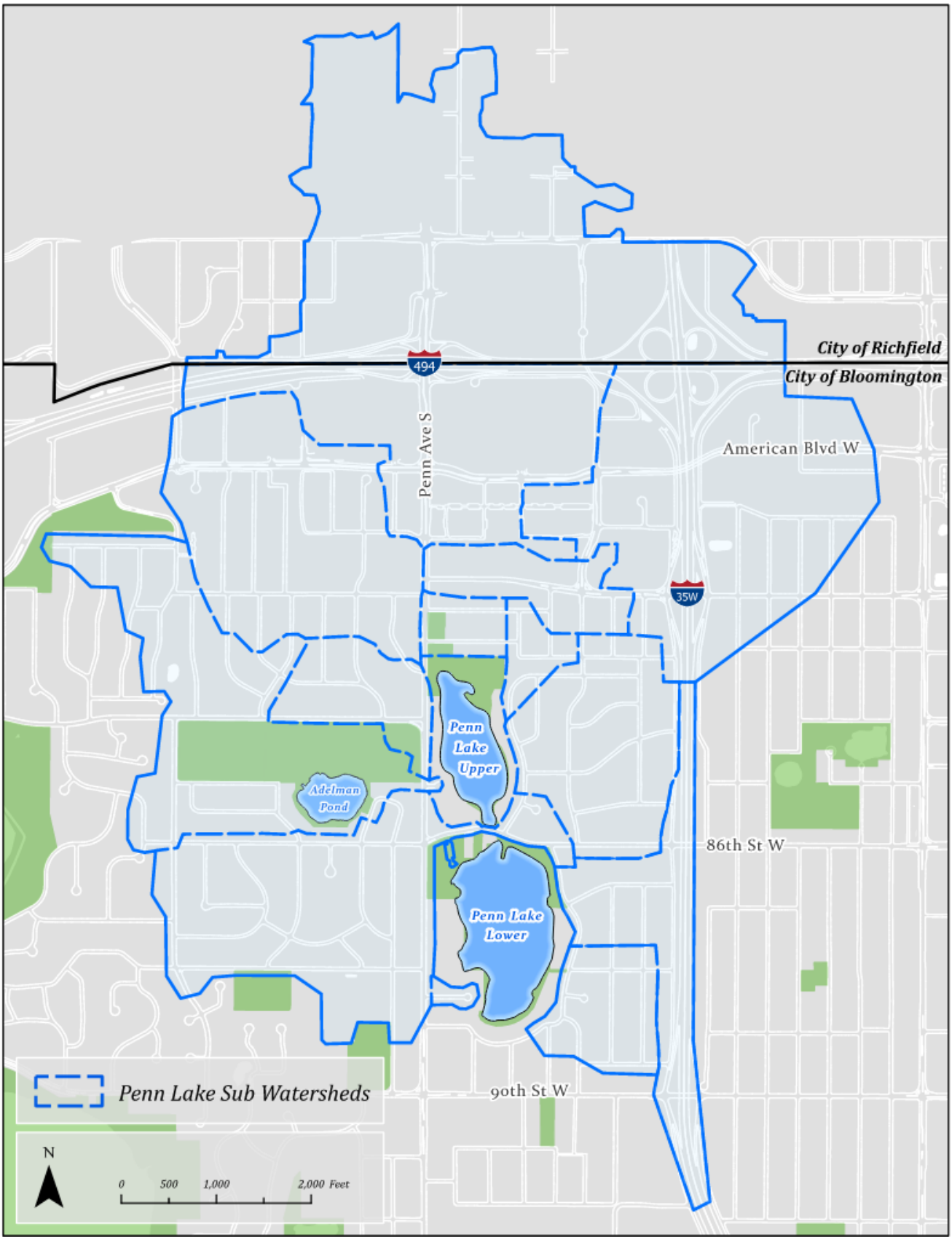

Figure 4. The Penn Lake Watershed and drainage map. The vast majority of surface and stormwater flows into Upper Penn. Penn's Upper and Lower sections are connected via a pipe and water control structure at 86th Street. The watershed extents in Richfield are shown without subwatershed delineations. Map created by Katherine Mayo.

