City of Fort Collins

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URBAN LAKES WATER QUALITY MANAGEMENT

Guidance

PREPARED BY:
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WITH ASSITANCE FROM:
SWCA Environmental

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ACKNOWLEDGEMENTS

The City's Urban Lakes Water Quality Management Guidance was developed by a diverse project team consisting of City staff from the Natural Areas, Parks and Utilities Departments and SWCA Environmental Consultants using a One Water Approach. The project team would like to acknowledge the importance of the feedback and recommendations received from the Land Conservation and Stewardship Board, Natural Resource Advisory Board, Parks and Recreation Board and the Water Commission. The project team also acknowledges the important role that subject matter experts and the general public played in the development of this project. Subject matter experts included representatives from Colorado Parks and Wildlife, Aquatic Associates, Colorado State University, Warren Lake HOA, Rigden Farm HOA, Richards Lake HOA, Fairway Estates HOA and Lake Sherwood Corporation.

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GLOSSARY OF TERMS

Algae – Aquatic plant-like organisms that contain chlorophyll.

Algae blooms – Excessive growths of algae caused by excessive nutrients.

Anoxia – The absence of oxygen.

Aquatic habitat – Area of a lake providing food, shelter and other resources for organisms.

Aquatic nuisance species – Plants or animals that can cause water quality issues in lakes.

Benthic Sediment – The sediment at the bottom of a lake.

Benthos – Organisms that live on or within benthic sediment in lakes.

Best management practice (BMP) – Industry standards, or practices, used to manage natural resources, such as lakes.

Bioaugmentation – A technique whereby bacteria are added to contaminated water to help treat a water quality issue.

Biological Oxygen Demand (BOD) – A measurement of the amount of oxygen that is consumed by microorganisms.

Contaminants of Emerging Concern (COCs and CECs) – Compounds for which water quality standards do not currently exist, such as certain personal care products, pharmaceuticals, pesticides, insect repellants and sunscreen.

Cyanobacteria (Blue-green algae) – Photosynthetic bacteria that can form blooms similar to algae and that can be toxic to both aquatic organisms, humans and other animals.

Detritus – Decomposing organic matter in aquatic systems.

Dissolved oxygen (DO) – A measure of the amount of oxygen dissolved in water.

Ecology – The study of how organisms interact with their environments.

Epilimnion – The uppermost layer of a lake that is stratified chemically and/or physically.

***Escherichia coli* (*E. coli*)** – A species of bacteria that occurs in the intestines of warm-blooded animals.

Eutrophication – Excess nutrients (nitrogen and/or phosphorus) in a lake.

Geographic information system (GIS) – A computer-based software platform used for analyses of geospatial data.

Growth Management Area (GMA) – An area within which the City's future growth is limited, as agreed upon by the City of Fort Collins and Larimer County.

Heavy metals – A group of metals often considered toxic to aquatic organisms in high concentrations.

Invasive species – Any species present in a lake that is considered non-native.

Lake productivity – A lake's ability to support algae and plants.

Littoral zone – A narrow, often shallow zone along the edge of a lake.

Macrophytes – Aquatic plants that can be seen with the eye that have roots and differentiated tissues.

Morphometry (of lakes) – The physical characteristics of a lake including surface area, maximum depth, mean depth, shoreline characteristics, and volume.

Nutrient loading – Influx of nutrients from the surrounding watershed are into a waterbody.

Nutrients – Nitrogen and phosphorus.

One Water approach - is an integrated planning and implementation approach to managing finite water resources for long-term resilience and reliability.

pH – A measurement of how acidic or basic a water is on a scale of 0 (most acidic) through 14 (most basic).

Photosynthesis – A chemical reaction whereby energy from sunlight and chlorophyll are used to convert water and carbon dioxide into carbohydrates, which are used by plants as food. Oxygen is produced as a by-product of this reaction.

Phytoplankton – Community of free-floating microscopic algae and cyanobacteria in a lake.

Residence time – The amount of time water remains in a lake before it is completely renewed by inflows of new water.

Salinity – A measure of the concentration of dissolved salts in water.

Shoreline – Shoreline is defined as the margin of land along the edge of a lake.

Stormwater runoff – Overland surface flow during and following precipitation events; stormwater runoff can convey pollutants from roadways, parking lots and other impermeable surfaces into lakes.

Stratification (of lakes) – Process by which different chemical and physical horizontal layers form seasonally in some lakes.

Thermal stratification – The formation of horizontal temperature zones or layers in some lakes.

Thermocline – The narrow zone of rapid temperature change in thermally stratified lakes.

Total Dissolved Solids (TDS) – A measure of the total concentration minerals, metals, salts, and organic materials dissolved in water.

Total Suspended Solids (TSS) – The total concentration of minerals, metals, salts, and organic materials suspended (not dissolved) in water.

Turbidity – A measurement of the relative clarity of water; lower values translate to high clarity and higher low clarity.

Urban Lakes – City-owned lakes, reservoirs and ponds located within the City's Growth Management Area (GMA).

Vegetation buffer – An urban lakes best management practice consisting of planting or maintaining vegetation along the edge of a lake to intercept pollutants that would otherwise enter a lake.

Water quality issue – A physical, chemical, or biological stressor impacting a lake.

1.0 INTRODUCTION

1.1 Background

The City of Fort Collins (Fort Collins) is located 65 miles north of Denver and is part of the northernmost extension of Colorado's Front Range urban corridor. Fort Collins currently has a population of approximately 175,000 people (2020 census) and is projected to grow by an additional 70,000 residents by the year 2040 (City of Fort Collins 2019; World Population Review 2021).

Concerns regarding Fort Collins' rapid growth and development and the potential for suburban sprawl led to the development of a Growth Management Area (GMA) Intergovernmental Agreement between the City and Larimer County in 2000 (City of Fort Collins 2019; City of Fort Collins and Larimer County, 2008). The GMA is an agreed upon zoning district within which urban growth and development is allowed (**Figure 1.1**).

Fort Collins' rapid urban growth and development can significantly impact environmental resources by reducing air quality; overcrowding parks and natural areas; and degrading water quality in the City's streams and lakes.

FORT COLLINS' RAPID URBAN GROWTH AND DEVELOPMENT CAN SIGNIFICANTLY IMPACT ENVIRONMENTAL RESOURCES.

1.2 Fort Collins' Urban Lakes

Fort Collins' urban lakes are defined as lakes and stormwater basins where the City owns the surrounding and underlying land and thus manages the water in them. The oldest of the City's urban lakes were originally constructed during the 1800s for the purpose of diverting and storing water for irrigated agriculture (Duggan 2005). Many of the City's urban lakes are either relic ditch or reservoir features from this early period or abandoned gravel mine pits that have been reclaimed as lakes, but the City has also continued to construct new urban lakes over the years. The City's urban lakes are diverse in age, form and function and provide a broad range of beneficial uses to our community; including providing recreational opportunities, serving as wildlife habitat, storing irrigation water, serving as elements of the City's stormwater infrastructure and other uses.

1.3 Urban Lakes Water Quality Management Challenges

Managing water quality in the City's urban lakes presents a range of challenges for City staff. For example, prior to the development of this project, a comprehensive list of all City-owned urban lakes and the City department responsible for managing each lake was lacking. In addition, the City's urban lakes jurisdiction had not been clearly defined, which led to some uncertainty in terms of water quality management scope and priorities.

City staff have become increasingly concerned with water quality issues impacting the City's urban lakes. Many of these lakes have physical characteristics that impact water quality, such as being relatively small, shallow, and lacking inlets and/or outlets to renew water. In addition, physical, chemical and biological pollution associated with urban growth and development, land use practices, climate change and other factors can lead to water quality issues such as algae blooms, elevated concentrations of water-borne pathogens, nuisance odors and fish kills.

The City's urban lakes are managed to meet a variety of objectives and are impacted to varying degrees by water quality pollution. Where should the City's finite urban lakes water quality management resources be focused? This is ultimately a