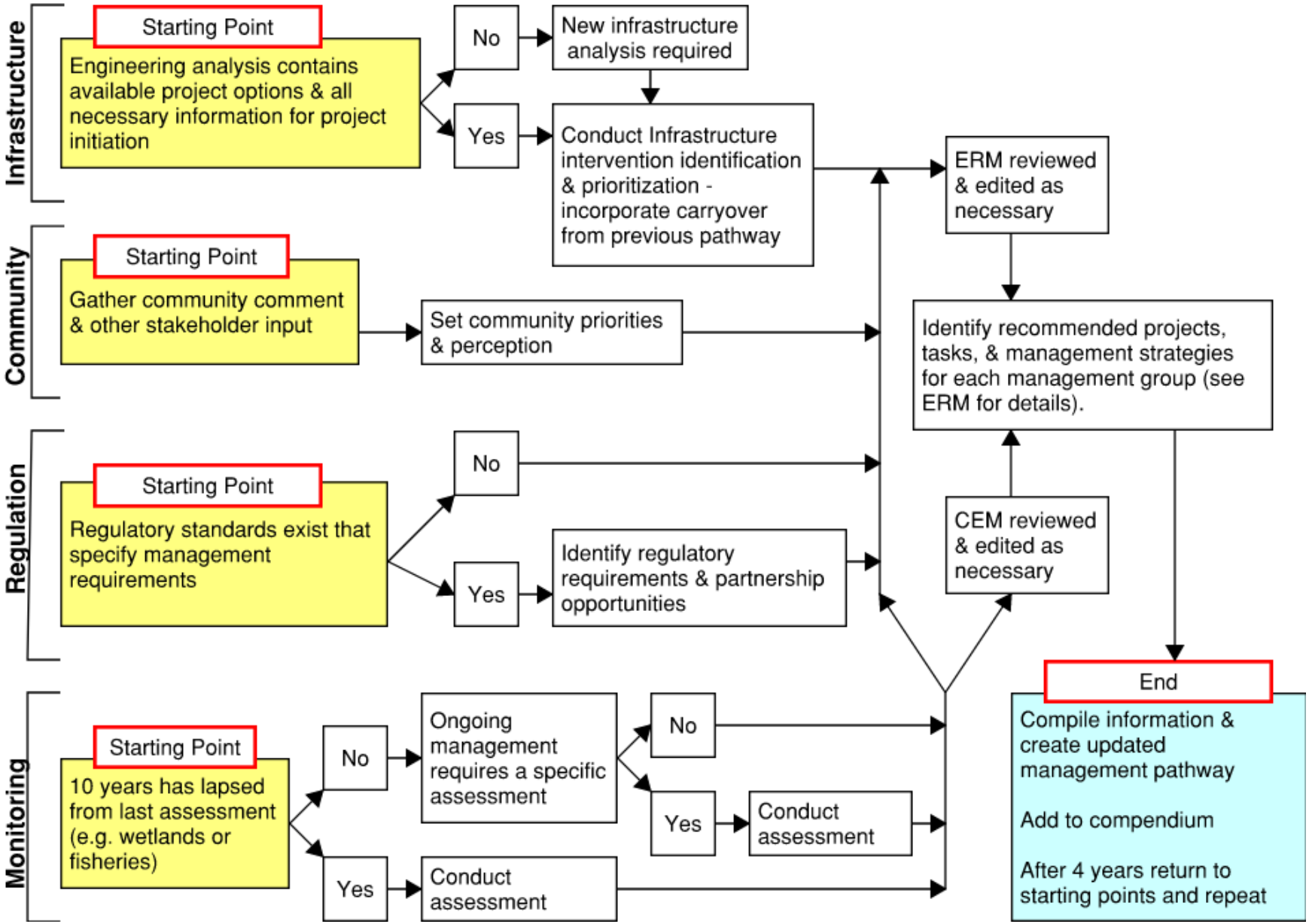

Figure 5. Procedure of the Management Framework. This diagram describes the standardized steps to create a management pathway.

Section 1
Infrastructure

To ensure the City is pursuing infrastructure interventions that maximize cost-benefit, intervention opportunities will be selected in a standardized, two-step process:

1. Identification of opportunities - This starts by selecting opportunity zones across the watershed. Then, infrastructure options are created for each zone. Opportunities can include new construction, retrofits, rebuilds, improvement in reoccurring maintenance, or impact monitoring. Probable construction costs, maintenance requirements, and water quality and quantity impacts are evaluated. Renderings showing site layouts can be included.
2. Prioritization via cost-benefit analysis – Benefit estimations can be done using models, reference projects, professional opinions, or other standardized methods. Phosphorus removal should be the default measurable benefit, but a manager can decide to analyze a specific parameter, like nitrates or suspended solids. Additionally, regulations and community priorities will be a significant contributing factor for cost benefit analysis. For example, trash capture may have no measurable nutrient impact to assess but it might be top priority for the community.

The Framework will always have an engineering analysis. The original was completed in 2022. It should be updated depending on the progress of implementation, emergence of new technologies, or other factors. The most recent version of the engineering analysis should always be located in the compendium (Section 7). Older versions will be archived as needed.

Once opportunities are identified and described, they will be prioritized using a simple analysis:

1. Does the project have a good cost-benefit relative to other projects?
2. Does the project offer multiple benefits?
3. Does the project correspond with other construction initiatives (e.g., road reconstructs) or is necessary due to infrastructure maintenance requirements?
4. Are project partners, particularly NMCWD, planning to pursue a specific project? Are they favorable to a particular option? Are there external funding opportunities, like grants?

After prioritization, managers should be left with a few projects for implementation that can be added to the management pathway. Then initial project work can begin, like budgeting, scheduling, pursuing grant opportunities, collaborating with partner agencies, and other planning requirements.

While most infrastructure projects will occur within the public domain there are opportunities on private property, mainly commercial and industrial properties. However, their private ownership creates unique challenges. The City can either actively create partnerships by approaching property owners directly or the City can use a sit-and-wait strategy, which entails waiting for redevelopment plans to be submitted to the City's planning department. When that occurs, the Water Resources Team can work with the private developers to find partnership opportunities. In this scenario, the earlier the conversation begins the better in promoting participation from private landowners.

Section 2
Community Inclusion

A significant component of the successful management of Penn Lake is the incorporation of community: during the initial assessment of the Lake, when implementing interventions, and in monitoring and evaluating impacts.

There are many important community groups, such as people who live near the lake, regulatory agencies, Tribal nations, Bloomington residents, visitors, and so on. The prioritized community categories for the Framework can be seen in Table 1.

Community Category	Description and Role within Framework
Nearshore residential property owners	Influence over nearshore land management, private property water management, and dominant vegetation communities. Within or adjacent to Penn Lake's floodplain.
Private property owners within Penn Lake's watershed	Influence over watershed-wide dominant vegetation communities and private property water management.
Recreational users of Penn Lake	Includes Bloomington community members and visitors. Influenced and influencers of attribute characteristics of the lake.
Community youth	Future lake stewards and members of all other community groupings.
Business community	Influence over watershed-wide dominant vegetation communities and private property water management.
Local Government Units (LGUs) and Nongovernmental Organizations (NGOs)	Organizations with regulatory authority or those that can help with project funding and/or implementation of management activities.
All City community members	Important to the long-term support of projects. Influential on the impact of infrastructure interventions.

Table 1. Prioritized community groups. Groups were selected based on their perceived role within Management. Groupings are broad and should only guide outreach initiatives.

Bloomington community members will play a significant role in three areas of Penn Lake's management:

1. Participation in updating Management Pathways, including:
    a. Draft review
    b. Identification of management priorities
2. Evaluation of community perception of ecosystem services
3. Participation in community-driven initiatives and volunteer opportunities within the parkland

Community priorities can help influence planning and define what management is striving to do. For example, if fish diversity is a high community priority, then fisheries projects aimed at improving fish species diversity can be prioritized. Community priorities can also influence the cost benefit analysis for selection infrastructure projects. For example, say that the reconstruction of the forebays around Lower Penn Lake were evaluated by the engineering analysis as having moderate to low phosphorus reduction benefits but the community felt strongly that this project was important. That would factor into the benefits of the project and could therefore make it a top priority. Of course, the arithmetic of cost benefit analysis is a bit subjective. Managers should always be clear about how projects were chosen.

Community perception is important because it is the basis of measurement for evaluating ecosystem services, which connects to one of the key goals of City management. Incorporating community input each time a pathway is written will enable managers to measure a change in perception over time. It can also be of use to managers because it connects management decisions to the community's professional knowledge, traditional ecological knowledge, and personal experiences.

In addition to playing a role in creating management pathways, community groups also play a role in management itself. Volunteer opportunities can offer helpful management services, like picking up trash, conducting community science monitoring, or tending to birdhouses. Volunteerism also helps build deeper connections between human-lake relationships. In addition, community outreach can help to create programming or improve existing opportunities.

Incorporation of community participation in specific management initiatives is also important because most of the Penn Lake watershed is developed. Community land use and lifestyle choices significantly impact the health of Penn Lake. Due to the freedoms afforded to landowners, most initiatives for private land management need to be voluntary – this includes single-family homes, multifamily properties, and commercial and industrial properties. Therefore, building community networks will be a key component of improving private land management.

The process for surveying the community to understand their priorities and perception should take advantage of the City's survey and community interaction tools, like websites or other third-party services. Because these tools change over time, it will be up to the acting manager to determine how outreach will be accomplished.

A description of how community input was collected should be included in the Pathway. The results from the surveys should be added to the respective Pathway. Additionally, the Pathway should include a concise description of the community priorities and how those are integrated into the upcoming or existing management initiatives. Reference section 6 for more information on the inclusion of community outreach metrics within a pathway.

Community initiatives within the Pathways, such as volunteer opportunities or community social marketing campaigns, should be described as a specific task. They should be included under the Community Participation Management category (Figure 6). The task must be described with enough detail to explain the general format and intended outcome of the respective community interaction program or activity.

Section 3
Regulations and Partnerships

Management of Penn Lake needs to be done in coordination with other government agencies and in accordance with applicable regulatory standards. (Table 2). Each management pathway should clearly define regulatory barriers and anticipated permitting requirements. Many regulations affecting management will be overarching rules and standards, like the Wetland Conservation Act (WCA) or Public Waters rules. It will be up to managers to determine the necessary project permitting requirements or regulatory requirements that drive management prioritization.

An example of a regulatory requirement that drives management is the MPCA's 2018 listing of Penn as a nutrient-impaired lake. The 2020 TMDL requires the City to put forth the effort to reduce external phosphorus loading by 40% from 2018 levels. Until the respective regulatory agency lifts these requirements, management interventions that impact them will be prioritized. Existing regulatory standards and the strategy for meeting regulatory requirements should be clearly described under "Permitting and Regulation" in the Management Pathway.