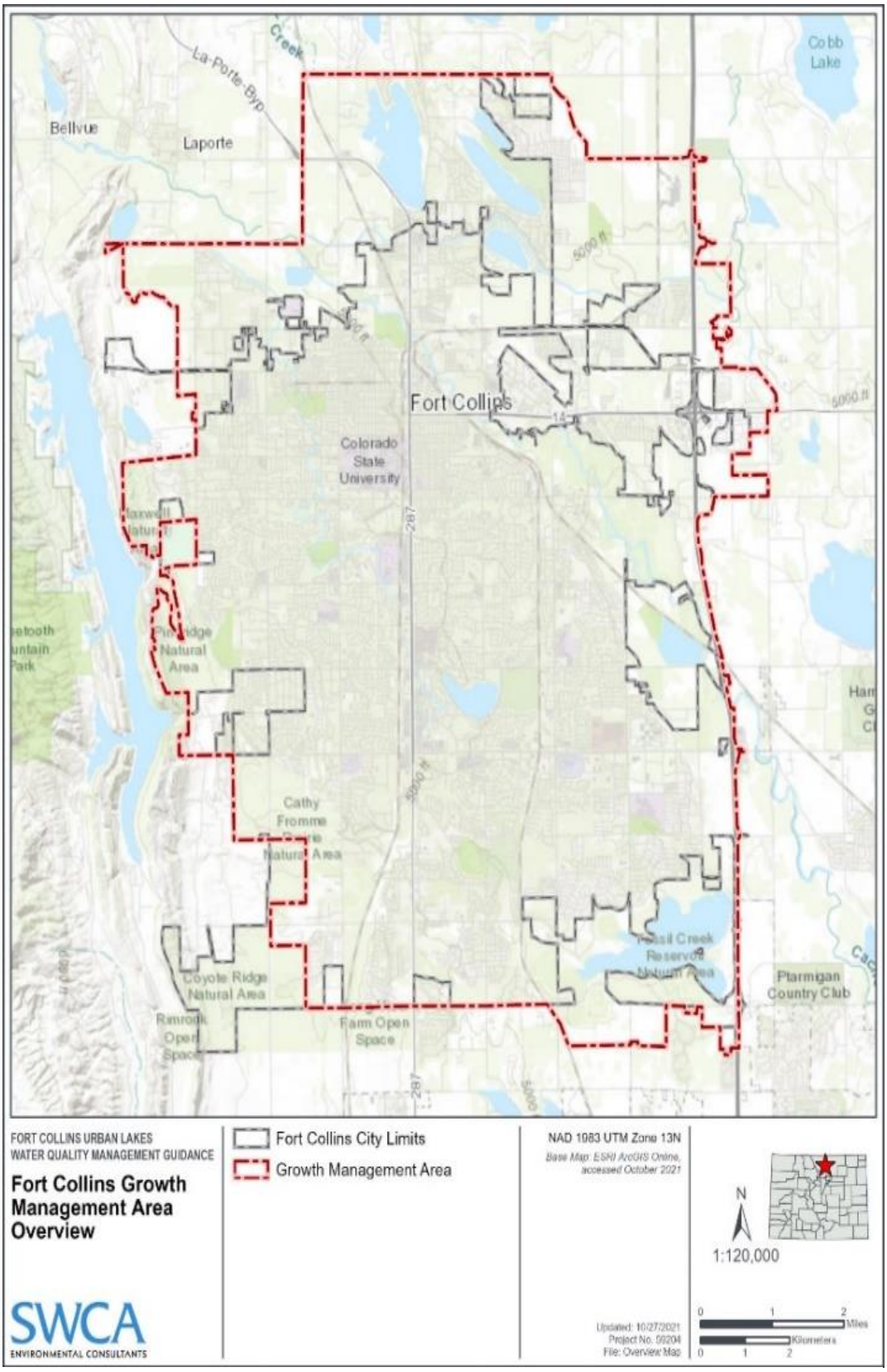

Figure 1.1 Map showing Fort Collins' City Limits and Growth Management Area (GMA) (Source: City of Fort Collins 2005).

decision for each managing department. However, combining information about each lake's management objectives, known water quality history and relative risk of future water quality degradation can assist managers in making these decisions.

Once an urban lake water quality issue has been identified and prioritized for more focused management, the question then becomes: what measures can be taken to mitigate the issue? A comprehensive reference of urban lakes water quality best practices to both reduce water pollution and to mitigate existing water quality impacts would be beneficial.

Algae Blooms

The City's urban lakes naturally contain aquatic communities, including macroinvertebrates, fish, plants, algae and other organisms. Algae are plant-like organisms containing chlorophyll that can be separated into three broad categories: filamentous, planktonic and macroalgae. As with plants, the growth of algae can be greatly influenced by environmental conditions. Many of the City's Urban Lakes are small and shallow, receive abundant sunlight and are relatively stagnant. Lakes with these physical conditions are prone to algae blooms, especially when enriched by nutrient (nitrogen and phosphorus) pollution.

> …ALGAE BLOOMS CAN PRESENT SIGNIFICANT WATER QUALITY MANAGEMENT CHALLENGES IN THE CITY'S URBAN LAKES.

While algae are important components of lake aquatic communities, algae blooms can present significant water quality management challenges in the City's urban lakes. Algae blooms can range in severity from the level of management nuisance to a significant community health threat. Algae blooms can harm other aquatic organisms and can lead to fish kills, odors and can negatively impact community usage. Some species of macroalgae called cyanobacteria can produce dangerous neurotoxins called cyanotoxins during harmful algae blooms (HABS). However, it is important to note that not all algae blooms are caused by cyanobacteria and not all cyanobacteria blooms are HABS. Algae blooms have been identified by City staff and stakeholder groups during Policy and Guidance development (see Section 2 below) as the most significant urban lakes water quality concern.

The mechanisms by which nutrients enter the City's urban lakes are varied and complex and include permitted wastewater discharge; permitted stormwater discharges; non-point pollution from urban landscapes; agricultural runoff; wildlife and pet waste; atmospheric deposition; and internal loading from lakebed sediments and other sources. The Best Management Practices (BMPS) Toolbox in Attachment 7 of this Guidance lists several suggested best practices to assist managers with reducing nutrient input to lakes and addressing algae blooms.

2.0 ADDRESSING URBAN LAKES WATER QUALITY CHALLENGES

2.1 Stormwater Management

Stormwater Infrastructure Maintenance

The City's Stormwater Maintenance Division is responsible for removing debris from several irrigation system trash racks associated with ditches that have been placed underground by the City. Local irrigation companies also regularly remove debris from open ditches throughout the City for the purpose of delivering water to shareholders. The City is currently in the process of hiring a contractor to remove homeless encampment debris from the City's stormwater infrastructure.

MS4 Program

The City of Fort Collins implements several programs and practices designed to reduce the discharge of pollutants to local water bodies via the storm sewer system. These programs are implemented in accordance with Colorado Discharge Permit System General Permit for Stormwater Discharges Associated with Municipal Separate Storm Sewer Systems (MS4), a practice-based permit under which the city is authorized to discharge.

Programs and activities, as they relate to urban lakes management and water quality protection, are as follows:

1. Public Education and Outreach – a public education program to promote behavior change by the public to reduce pollutants in discharges from the MS4. Staff take a multi-pronged approach, from school-age and adult programs to social media to address the impacts of stormwater discharges on water bodies, the steps that can be taken to reduce pollutants in stormwater runoff, and water quality impacts associated with spills and improper disposal of waste. Topics include nutrient sources such as yard waste and fertilizer use, as well as other pollutant sources and reduction practices.

2. Illicit Discharge Detection and Elimination – a program to effectively prohibit pollutant discharges to the MS4, which includes municipal code Section 26-498 and enforcement procedures. Staff respond to reports of spills, dumping, and illegal connections to ensure pollutant sources are stopped and mitigated.

3. Construction Sites Runoff Control - a program to reduce or prevent the discharge of pollutants to the MS4 from applicable construction activities. Construction sites are required to implement sediment and erosion control and pollution prevention practices in accordance with the city's Stormwater Criteria Manual; staff implement a plan review and inspection program to verify compliance with the requirements.

4. Post-Construction Stormwater Management – a program to reduce the discharge of pollutants to the MS4 from applicable development sites after development is completed. New and redeveloped sites are required to install permanent stormwater quality treatment measures, such as Low Impact Development (LID) that meets the city's Stormwater Design Criteria; staff must ensure proper design, installation, and long-term operation and maintenance of these measures.

5. Pollution Prevention/Good Housekeeping for Municipal Operations – a program to prevent or reduce water quality impacts from pollutants being discharged to the MS4 from municipal facilities and operations. Staff implement a program to provide staff training, Municipal Facility Runoff Control Plans, inspections, and Standard Operating Procedures including the storage and application of fertilizers.

2.2 Urban Lakes Water Quality Management Policy

A project team consisting of staff from Natural Areas, Parks and Utilities Departments, the City Attorney's Office and SWCA Environmental Consultants (SWCA) addressed the above urban lakes management concerns by developing an Urban Lakes Water Quality Management Policy (see Attachment 1 for Policy) using an integrated One Water Approach. The purpose of the Policy is to provide a foundational framework for the City's operational and management decisions related to water quality management in City-owned lakes and stormwater basins and to support implementation of the Guidance.

The project team conducted community engagement to better understand urban lake water quality concerns and inform policy development. Community engagement included:

1. **Urban Lakes Water Quality Management Subject Matter Experts (SMEs)** were interviewed and/or surveyed during April and May of 2021 to better understand known water concerns in City-owned urban lakes (see Attachment 2). SMEs included City staff; local private lakes managers; ecological consultants; scientists with Colorado Parks and

Wildlife and Colorado State University; and others. Information from this effort was used to both develop the Guidance (see Section 5.1 below) and inform Policy development.

SME feedback included:

- Nutrient pollution, algae blooms, odors, and low oxygen concentrations were the primary water quality concerns
- A technical resource is needed to assist City staff with managing urban lakes water quality and implementing the Policy

2. **City Advisory Boards** were engaged during September of 2021 to solicit feedback on the project team's Policy development approach, including community engagement. City Advisory Boards included the Land Conservation and Stewardship Board; Natural Resource Advisory Board; Parks and Recreation Board; and Water Commission.

   City Advisory Board feedback included:

   - City-owned Urban Lakes and the City's management jurisdiction should be defined in the Policy
   - Recommended improving urban lakes water quality-related communication with community members
   - Suggested increasing transparency with how City-owned lakes are managed
   - Should be made clear that the Guidance is meant to support implementation of the Policy

   The project team presented final drafts of the Policy and Guidance to these City Advisory Boards in January 2022 and requested a formal motion from each board to recommend that City Council adopt the Policy.

3. The **Community at large** was engaged to better understand the diverse perspectives in our community regarding water quality in City-owned Urban Lakes. Engagement efforts were designed to be equitable and inclusive, to better understand the diverse perspectives in our community, with a focus on community members whose voices are often underrepresented during City processes.