Agency	Role or Opportunity	Regulatory Responsibility
FEMA – Federal Emergency Management Agency	Regulatory standards	Flood and floodplain
EPA - Environmental Protection Agency	Grants	Clean Water Act, Federal Pollution Standards
MPCA - Minnesota Pollution Control Agency	Grants- Minnesota Stormwater Manual	NPDES Permit, TMDL requirements
DNR - Department of Natural Resources	Grant- Play a primary role in species management	Public Waters, species management (e.g., fish), WCA enforcement
BWSR - Board of Water & Soil Resources	Grants	WCA rulemaking
MNDOT - Department of Transportation	Authority over contributing watershed into Penn Lake	NA
NMCWD - Nine Mile Creek Watershed District	Grants, management authority over all of Penn Lake, partnership	Wetlands, erosion control, stormwater, floodplain, shoreline improvements
City of Richfield	Authority over contributing watershed into Penn Lake	NA
NGOs - Non-government Organizations	Grants, management partnership opportunities	NA

Table 2. Regulatory summary. This table shows a list of agencies or organizations with influence or partnership opportunities associated with the management of Penn Lake. "NA" stands for "Not Applicable".

In addition to coordination with partners outside of the City, collaboration between City departments will be key in successful long-term management. Table 3 lists City departments and a description of each department's role or influence in Penn Lake management.

Collaboration and partnership between City departments is especially important for any project that requires reoccurring maintenance or management, like storm sewer infrastructure, vegetation management, or even volunteer programming. When creating a program, managers should be sure that maintenance responsibilities and methods should be understood. Then, as the years go by, the adaptive management approach of the Framework should prompt evaluations that sustain or identify needs for improvement in this reoccurring maintenance.

Community Category	Description and Role within Framework
City Council	Approves project contract s with costs over $175k
Sustainability Commission	Community led advisory group. Helps promote sustainability initiatives including ecosystem management programs.
Engineering - Water Resources	Manages surface water quality, quantity and ecological impact throughout the City. Oversees Penn Lake Management Framework.
Engineering - Infrastructure	Carries out street and trail design and reconstructions. Influential in City storm sewer and other water infrastructure.
Sustainability	Heads sustainability initiatives. Highly involved in climate, energy, and solid waste management.
Parks and Recreation	Decision makers for land use of City Parkland. Manages programming and volunteering opportunities for the community.
Parks Maintenance	Maintains City parkland, including mowing, ecosystem management, invasive species control, and plant establishment.
Maintenance - Street Division	Maintains city streets, including sealcoating, patching plowing, storm sewer maintenance, and right-of-way mowing
Maintenance - Utilities Division	Operates water treatment plant, water analytical laboratory, and performs water and sanitary sewer related maintenance.

Table 3. City department summary. This table shows a list of the City departments that have a role or influence over the management of Penn Lake. Partnering with these departments will be important in long term maintenance of programs or projects created as a part of Penn Lake management.

Section 4
Monitoring and Evaluation

Understanding how Penn Lake is functioning is very important for creating management interventions. Monitoring and evaluation (M&E) includes collecting data across a wide range of parameters and timeframes. Because of the high cost associated with M&E, consideration should be taken to find an appropriate balance where the City is collecting as much information as possible while expending the least amount of cost.

M&E will include four categories of measurement:

1. **Water quality and hydrology data**
   Due to the variability of this data throughout and between years, this dataset should be collected on a timescale that can identify seasonal patterns and long-term trends between years. This means that data needs to be consistent in both the short and long term. As of 2023, the current method is to sample upper and lower Penn Lake monthly. This follows the general, citywide surface water quality sampling regiment. Lake level observations are collected using autonomous samplers installed from May to October and field calibrated by City survey staff.
2. **Biotic Assessments**
   The management pathway reassessment procedure (Figure 4) describes the method for implementing biotic surveys. Due to the wide range of measurable variables, from birds to macroinvertebrates, the only main requirement in the Framework is that each biotic variable be measured at least once every 10 years. Project-specific data requirements are described below.
3. **Community perception**
   As described in Section 1, community members should be repeatably surveyed to accurately identify perceptions and priorities. Measurement of community perception will occur based on the timeline described in the pathway reassessment procedure (Figure 4).
4. **Project-specific data requirements**
   Data collection is often required throughout the incorporation of a specific intervention (i.e., carp management). These requirements are project-specific but may also influence the schedule of other sampling parameters, like biotic assessments or water quality and hydrology data. It is the acting manager's responsibility to incorporate project specific data requirements into management pathways.

The M&E section of the management pathway should include details on the current method of re-occurring management and the inclusion of project specific sampling regiments. At each reassessment, data should be used to describe the lake's existing state and progress toward centralized goals. Each of these will help to calibrate management decisions within the CEM and ERM.

Functionality and Use of the Conceptual Ecological Model and Ecological Results Map

The Framework is made up of two key final steps: selection of management priorities using a conceptual ecological model (CEM) and the Ecological Results Map (ERM).*

The CEM maps the interactions within an ecosystem (Figure 5). It helps anticipate management impact, identify efficient project phasing based on the ecological principle of self-organization, and selection of priority interventions that maximize return on investment. The Framework's CEM is representative of an urban shallow lake. It accounts for many of the primary ecosystem characteristics that exist within the boundaries of Penn Lake's watershed.