   The project team's engagement approach included the development of an urban lakes water quality survey; the use of a social media campaign and the creation of project informational websites, where the survey was posted. All engagement materials were developed in both English and Spanish.

   City staff also engaged community members directly at targeted lakes and in using focused meetings with some groups. Targeted lakes, representing each department were selected using vulnerability indicators included in the City's 2021 Equity and Opportunity Assessment Study (City of Fort Collins, 2001b). Vulnerability indicators included housing, education, income and race and ethnicity. Targeted lakes included Overland Park Pond and Sheldon Lake (Parks); Arapaho Bend Ponds, North Shields Pond and Riverbend Ponds (Natural Areas); Avery Pond (Utilities); and Rigden Reservoir (Utilities/Natural Areas).

   The project team conducted 30 community engagement events at targeted lakes between May and June of 2022. A total of 437 people were observed engaged in various activities at targeted lakes. The project team directly engaged with 1,444 people at engagement events and a total of 273 surveys were completed.

   The majority of survey respondents (87%) identified as white, which is 2021 US census where 85% of people in Fort Collins identified as white. Respondent age varied greatly, with the exception of minimal participation in the 15–19-year-old range. Household income also varied greatly, with the most common responses (35%) indicating between $75,000- $150,000 household income. 15% of respondents indicated some college or an associate's degree, while 76% of respondents indicated an education level of Bachelor degree or higher.

   What did we learn from community members regarding City-owned urban lakes?

   - The City's urban lakes are highly valued assets to our community;

- Wildlife viewing, aesthetic, intrinsic and accessibility were the most commonly reported values;
- Hiking/walking, dog walking, wildlife viewing and fishing were the most commonly reported activities;
- Algae, odors and fish kills were the most common water quality concerns; and
  Nearly half of survey respondents reported that water quality had negatively impacted their experience and altered their patterns of usage.

> THE CITY'S URBAN LAKES ARE HIGHLY VALUED ASSETS TO OUR COMMUNITY

In summary, the City's urban lakes are important to many in our community and support wildlife habitat, provide natural beauty, intrinsic and other values. The community engagement survey helped staff to document our community's urban lakes water quality priorities and concerns. Engaging with community members at select urban lakes provided additional insight through observation of activities and direct feedback. It is concerning that nearly half of people surveyed have been negatively impacted by water quality issues in some City-owned urban lakes and avoid these areas. Survey respondents expressed support and appreciation for the development of an urban lakes water quality management Policy and Guidance.

The City's project team used a series focused meetings and facilitated workshops to create a draft Policy. The Policy was recommended for adoption by the City Advisory Boards above and was ultimately adopted by City Council on ?, 2023. The Policy is included in Attachment 1. The policy includes:

- a background, vision and purpose to provide a rationale for why Policy was developed;
- definitions for several key terms;
- a description of the City's urban lakes water quality management scope, including jurisdiction;
- expectations regarding urban lakes water quality management and management plans;
- communication between departments and the community; and
- staff accountability regarding Policy implementation, including future Policy and Guidance updates.

2.4 Urban Lakes Water Quality Management Guidance

The project team developed this Urban Lakes Water Quality Management Guidance as a technical resource to assist City staff with implementing the Policy. The Guidance is not intended to serve as a prescriptive water quality management plan for the City's urban lakes. Rather, water quality in urban lakes is complex and management plans should be developed on a case-by case basis.

This Guidance includes a complete inventory of all City-owned Urban lakes within the growth management area, as well as a summary of known water quality issues. Urban lakes management categories were developed based on departmental management goals and lakes were prioritized for management based on relative water quality risk. And lastly, a list of effective best management practices (BMPs) for mitigating water quality in urban lakes was developed. A suggested Guidance implementation approach is included in Section 3.0 below under 'How to Use this Guidance'. A detailed description of how each element of Guidance was developed is described in Section 5.0.

3.0 HOW TO USE THIS GUIDANCE

3.1 City-owned Lakes Managers

This Guidance provides City staff with an inventory of City-owned urban lakes within the City's GMA and which lakes are

under Natural Areas, Parks and Utilities management jurisdiction – where known. The Guidance also includes a summary of what is known about water quality in each of the City's Urban Lakes. This information can be accessed using Geodatabase tables in Appendix B of this document and the Map Book in Appendix C; using the Urban Lakes Map Package with ArcGIS Geographic Information System Software; and/or using Urban Lakes KMZ files with Google Earth.

The City owns hundreds of Urban Lakes that have either been specifically designed or adapted to meet a range of management goals, which can have water quality implications. Lakes have therefore been sorted into detention and retention lakes based on hydrologic regime and then further separated into management categories based on primary and secondary management goals.

Managing departments have the daunting task of determining which lakes within their jurisdiction should be prioritized for focused water quality management. In an effort to assist with these decisions, the project team developed a risk rank geospatial model that ranks retention lakes from low-high priority based on water quality risk.

And lastly, the Guidance contains a diverse toolbox of BMPs to assist managers with mitigating urban lakes water quality issues. BMPs include those designed to reduce pollution loading to lakes and others designed to mitigate existing water quality issues (see Appendix F).

3.2 Private Lakes Managers

Fort Collins' private lakes managers face many of the same water quality management challenges as those documented for the City's Urban Lakes. As such, there exists an opportunity for private lakes managers and City staff to share information on BMPs that have been successfully implemented to mitigate water quality issues. The City's project team engaged several local private lakes managers along with other local subject matter experts during Guidance development to identify urban lakes water quality challenges and appropriate BMPs. The project team anticipates that the BMP Toolbox in Attachment F of the Guidance will be particularly useful for assisting private lakes managers with managing water quality issues on private lakes.

4.0 ALIGNMENT WITH THE CITY AND STRATEGIC PLANS

Fort Collins' *City Plan* (City of Fort Collins 2019) lists Environmental Health as a key outcome area, which is supported by several policies and principles. The Urban Lakes Water Quality Management Policy and Guidance align with the Environmental Health principles listed below:

Principle ENV 1 – Conserve, create and enhance ecosystems and natural spaces within Fort Collins, the GMA and the region.
Principle ENV 6 – Manage water resources in a manner that enhances and protects water quality, supply and reliability.

The Policy and Guidance further aligns with the *City's Strategic Plan* by addressing the following strategic objectives:

Strategic Objective 4.5 – Protect and enhance natural resources on City-owned properties and throughout the community.
Strategic Objective 4.6 – Sustain and improve the health of the Cache la Poudre River and all watersheds within the City.

5.0 METHODS - HOW WAS THIS GUIDANCE DEVELOPED?

The project team developed this Guidance using the process summarized in Figure 5.1 below, including urban lakes data and information gathering; data analyses; development of a geographic information system geodatabase; and development of urban lakes water quality management tools. Detailed methods for each step of the Guidance development process are provided in subsections below.

5.1 Data and Information Gathering

An important first step in Guidance development was to gather existing water quality data and other information regarding the City's Urban Lakes. This process involved conducting subject matter expert (SME) interviews and surveys and a literature review.

Subject Matter Expert Interviews and Surveys

Internal (City staff) and external (non-City staff) subject matter expert (SME) interviews and surveys were conducted to gather data and other information about the City's urban lakes. SWCA conducted five 1-hour virtual interviews with SMEs selected by the City's project team. Three of the interviews were conducted with small groups of City staff (four to six attendees) from Parks, Utilities and Natural Areas Departments. The remaining two interviews were conducted with Colorado Parks and Wildlife (CPW) and Aquatic Associates, LLC staff. External SME surveys were also conducted to gather additional water quality related data and other information. The survey was sent to 12 external SME representatives from local ditch companies, Colorado State University, private lake homeowners associations (HOAs) within Fort Collins and local non-profits. In instances where there were incomplete responses to interview or survey questions or clarification was needed, SWCA conducted brief follow-up interviews or sent additional questions by email. Interview and survey structure and questions are included in Appendix A. In order to maintain anonymity, a complete list of individuals involved in the SME interviews and surveys is not provided herein.

Interviews and surveys helped inventory City-owned lakes; yielded information about lake-specific physical characteristics and water quality information; documented available water quality data sources; management objectives; and water quality best practices that have been implemented. Water quality information and data, including water quality issues and best management practices, were added to the geodatabase.

Literature Review

A literature review was conducted by SWCA to identify peer-reviewed literature and online-published news articles on urban lake water quality issues along Colorado's Front Range. Search terms included word combinations such as "Colorado urban lakes water quality," "Colorado urban lakes," "lake algae Colorado," and "Colorado lake fish kills." Resulting articles and news events were reviewed for water quality issues and best practices that may be applicable to the City's urban lakes. Results of the literature review were used to help develop a baseline inventory of urban lake water quality issues for this Guidance.

Inventory of City-Owned Urban Lakes

Data and information obtained during subject matter expert interviews and surveys and from the project team were used to develop a detailed inventory of City-owned lakes within the City's Growth Management Area (GMA).

Inventory of Water Quality Best Management Practices

An inventory of urban lakes water quality best practices (BMPs) was developed to provide lakes managers with a toolbox of relevant BMPs. BMPs can be grouped into two broad categories: those used to mitigate existing urban lakes water quality issues and those used reduce the risk of future issues occurring. The inventory of BMPs was compiled using information obtained during SME interviews and surveys and was augmented with additional BMPs as suggested by the project team.

5.2 Data Analyses

Water quality related information ere used to conduct a series of analyses including an inventory of known water quality issues impacting the City's lakes; the creation of management categories; and the development of a process to assist managers with prioritizing lakes for management.