The CEM's utility is similar to the utility of using a map. It helps you find where you are and the best route from one place to another. But, as a roadmap does not include every landmark, the CEM does not include every ecosystem feature. For example, despite their importance, factors outside the watershed, like climate, are not referenced. Managers should try to recognize and address missing factors. Using the CEM to guide management should help build resiliency in desirable ecosystem characteristics.

CEMs are split into four levels: ecosystem drivers, stressors, effects, and attributes. Feedback loops form between levels. The Penn Lake CEM is stacked into two consecutive models, the watershed on top and the internal function of the lake on bottom. It is done in this way to show how external watershed management and internal lake management influence each other. Table 4 offers some descriptions of several categories from the CEM.

To use the CEM effectively, managers must know the actual characteristics of Penn Lake through direct observation and measurement. This information orients the CEM and allows managers to set and track measurable management interventions. Because of their influence on system characteristics, management should prioritize interventions that impact ecosystem drivers and stressors, and components that are key in creating reinforcing positive feedback loops.

The value of using a CEM is that it offers a simplified, two-dimensional map within the ecological landscape. This view orients interventions and their corresponding cascade of effects. However, a CEM does not indicate specific tasks required for intervention or how tasks interact. So, to identify tasks, the Framework utilizes an ERM (Figure 6). Where a CEM is system-oriented, an ERM is task oriented.

The ERM, set up in a series of concentric circles, organizes tasks into functional groups: flora, fauna, abiotic habitat, pollution prevention, hydrology, community participation, and monitoring and evaluation. From the outer ring, tasks start to coalesce toward the shared, central goals of the Framework: high-value ecosystems services, self-sustaining species diversity, good water quality, and resilient system hydrology. These goals are described in the introduction.

*To ensure a standard reference, the CEM and ERM provided in this Framework will remain unchanged. However, managers can create new CEMs and/or ERMs when writing pathways. Doing so can help to include new scientific discoveries, incorporate updated field data, implement novel management techniques, and so on. Any updated CEMs and ERM should be included in their respective pathway.

The ERM helps optimize capital investment, ensuring ongoing work builds upon itself and that management in one group does not outpace overall progress elsewhere. The success of one task is often dependent on tasks from other functional groups. For example, achieving the goal of species diversity is dependent upon quality native plant communities, useful habitat structure, and self-sustaining animal populations. Each of those are within their own functional group and each has its own web of interacting tasks. If you look at quality native plant communities, for example, they require improved private land management, reinforcing management activities, erosion mitigation and repair, *et cetera*.

Management progress can become fragile if the effort put into one functional group outpaces the work done in the others. This fragility can lead to system regression and a degraded state. For example, unmanaged carp can ruin the effects of an alum dose by stirring up sediment. In this example, project implementation in the hydrology functional group (alum treatment) got ahead of tasks in the fauna functional group (carp removal).

The ERM visualizes tasks. The CEM provides insight into ecological interaction. Because they offer different perspectives, the CEM and ERM should be used in tandem to create efficient and effective management pathways.

Water infrastructure	Includes all the built infrastructure for surface water, like sewers, infiltration basins, ponds and so on. As technology improves, managers will need to identify how new practices change the attributes of surface water.
Re-occurring maintenance activities	From fixing broken pipes, clearing trees, mowing meadows, to cleaning out sumps, these reoccurring activities have a significant effect on the surface water landscape. While labeled a system driver, some maintenance activities, like street sweeping, directly affect pollutant transport simply by limiting a pollutant source (e.g. sucking up the tree leaves before they can wash away).
Landuse	Can be the classic landuse categories, like commercial or residential, or it can include specific development practices, like parking lot designs that improve stormwater capture.
Turbidity & Water chemistry	Aspects that affect water turbidity (e.g. algal blooms, and suspended solids) have a direct effect on water chemistry, thus why the two are co-dependent. A significant feedback loop is created as the water chemistry drives nutrient availability which in turn drives algae populations.
Aquatic habitat quality	This should be thought of as the large, structural aspects of aquatic habitat, like dead woody material, wetland fringes, and so on. Obviously living material, like submerged vegetation also add to aquatic habitat but because they are so susceptible to change, they are analyzed on the attribute level.
Photosynthetic potential	How much sunlight can get into the water and how far can it reach. Clear water has high photosynthetic potential and murky water does not. Floating aquatic vegetation or significant tree sheltering can also limit light availability.

Table 4. Descriptions of some categories from the conceptual ecological model (CEM). The descriptions should help to show how the parts of the CEM were laid out and how they interact with one another.