Water Quality Issues Analysis

The Water Quality Issues Analysis (WBI) included an inventory of current, historic and potential future water quality impacts to the City's urban lakes. The project team compiled this information using SME interviews and surveys and the literature review described above. The inventory provides a description of each issue, causes, management challenges, recommended pollution mitigation best practices and other information.

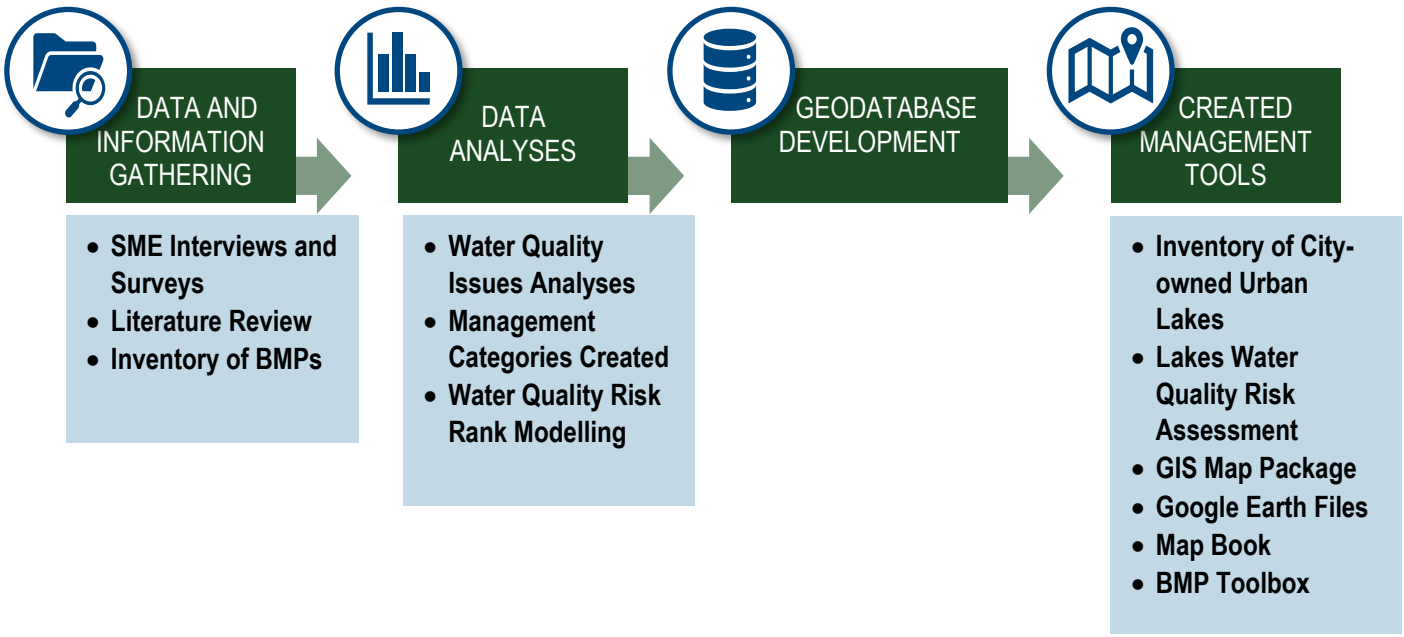

Figure 5.1. Graphic showing the process used for developing the City's Urban Lakes Water Quality Management Guidance.

Management Categorization

The City's urban lakes have been designed and are currently managed to achieve a range of goals, which can impact water quality to varying degrees. It is therefore useful for the City's urban lakes to be grouped into discrete management categories to better anticipate and mitigate water quality issues.

The project team used information obtained during SME interviews and surveys to develop a draft list of potential management categories for the City's urban lakes. The draft list was further refined using additional feedback from City staff from Natural Areas, Parks and Utilities Departments into a final list of urban lakes management categories.

Because many of the City's urban lakes are managed to achieve more than one management goal, primary and secondary management categories were assigned by the project team for each urban lake, where applicable.

Table 5.1 Table showing Water Quality Risk Rank Geospatial modelling scoring ranges, ranking categories and descriptions

WATER QUALITY RISK RANK GEOSPATIAL MODELLING		
Score	Risk Rank	Description
0.1-0.25	Low	Lakes with low risk of water quality issues
0.251-0.50	Medium	Lakes with medium risk of water quality issues
0.51-1.0	High	Lakes with high risk of water quality issues

Water Quality Risk Rank Model

City staff are tasked with managing the water quality of many urban lakes with limited resources. Which lakes should managers focus resources to address the highest water quality risks and achieve the greatest impact? The project team attempted to address this question by developing a Risk Rank Geospatial Model (Model) to help guide managers.

The Model combines a variety of lake water quality criteria, including primary and secondary management category; lake surface area; existing water quality issues; adjacent land use within 200 feet of the lake; estimated water residence time; groundwater connection to the Poudre River; and whether each lake is on the Colorado Department of Public Health and Environment's 303(d) List of Impaired and Threatened Waters.

These model inputs were broken out into separate categories, such as "yes" or "no" for existing water quality issues or "vacant," "residential," or "industrial" for adjacent land uses. The project team assigned a relative numeric value, or 'weight' to each model factor based on the level of urban lakes water quality management concern. For example, "vacant" land received a lower score than "commercial" because developed lots would be expected to present a greater water quality risk to adjacent lakes due to elevated risk of nutrient, pathogen and other pollutant loading.

Risk Rank Model scores were calculated for each lake by summing individual criteria scores (Table 5.1). Lake scores ranged from 0 to 1, with higher values near 1 representing lakes with a higher relative water quality risk. Scores were separated into three discrete bins corresponding to low (0.1–0.25), medium (0.251–0.5) and high (0.51–1.0) water quality risk. Lakes having no data for one or more criteria were not assessed. Model inputs; criteria descriptions, weights and supporting rationale; and calculated scores can be found in Attachment B.

Model risk rankings were validated using desktop analyses on a subset of 20 randomly selected lakes to ensure that the model was accurately calibrated. Minor adjustments were made to the numeric scores and weights as needed.

Geodatabase

The project team developed a geographic information system (GIS) geodatabase and an associated Map Package of City-owned Urban Lakes within the GMA. The geodatabase includes individual lake physical, chemical, biological and other water quality information collected during SME interviews and surveys and literature review. The metadata associated with the Risk Rank Model are also included in the Geodatabase.

5.3 Management Tools

The project team developed several tools to assist City staff with managing water quality in the City's Urban Lakes. These tools included an inventory of all City-owned lakes within the GMA (see Section 6.3); a water quality risk assessment (see Section 6.2.3); a Geographic Information System Map Package and Google Earth Files; a Map Book; and BMP Toolbox.

GIS Map Package, Google Earth Files and Map Book

An Urban Lakes Geographic Information System Map Package was developed to provide the City's lakes managers with interactive mapping tools in addition to what is provided in this Guidance. In addition to the Map Package, Google Earth KMZ files were also created, providing managers with the option to use Google Earth as an additional urban lakes management tool. And lastly, a Map Book including all of the City's Urban Lakes was developed as an additional reference for managers.

Best Management Practices Toolbox

The BMP Toolbox includes a list of more than 50 BMPs and additional supporting information for each, including a brief description of the BMP; water quality issue(s) being targeted; applicable lake conditions; any potential negative outcomes; relevant permitting and water rights for managers to consider; any potential BMP co-benefits, approximate costs, including operations and maintenance costs per year; and additional resources. A description of these attributes can be found in the *BMP Analysis Summary* below.

6.0 RESULTS - WHAT DID WE LEARN?

This section provides a summary of what was learned during the data and information gathering and analyses phases of the Guidance development process and the tools that have been developed to assist City staff with managing Urban Lakes water quality.

6.1 Inventory of City-owned Urban Lakes

City-owned urban lakes were sorted into two broad categories: detention and retention lakes. Detention lakes typically only hold water temporarily (<72 hours) and are mostly used to achieve specific stormwater management objectives. In contrast, retention lakes are characterized by holding water for longer periods of time (>72 hours) (**Figure 6.1**). Both categories of lakes were inventoried in this Guidance; however, the development of water quality management tools focused on retention lakes only.

Table 6.1. Table listing the number of detention and retention lakes managed by Natural Areas, Parks and Utilities Departments, and the total number of City-owned lakes.

CITY-OWNED URBAN LAKES			
	Detention Lakes	Retention Lakes	Total Lakes
Natural Areas	4	50	54
Parks	27	28	55
Utilities	87	7	94
Natural Areas/Utilities	0	3	3
Unknown	38	60	98
	156	**148**	**304**

There are a total of 461 lakes within the City's Growth Management Area; including 304 City-owned Urban Lakes and 157 that are not City-owned. The City's Urban Lakes include 148 detention lakes and 156 detention lakes (**Table 6.1; Figures 6.1 and 6.2**). The distribution of retention vs detention lakes under management by Natural Areas, Parks and Utilities Departments differs widely. Natural Areas primarily manages retention ponds, whereas Utilities manages mostly stormwater detention ponds. Parks manages roughly equal numbers of retention and detention ponds. It's important to note that a managing

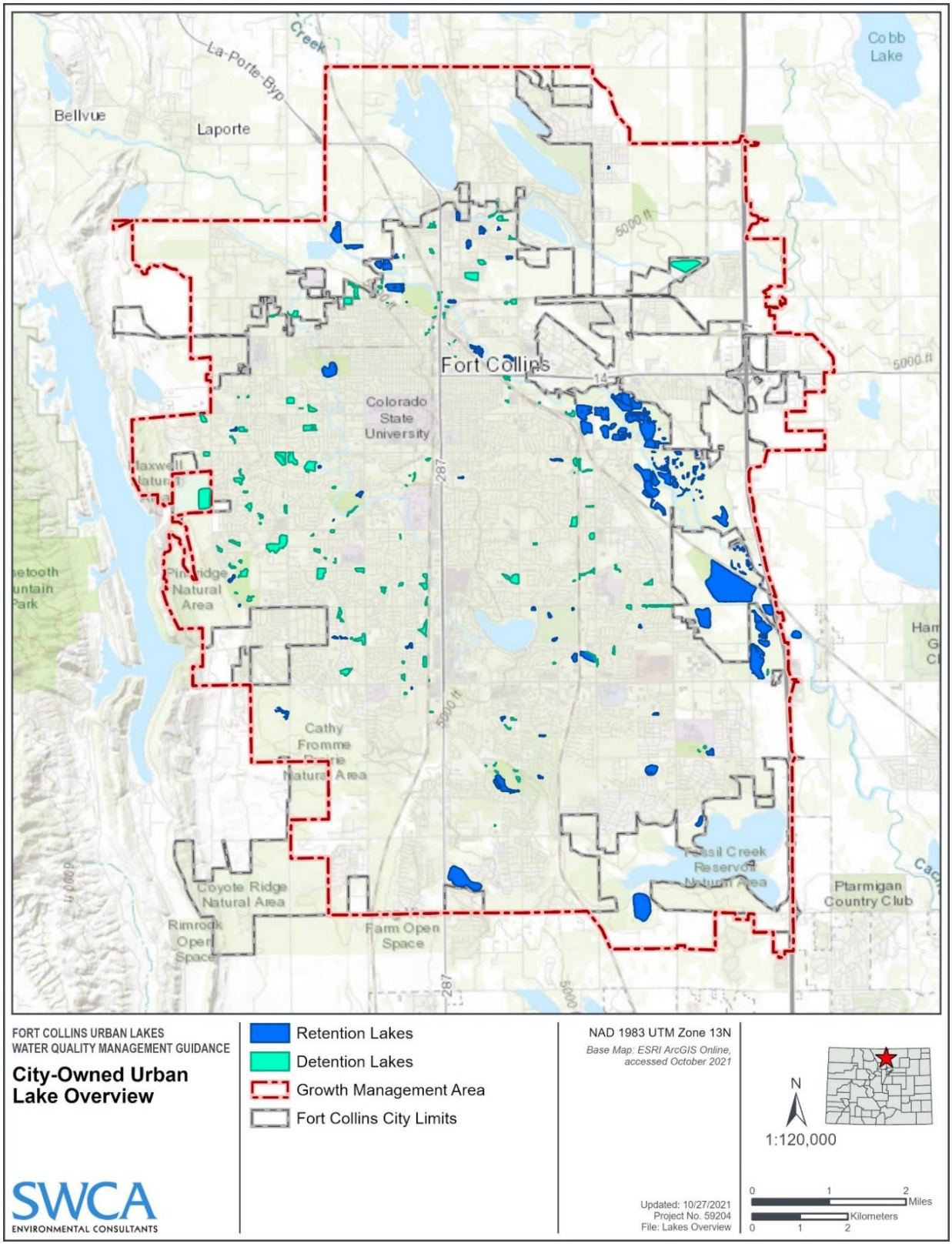

Figure 6.1. City of Fort Collins City-owned retention and detention lakes within the Fort Collins Growth Management Area (Source: City of Fort Collins 2005).

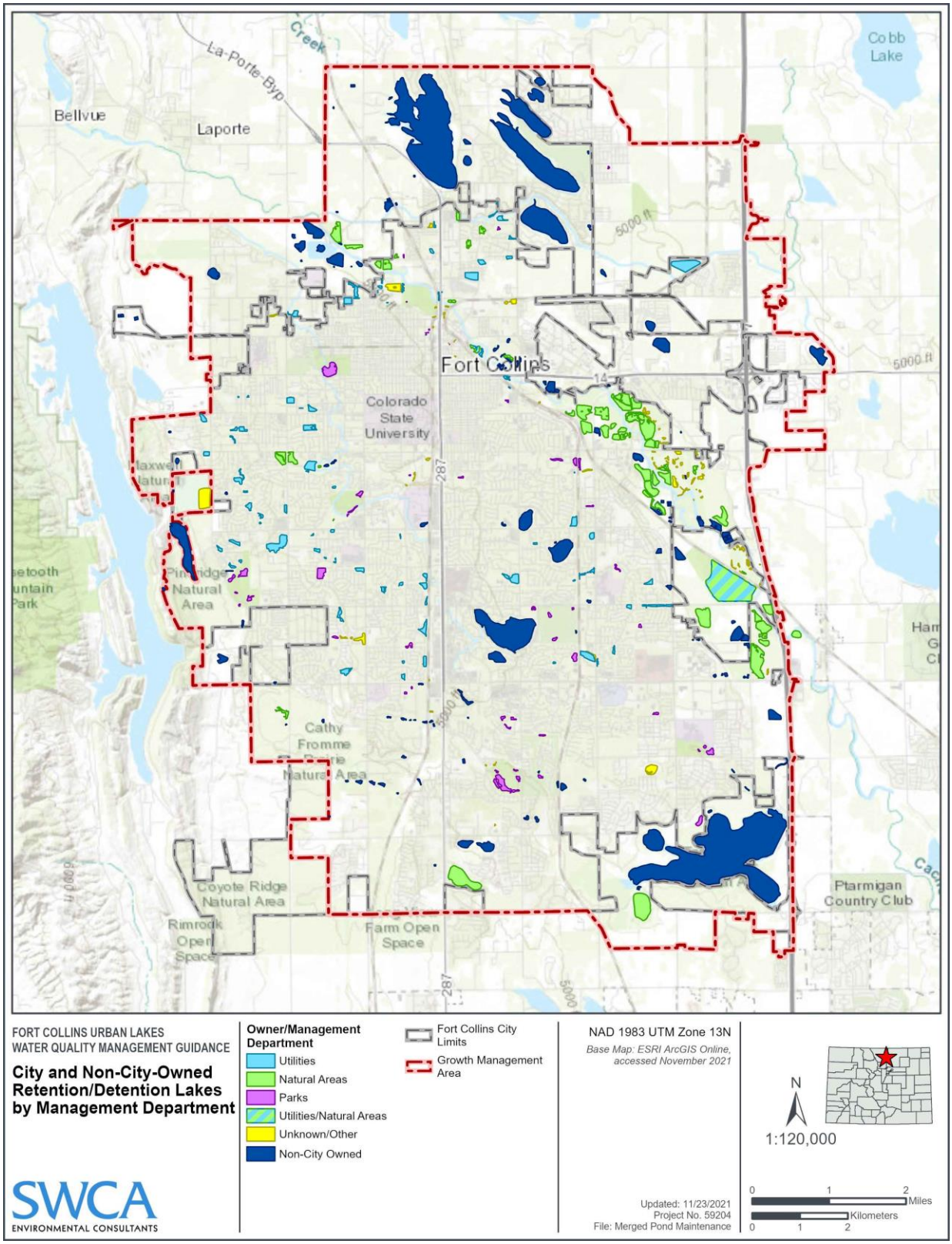

Figure 6.2. Map showing City-owned Urban Lakes within the GMA and managing department.

department has not currently been identified for 98, or 32% of City-owned lakes. A full list of City-owned detention and retention lakes, along with unique identification numbers (MXASSETNUM) and other data and information can be found in Attachment C. A detailed Mapbook of all City-owned Urban Lakes can be found in Attachment D.

6.2 Water Quality Issues

The water quality issues analyses resulted in 49 unique urban lakes water quality issues (Attachment E). Issues range from specific pollutants to physical causes of water quality degradation. Additional information includes a description of each issue; potential cause(s), management challenges and reference materials are also provided as management resources. Information regarding known urban lakes water quality issues is included in the Geodatabase and Urban Lakes attribute tables in Attachment C.

6.3 Management Categories

There were nine unique management categories created for this Guidance; these included: Golf Course, Wildlife, Fisheries, Stormwater/Flood Control, Ornamental, Recreation, Water Storage, Sediment Retention and Other/Urban. The City's retention lakes were assigned primary and secondary management categories based on departmental management objectives (**Table 6.2**). The majority of the City's retention lakes are managed to provide wildlife habitat, to serve as stormwater infrastructure features or as storage reservoirs. The most common departmental management categories were Wildlife, Storage and Stormwater/Flood Control for Natural Areas, Parks and Utilities, respectively.

6.4 Urban Lakes Geodatabase

The Urban Lakes Guidance Geographic Information System (GIS) Geodatabase contains an attribute table with detailed information about City-owned retention lakes. Managers are able to use the attribute table to quickly identify individual lakes using a unique identification number (MXASSETNUM) that is referenced in the City's Maximo Asset Management System as well as lake names, when available. Additional lake-specific information includes lake physical characteristics; managing department and assigned management categories; water quality issues referenced in see Appendix E; BMPs referenced in Appendix F that have been implemented and level of effectiveness; and additional notes to help inform managers. A complete copy of the Urban Lakes Geodatabase attribute table is included for reference in Appendix C. Please note that many of the City's urban lakes have little or no attribute data beyond a MXASSETNUM.