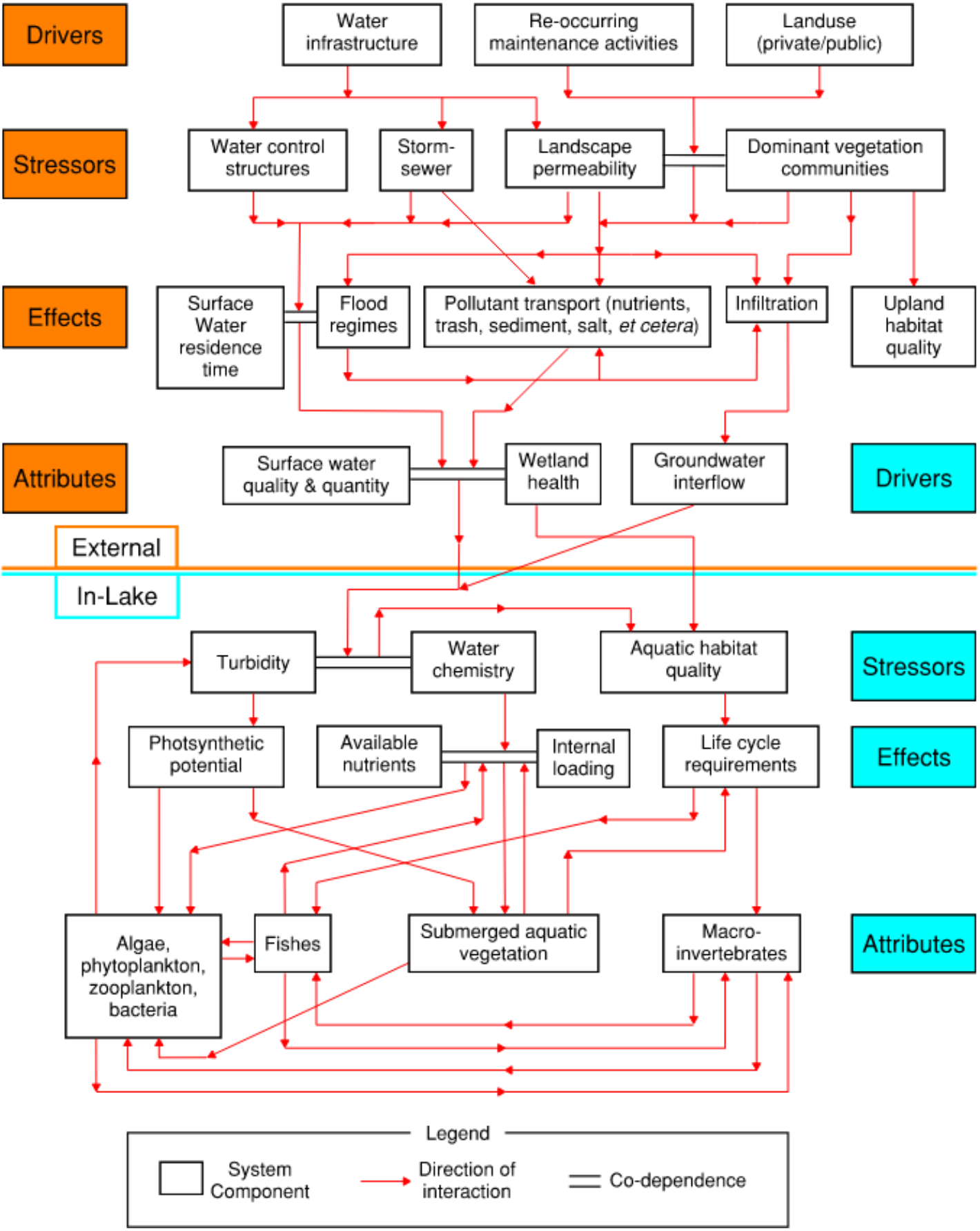

Figure 6. Penn Lake Conceptual Ecological Model (CEM).Showing a cascade of effects from system drivers to attributes, a CEM helps show interconnection and influence between ecosystem parts. The Penn Lake CEM is influenced by urban landscapes and feedback loops observed in reference shallow-lake systems. Arrows going up levels are indicative of feedback loops.