6.5 Map Package and Google Earth Geospatial Files

The Urban Lakes Geodatabase was used to develop an Urban Lakes GIS Map Package that can be used with Geographic Information System Software and KMZ lakes files that can be used with Google Earth. The Map Package and KMZ files contain the same lake specific attributes contained in Appendix A, providing managers with several options for accessing this information. The Risk Rank Model results (see below) can be viewed by lakes managers using the Map Package and .KMZ files in Google Earth.

6.6 Urban Lakes Water Quality Risk Rank Model

The Urban Lakes Water Quality Risk Rank Model was developed to help the City's lakes managers identify which retention lakes are at low, medium and high risk for water quality issues. The model identified 19 retention lakes that are considered the highest priority based on known water quality history, adjacent land use and other risk factors (**Table 6.2**). A full listing of prioritization ranks for retention lakes is available in Attachment C and a map of these lakes is included in **Figure 6.3**. There were 58 lakes that could not be assessed because necessary data to run the model were lacking.

Table 6.2. Table summarizing urban lakes primary and secondary management categories for retention lakes managed by Natural Areas, Parks, Utilities and Utilities/Natural Areas Departments. The number of retention lakes managed by each department is shown in parentheses.

URBAN LAKE MANAGEMENT CATEGORIES				
	Natural Areas (50)	**Parks (28)**	**Utilities (7)**	**Utilities/ Natural Areas (3)**
Golf Course		1		
Wildlife	50			2
Fisheries	11			
Stormwater/Flood Control	27	2	5	2
Ornamental				
Recreation	10			
Storage		27	2	1
Sediment Retention				
Other/Urban		1		

Table 6.3. Table summarizing City-owned urban lakes that are considered the highest priority for management based on risk rank water quality modelling.

HIGH PRIORITY URBAN LAKES		
Lake Name	**Managing Department**	**Priority**
Prospect Ponds North	Natural Areas	High
Merganser Pond (Prospect Ponds)	Natural Areas	High
Catfish Pond (Prospect Ponds)	Natural Areas	High
Heron Pond	Natural Areas	High
Cathy Fromme Pond	Natural Areas	High
Blackbird Pond (Cattail Chorus)	Natural Areas	High
Sunfish Pond (McMurry)	Natural Areas	High
Duck Lake	Natural Areas	High
Little and Big Bass Ponds (Arapaho Bend)	Natural Areas	High
I-25 Pond (Arapahoe Bend)	Natural Areas	High
Homestead Pond	Natural Areas	High
Edora Park Pond	Parks	High
Spring Creek Park Pond	Parks	High
Spring Creek Dog Park Pond	Parks	High
Portner Reservoir #2	Parks	High
Portner Reservoir #3	Parks	High
Sheldon Lake	Parks	High
Fossil Creek Community Park Pond #1	Parks	High
Troutman Park Pond - East	Parks	High

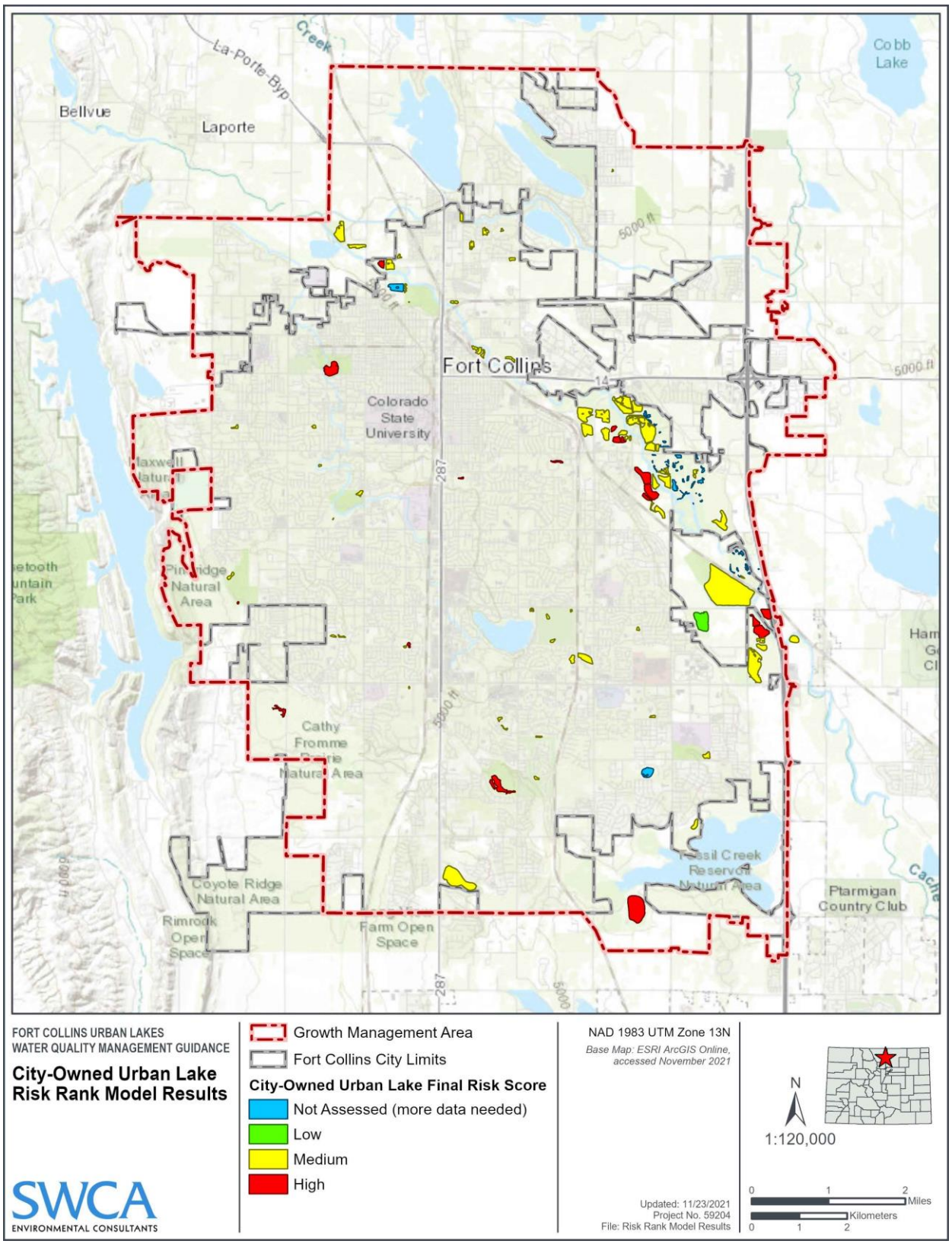

Figure 6.3. Map showing water quality risk rankings, from low to high, for the City's urban retention lakes.

6.7 Best Management Practices Toolbox

The BMP inventory that was conducted as part of Guidance development was used to create a BMP Toolbox (Appendix F). The BMP Toolbox includes 51 unique BMPs, including those currently used by City staff, and others that were suggested by SMEs or identified by the project team. BMPs include those that are designed to mitigate existing water quality issues and those that are reduce the risk of future water quality issues. BMPs are designed to target water quality issues such as algae blooms, macrophytes, sedimentation, water-borne pathogens, low dissolved oxygen, nutrient loading and other management challenges. Each BMP is detailed in the BMP Toolbox; including a description on the BMP, treatment mechanism, targeted pollutants, cost estimates for implementation, references and other information.

7.0 FUTURE RECOMMENDATIONS

This Guidance is meant to provide a starting point for City staff tasked with managing Urban Lakes water quality – including a lakes inventory and management tools. An important next step for managers will be to prioritize lakes for management based on information in this Guidance and other resources and to develop specific management plans with targeted mitigation strategies as necessary.

This Guidance is intended to be iterative and should be updated periodically to maintain an accurate inventory of the City's Urban Lakes, water quality issues impacting these important resources and the latest BMPs. The Geodatabase, .KMZ map files and Risk Rank Model should also be updated as necessary over time to add new lakes or edit attributes of existing lakes.

The Guidance has been primarily developed to support the City's Urban Lakes management. However, it will be shared with the public and will likely be particularly useful for private lakes managers. It is recommended that the City also develop a webpage containing the Guidance and other information about the City's Urban Lakes and ways our community can help reduce water quality impacts. It is further recommended that the City develop an interactive webmap that allows the public to learn more about Urban Lakes water quality concerns.

And lastly, the Urban Lakes Water Quality Management Policy and Guidance were developed using a cross-departmental One Water Approach. The process ultimately aligned Natural Areas, Parks, Utilities and provided an opportunity for increased communication, teamwork, the identification of co-benefits, and overall integration of resource management. It is the hope of the project team that this project serves as another strong example of the potential benefits of adopting a City-wide One Water Framework.

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ATTACHMENT 1 – URBAN LAKES WATER QUALITY MANAGEMENT POLICY

City of Fort Collins

Water Quality Management Policy for City-Owned Lakes and Stormwater Basins in the Growth Management Area

Background

As development and urbanization have continued and increased in the Fort Collins Growth Management Area ("GMA"), new and existing water quality challenges in lakes and stormwater basins have arisen and intensified. Examples of these challenges include: pollution associated with urban growth, development, and land use practices; climate change; and other factors that can lead to water quality impacts such as sedimentation, fish kills, algae blooms, and water-borne pathogens.