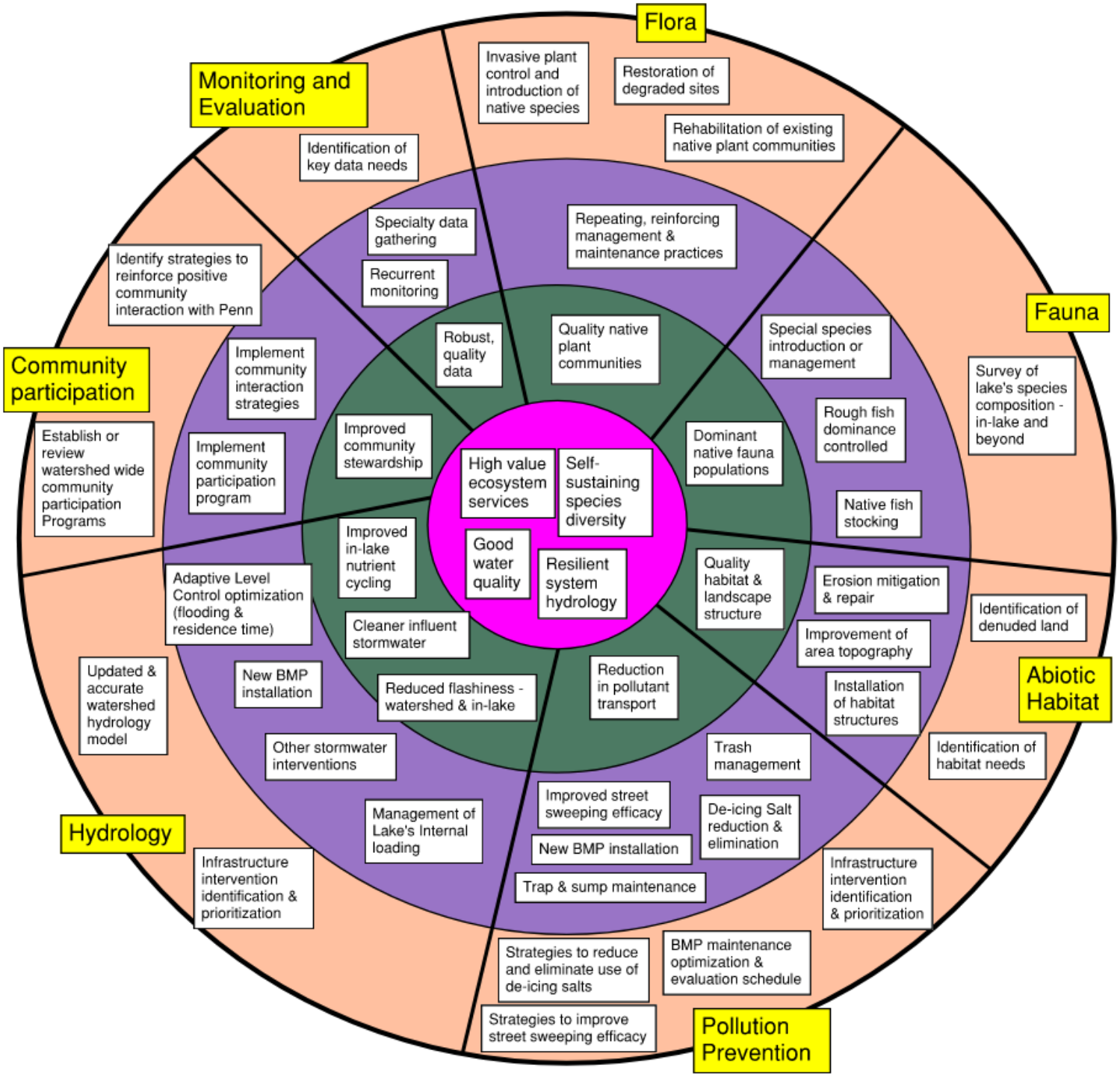

Figure 7. Ecological Results Map (ERM). This task-oriented chart show how tasks intersect across seven functional groups to achieve management goals. The outer ring describes short-term tasks or first steps. Moving inward, these tasks begin to coalesce towards shared, central goals. While not shown on the ERM, these tasks are intertwined. Often, progress in one functional group depends on the success of a task in another.

Creation and Adoption of Management Pathways

The Framework is a static document that sets up the standards to which management will be carried out. It will be approved by Bloomington City Council. Each pathway that is created under the guidance of the Framework, after a standard review process, will be approved by the City Engineer. Each new pathway will be added to the Frameworks compendium. Older pathways will be archived. Depending on the pace of management progress, an updated pathway may look very similar to its predecessor.

The standard process for creating and approving management pathways is as follows:

I. Step 1: At the start of the fifth year, the City's water resources engineering group will begin the process of drafting of the upcoming pathway. This process includes collecting community input, identifying needs for biotic assessment and engineering analyses, and evaluating progress and carryover from the previous pathway.

II. Step 2: Once fully drafted, the pathway will be submitted for review to NMCWD, community groups, and City staff. City staff review should include the City's Water Resources Manager, the City Engineer, and a representative from Parks Maintenance. Others may be involved as needed.

III. Step 3: Once review and editing is completed, the Management Pathway will be officially approved by the City Engineer. It can be approved at any point during the year-long reassessment period.

There is some flexibility in adding information or implementing new management tools, like Gantt charts, into any respective pathway. However, effort should be made to create a pathway that fits within the standardized layout. It is likely that many of the management items in a pathway are being carried over or updates from projects that were included in the pathway that is being replaced. Therefore, the existing pathway should serve as a valuable template when writing a new pathway.

Because it is quite likely that many management initiatives will not be completed in a pathway's five-year lifespan, project carryover will be a very important aspect of new Pathways. Projects that were not started can be carried over with nothing more than an update explaining why they continue to be prioritized. Projects that have been started and not finished Can be carried over to the new pathway with a note describing progress and what is still needed to be done.

The summary of past management should describe the projects that were completed. Then the new management opportunities might then become available due to the progress of work can be explained in the summary of proposed management. Of course, there is always the possibility to add new project ideas that had not been included in past pathways or are not directly connected to past projects.

Pathway Format

Each header in the pathway format below should be included in each pathway. The text below is a description of what information should be included within each header.

Summary of Tasks: This section will provide a very brief list of the top priority tasks. No descriptions are necessary as each task should be detailed in the task section of the Pathway. Simplified CEM's or other figures can be included but care should be taken to ensure this section stays brief and easy to read.

Introduction: Explanation of how this pathway works into previous work. This section can include relevant information about policy changes, partnerships, etc. It does not need to be long, but this section should explain the strategy, viewpoint, or even ethos of the manager writing the pathway.

Summary of proposed management –The summary should include a high-level description of proposed management. It should describe the tasks and partnerships that are to be chosen in the newest pathway and how they will work together to reinforce past work and progress management towards centralized goals. No need to describe each task in detail. That information will be included in the tasks section.

Summary of past management – This section is particularly useful for building an easy-to-follow narrative of how management changes over time. The summary should describe past management work that occurred during the previous pathway, and beyond if necessary. The information included in the past management summary should inform how the selection of management tasks was made for this newest Pathway. Where possible, this summary should include a description of Progress towards the centralized goals using quantifiable information. Monitoring and evaluation data, including project-specific data, will be useful in this regard. The description should tie into the four goals of the framework: high-value ecosystem services, self-sustaining species diversity, good water quality, and resilient system hydrology. Graphic visualization of progress is recommended.

Existing state of Penn Lake – This does not need to be an exhaustive description but should present an accurate picture of Penn Lake at the time of writing the Pathway. Specific information can be referenced in the relevant biotic surveys, or the summaries of the monitoring and evaluation data used to describe the existing state of Penn Lake. That information is stored in the Framework's compendium. This section should clarify how ongoing management has changed the lake since the most recent survey, like carp Summaries of the monitoring and evaluation data used to describe the existing state of Penn Lake removal or fish stocking.

Partnerships, regulations, and other agency authority – This section should include clear description of the existing permitting and regulatory requirements that will influence the management work of Penn Lake. If a permitting requirement has been lifted during the previous management pathway, then information on that regulatory circumstance and process of resolution should be clearly described.

Ongoing or planned partnerships should be described. NMCWD will play a large role in management and will likely appear in each Pathway. If an outside agency is doing work that will affect Penn Lake, like MNDOT or City of Richfield, then those projects can be briefly described here.

List all existing regulatory requirements. This is particularly important while Penn Lake's TMDLs are active. As of 2023, these are: Penn Lake Nutrient (phosphorus) TMDL, Nine Mile Creek E. Coli TMDL, TCMA Chloride TMDL, and Nine Mile Creek Chloride TMDL. This list can be done in table format.

Community priorities – Description of the community integration process and results. A short summary of community priorities should follow. The metrics obtained during the community outreach process should be included in the Pathway's appendix.

Infrastructure identification and prioritization – This section is based on the engineering report. Details should focus on the prioritization process and explain the selection of priority projects. Carryover projects should be included. These carryover projects should also be included in the summary of past management.

Tasks – focus should be kept on the high-level details of carrying out tasks. The tasks should be broken up between each of the seven functional categories, as shown in the ERM (Figure 6). Each functional group should have a short summary describing the overall management intent and how that work connects between initiatives or management progress in other groups. Then a list of tasks for that group should be provided with a short description that includes enough detail for readers to understand intent, priority, implementation schedule, and if it is dependent on or other tasks are dependent on it. If it is a carryover task, then any past progress should be explained. Care should be taken to ensure tasks descriptions are kept task specific. The overall description of management intent and how it connects to the CEM and ERM should be done in the above 'summary of proposed management'.

Pathway Adoption – Each pathway will be adopted by the City via a signature by the City Engineer. The signature line will read as follows:

> In acknowledgement that this management pathway was properly written, as outlined by the Penn Lake Management Framework approved by City Council on January 28, 2024, this management pathway is hereby adopted by the City of Bloomington.
>
> DATED:_____ BY:_____
> [INSERT PRINTED NAME HERE]
> City Engineer

Appendix – This section includes:

- Community outreach metrics
- Documentation from past work that is being carried over to the updated Pathway
- Any new documentation from work that occurs within the Pathways timeframe, like Monitoring data and evaluation reports.

Compendium

Pathways, engineering analyses, and assessments are going to be continually updated throughout the life of the Framework. The compendium is where the most up-to-date documents will be stored. The compendium contains three main documents: These are:

1. Management Pathway
2. Monitoring Assessments
3. Engineering Analyses

All three of these documents will be, at one point or another, updated throughout the life of the Framework (as described in the procedure for the creation of management pathways - figure 4). The version shown in the compendium will be considered the "active document". Older versions will be archived. Any updates, clarifications, or other additions created for the active documents should be saved as a supplemental document or memo. It will be up to the acting manager to ensure that information is adequately carried over during the Pathway reassessment phase.

The compendium should not be mistaken for the appendices that will accompany management pathways. Those appendices will include the documentation and information associated with ongoing management work. For example, a pathway's appendix may include community outreach metrics, project documents, or project specific sampling data created or obtained throughout management work.

The compendium is also important in setting a standard file format for document storage. Proper file format for documents storage is important for two reasons. One, it helps to create a long-term record of management that can be referenced by future managers. Two, it minimizes cluttering up the Framework with old documentation.

Figure 8. A view of Upper Penn Lake.