The City of Fort Collins ("City") recognizes the importance of managing water quality in lakes and stormwater basins to support management goals for the benefit of community, ecosystems, and downstream water quality. Such management can also implement the City's triple bottom line approach to consider social, economic, and environmental impacts, as well as supporting and furthering various City plans and objectives related to water quality. Numerous lakes and stormwater basins in the GMA are privately owned. By comparison, the City has some degree of control and influence over the water quality of the lakes and stormwater basins it owns.

This City of Fort Collins Water Quality Management Policy for City-Owned Lakes and Stormwater Basins in the Growth Management Area ("Policy"), and the associated Guidance Document, have been created to provide a foundational framework for the City's operational and management decisions related to water quality in City-owned lakes and stormwater basins.

This Policy was developed using an integrated One Water approach by an inter-departmental team of City staff, including the Managing Departments listed below. The Policy's content was further informed by feedback from key stakeholder groups, which included: urban lakes and water quality management subject matter experts; the City's Land Conservation and Stewardship Board, Natural Resources Advisory Board, Parks and Recreation Board, and Water Commission; and members of the Fort Collins community.

Vision and Purpose of the Policy

The City's vision is that water quality in City-owned lakes and stormwater basins in the GMA supports management goals while also maintaining or improving aesthetics. To that end, the purpose of this Policy is to provide a foundational framework for the City's operational and management decisions related to water quality management in City-owned lakes and stormwater basins.

Key Terms

The following describes and discusses several key terms used throughout this Policy.

City-owned lakes and stormwater basins refers to lakes and stormwater basins where the City owns the surrounding and underlying land and thus manages the water in them.

Fort Collins Growth Management Area ("GMA") is as defined in Section 1-2 of the Fort Collins Municipal Code, being the Fort Collins Urban Growth Area as defined in Article XIII of the Charter of the City, namely, that geographic area within and adjacent

to the City identified by the Intergovernmental Agreement between the City and Larimer County as that area identified for annexation and urbanization by the City, including the Urban Growth Area as it exists on March 5, 1985, together with any amendments or changes thereto.

Guidance Document refers to a separate document the City has developed and will update as a technical resource intended to support City staff in implementing this Policy. The Guidance Document provides Managing Departments with management tools, including[1]:

- Inventory of all City-owned lakes and stormwater basins;
- Certain water quality-related information for City-owned lakes and stormwater basins;
- Management categorization for City-owned lakes and stormwater basins, based on management goals of the respective Managing Departments;
- Assistance with management prioritization; and
- Best management practices for water quality management.

Lakes refer to basins and depressions that are generally filled with water. For the purposes of this Policy, lakes include: on- and off-stream reservoirs filled with water diverted from the stream; ponds used to manage water for irrigation and other uses; unlined gravel pits that have filled in with groundwater; and other basins and depressions that are generally filled with water.

Managing Departments refer to the components of the City organization that manage the City-owned lakes and stormwater basins. The current Managing Departments are Natural Areas, Parks, and Fort Collins Utilities.

Stormwater Basins refer to areas that are designed to collect precipitation runoff, including snowmelt. Stormwater basins include both: stormwater detention basins/ponds, which are designed to temporarily detain stormwater, generally for less than 72 hours; and stormwater retention basins/ponds, which are designed to detain or store stormwater runoff for longer than 72 hours. Stormwater retention basins/ponds may also be lakes. Although stormwater basins do not always have water in them, they can influence water quality and are thus included in this Policy.

Water quality refers to the physical, chemical and biological characteristics of water. Numerous human and natural factors can influence water quality.

Water quality management refers to the use of pollution prevention and/or mitigation best practices to address water quality management goals.

Scope and Applicability of this Policy

This Policy applies only to City-owned lakes and stormwater basins in the GMA. Nothing in this Policy is intended to conflict with any applicable laws, including: the City Charter and City Code; Colorado state law, including permits and approvals issued thereunder; federal law, including permits and approvals issued thereunder; and applicable agreements and other contractual arrangements. To the extent that there is such a conflict, the applicable law controls.

This Policy does not apply to lakes and stormwater basins in the GMA that are not City-owned. For example, this Policy does not apply to lakes and stormwater basins owned by homeowners associations, or lakes owned by ditch or reservoir companies in which the City owns shares. The owners of such other lakes and stormwater basins are free to consider this Policy and the Guidance Document, in their discretion, in their management of their structures.

This Policy does not apply to lakes and stormwater basins that are outside of the GMA. This includes reservoirs the City owns that are outside of the GMA (e.g., Joe Wright Reservoir). Those lakes and stormwater basins are generally located outside of the urban environment and face challenges distinct from those addressed in this Policy. The water quality challenges of those

[1] In this Policy, "include" signifies a list that is not necessarily exhaustive.

lakes and stormwater basins are thus addressed separately. The owners of such other lakes and stormwater basins are free to consider this Policy and the Guidance Document, in their discretion, in their management of those structures.

Management

Each Managing Department will manage water quality in their lakes and stormwater basins to address their own management goals. Specifically, Managing Departments will:

1. Identify which City-owned lakes and stormwater basins they are responsible for, relying on the inventory in the Guidance Document. If more than one Managing Department is responsible for a lake or stormwater basin, the responsible Managing Departments will work together on all aspects of management.
2. Identify the management goals for their lakes and stormwater basins based on their uses and purposes. This may include a consideration of the categories of types of lakes and stormwater basins and their various uses and purposes, as described in the Guidance Document.
3. Determine which of their City-owned lakes and stormwater basins should be prioritized for water quality management or other related actions.
4. Determine whether to act (or not act) on water quality issues.[2]
5. Develop water quality management plans as necessary for prioritized City-owned lakes and stormwater basins (as discussed below).
6. Collaborate with other Managing Departments where responsibilities, projects, or other actions related to water quality management overlap with or will affect other departments.
7. Communicate internally within the City organization and externally to the Fort Collins community (as discussed below).

Management Plans

Managing Departments will develop water quality management plans for individual lakes and stormwater basins, as necessary, to address their water quality management goals. These plans may be separate, standalone documents, or may be integrated into other plans or other documents related to their lakes and stormwater basins. These plans should include:

- statement of the Managing Department's goals and priorities for their lakes and stormwater basins;
- consideration of the analyses, recommendations, and other aspects of the Guidance Document;
- water quality-related goals for their lakes and stormwater basins;
- water quality management practices for their lakes and stormwater basins;
- a communication strategy (as discussed below); and
- other items appropriate to further the Managing Department's goals and priorities.

Communication

Consistent with their communication strategy, Managing Departments will communicate internally within the City organization and externally with the Fort Collins community regarding water quality of lakes or stormwater basin. This will include communications regarding: water quality data; any public health risks; and non-routine maintenance work. Communications will be made pursuant to applicable City policies. Managing Departments will periodically communicate internally to improve interdepartmental alignment regarding water quality management practices.

Policy and Guidance Document Updates

An inter-departmental team from all of the Managing Departments (minimum 1 staff member from each) will be established to ensure proper implementation of this Policy and to periodically revise and update the Policy and Guidance Document as needed.

[2] How Managing Departments staff and otherwise resource their actions are not addressed in this Policy.

The team will annually review the Guidance Document to identify and address data errors, necessary updates, and other opportunities for improvement, including:

- Adding any City-owned lakes and stormwater basins to the inventory;
- Updating lake-specific water quality information; and
- Adding or updating water quality management practices.

ATTACHMENT 2 – SUBJECT MATTER EXPERT (SME) INTERVIEW AND SURVEY QUESTIONS

SME Interview Questions

- What is your role and background in managing water quality issues?
- Are there any lakes represented in the GMA that are not highlighted but should be?
- Which Urban Lakes do you manage?
- What are their surrounding land uses?
- What are their major uses?
- Are there known water quality issues in the waterbodies that you manage? Are their historic, current, and future water quality concerns in these waterbodies?
- What are the causes of these water quality issues?
- Are there known BMPs implemented at the lakes that you manage? Do you know of historic, current, or emerging/potential BMPs that were used or would be helpful in managing these water quality issues?
- Are there any BMPs that you would like to try to manage water quality issues?
- Were the BMPs that have been used to treat water quality issues effective?
- What Management Categories would you place the lakes that you manage into:

  Golf Course

  Wildlife

  Fisheries

  Stormwater/Flood Control

  Ornamental

  Recreation

  Storage

  Sediment Retention

  Other/Urban

1. Who else would you recommend that we reach out to for this project?
2. Do you have any water quality or BMP data for the urban lakes within the GMA that you would be willing to share?

SME Survey Questions

1. Are you a lake manager or do you support the management of lakes?
2. What are the three most critical water quality issues that trigger management action for you?

3. What are the other water quality issue(s)?
4. What are the main sources of pollution for the water quality issues you listed in #2? Such as livestock inputs, urban development, rangeland use, agriculture, stormwater runoff, pet waste, low flow, no lake inlet/outlet, etc.
5. Of the lake water quality best management practices (BMPs) that you use, what are the three most common or effective? BMPs are tools used to manage urban lake water quality. Though there are many, examples include hand-pulling aquatic nuisance species, using biochar to remove nutrients, developing wetland habitat to sequester pollutants, and providing pet waste bags and bins to avoid/reduce animal waste from entering the waterbody.
6. Are there other water quality BMPs that you would prefer to use, and if so what are they?
7. When you consider your ability to effectively manage water quality in urban lakes, what resources limit your success? These may be factors such as knowledge, data, sampling technicians (i.e., work force), funding, red tape, stakeholder buy-in, etc.
8. When getting buy-in or opinions about urban lake policy, which groups or organizations in the community are most important to talk with? Please list them below.

- What are three key pieces of literature or resources you would recommend on urban lake water quality management and/or BMPs? Please provide as much citation information as possible. Such as books, articles, manuals, online databases, web platforms, etc.

ATTACHMENT 3 - URBAN LAKES WATER QUALITY RISK RANK MODEL

MODEL INPUT	DATA SOURCE	CRITERIA	DESCRIPTION	REASONING	SCORE	WEIGHT	VALUE SCORE
Adjacent Land Use (within 200ft)	City Geodatabase	Vacant	Land zoned as vacant that may be developed or undeveloped.	Vacant lands include all lands classified as vacant by the City.	0.5	0.1	0.05
		Residential	Land zoned as residential, that may have single family or multi-family structures, and may have lawns.	Residential lands include all single, duplex, and multi-family areas, supplementary, support, and HOA lands, support shelters, and senior citizen housing.	0.5		0.05
		Public	Public use lands, which may include parks, open space, other.	Public lands include BLM, cemeteries, religious buildings, childcare centers and education facilities (including grade school and colleges/universities), county admin and housing, parks and rec land, conservation lands, municipality buildings, emergency infrastructure, and others.	0.5		0.05
		Industrial	Industrial land that may include all structures, storage yards, and waste facilities associated with industrial operations.	Industrial lands that include construction, manufacturing, industrial condos, and warehouses.	0.25		0.025

MODEL INPUT	DATA SOURCE	CRITERIA	DESCRIPTION	REASONING	SCORE	WEIGHT	VALUE SCORE
		Commercial	Commercial land that may include all structures, storage yards, parking, lawns, and features associated with commercial operations.	Commercial lands that include businesses, residential, multi-use, or recreational use.	0.5		0.05
		Agriculture	Agricultural land that may include all structures, storage yards, waste areas, fields, and pastures that may be associated with crop or livestock farming.	Agriculture lands that include dry, irrigated, grazed, hay meadow, waste, or support infrastructure for agriculture.	1		0.1
Primary Management Category	City Geodatabase	Stormwater/Flood Control/Floodplain Expansion	Lake or pond used primarily for managing stormwater runoff, flood control, and/or floodplain expansion	Ponds used for stormwater, flood control, and floodplain expansion appear to have more water quality issues related to runoff, and therefore higher likelihood of having water quality issues.	1	0.05	0.05
		Wildlife	Lake or pond managed primarily for wildlife, other than just fisheries.	Ponds managed for wildlife may have more native aquatic vegetation, cycling of nutrients, and healthier system cycling, which may reduce potential for water quality issues.	0.25		0.0125
		Stormwater	Lake or pond managed primarily for stormwater without specificity, such as flood control, floodplain expansion, or water quality.	Ponds used for stormwater, flood control, and floodplain expansion appear to have more water quality issues related to runoff, and therefore higher likelihood of having water quality issues.	1		0.05

MODEL INPUT	DATA SOURCE	CRITERIA	DESCRIPTION	REASONING	SCORE	WEIGHT	VALUE SCORE
		Native Fisheries	Lake or pond managed primarily for native fisheries	Ponds managed for native fisheries appear to have populations of native aquatic vegetation, cycling of nutrients, and overall monitoring, which may reduce potential for water quality issues.	0.25		0.0125
		Storage/Irrigation	Lake or pond used primarily for storage and/or storage for irrigation use	Ponds used for storage and irrigation appear to have more water quality issues related to runoff, sedimentation, residence time, and/or nutrient loading, and therefore have a higher likelihood of having water quality issues.	1		0.05
		Stormwater/Water Quality	Lake or pond used primarily for managing stormwater runoff and water quality of downstream waterbodies.	Ponds used for stormwater and water quality appear to have more water quality issues related to runoff, and therefore higher likelihood of having water quality issues.	0.5		0.025
		Recreation	Lake or pond used primarily for recreational human use, such as swimming, boating, fishing, etc.	Ponds used for recreation are more likely to be monitored for water quality and therefore are less likely to have ongoing water quality issues.	0.25		0.0125
Secondary Management Category	City Geodatabase	Stormwater/Flood Control/Floodplain Expansion	Lake or pond used primarily for managing stormwater runoff, flood control, and/or floodplain expansion	Ponds used for stormwater, flood control, and floodplain expansion appear to have more water quality issues related to runoff, and therefore higher likelihood of having water quality issues.	1	0.025	0.025
		Wildlife	Lake or pond managed primarily for wildlife, other than just fisheries.	Ponds managed for wildlife may have more native aquatic vegetation, cycling of nutrients, and healthier system cycling, which may reduce potential for water quality issues.	0.25		0.00625

MODEL INPUT	DATA SOURCE	CRITERIA	DESCRIPTION	REASONING	SCORE	WEIGHT	VALUE SCORE
		Stormwater	Lake or pond managed primarily for stormwater without specificity, such as flood control, floodplain expansion, or water quality.	Ponds used for stormwater, flood control, and floodplain expansion appear to have more water quality issues related to runoff, and therefore higher likelihood of having water quality issues.	1		0.025
		Native Fisheries	Lake or pond managed primarily for native fisheries.	Ponds managed for native fisheries appear to have populations of native aquatic vegetation, cycling of nutrients, and overall monitoring, which may reduce potential for water quality issues.	0.25		0.00625
		Non-native Fisheries	Lake or pond managed primarily for non-native fisheries.	Ponds managed for non-native fisheries may have populations of native aquatic vegetation, cycling of nutrients, and overall monitoring, which may reduce potential for water quality issues. However, some non-native fish can exacerbate water quality issues.	0.3		0.0075
		Storage/Irrigation	Lake or pond used primarily for storage and/or storage for irrigation use	Ponds used for storage and irrigation appear to have more water quality issues related to runoff, sedimentation, residence time, and/or nutrient loading, and therefore have a higher likelihood of having water quality issues.	1		0.025
		Stormwater/Water Quality	Lake or pond used primarily for managing stormwater runoff and water quality of downstream waterbodies.	Ponds used for stormwater and water quality appear to have more water quality issues related to runoff, and therefore higher likelihood of having water quality issues.	0.5		0.0125

MODEL INPUT	DATA SOURCE	CRITERIA	DESCRIPTION	REASONING	SCORE	WEIGHT	VALUE SCORE
		Recreation	Lake or pond used primarily for recreational human use, such as swimming, boating, fishing, etc.	Ponds used for recreation are more likely to be monitored for water quality and therefore are less likely to have ongoing water quality issues.	0.25		0.00625
Lake Size (surface area)	City Geodatabase	Very Large	>30 acres	Very large ponds likely have less residence time, less relative surface area for evaporative loss, solar insulation, and provide greater opportunity for dilution for chemicals, nutrients, etc. They are therefore less likely to have water quality issues.	0.25	0.1	0.025
		Large	6-29 acres	Large ponds likely have less residence time, less relative surface area for evaporative loss, solar insulation, and provide greater opportunity for dilution for chemicals, nutrients, etc. They are therefore less likely to have water quality issues.	0.5		0.05
		Medium	1-5 acres	Medium ponds likely have greater residence time, greater relative surface area for evaporative loss, solar insulation, and can easily become concentrated with chemicals, nutrients, etc. They are therefore less likely to have water quality issues.	0.75		0.075
		Small	<1 acre	Small ponds likely have greater residence time, greater relative surface area for evaporative loss, solar insulation, and can easily become concentrated with chemicals, nutrients, etc. They are therefore less likely to have water quality issues.	1		0.1

MODEL INPUT	DATA SOURCE	CRITERIA	DESCRIPTION	REASONING	SCORE	WEIGHT	VALUE SCORE
Known Water Quality Issues?	City Geodatabase	Yes	Known water quality issues present.	If a known water quality issue already exists, a pond is automatically designated as being prone to water quality issues.	1	0.225	0.225
		No	No known water quality issues present		0		0
Residence time contributor?	City Geodatabase	Yes	Pond water residence time is a contributor to water quality issues.	Ponds with greater residence time are more likely to have water quality issues. If residence time is a contributor to water quality issues, this has been identified by SMES.	1	0.2	0.2
		No	Pond water residence time is not a contributor to water quality issues.	Ponds with less residence time are less likely to have water quality issues. If residence time is a contributor to water quality issues, this has been identified by SMES.	0		0
303d Listed Lake?	EPA 303d Listed Impaired Waters	Yes	The pond is 303d listed.		1	0.2	0.1
		No	The pond is not 303d listed.		0		0
Within Poudre River alluvium soil layer?	NRCS Soils Layer	Yes	The pond overlaps with the Poudre River alluvium soil layer.	Based on SME input, there appears to be some correlation with connectivity to the Poudre and water quality issues. Those with greater connectivity have greater turnover, and therefore fewer water quality issues.	0	0.05	0
		No	The pond does not overlap with the Poudre River alluvium soil layer.	Based on SME input, there appears to be some correlation with connectivity to the Poudre and water quality issues. Those with greater connectivity have greater turnover, and therefore fewer water quality issues.	1		0.05

MODEL INPUT	DATA SOURCE	CRITERIA	DESCRIPTION	REASONING	SCORE	WEIGHT	VALUE SCORE
Within Poudre River groundwater layer?		Yes	The pond overlaps with the Poudre River groundwater layer.	Based on SME input, there appears to be some correlation with connectivity to the Poudre and water quality issues. Those with greater connectivity have greater turnover, and therefore fewer water quality issues.	0	0.05	0
		No	The pond does not overlap with the Poudre River groundwater layer.	Based on SME input, there appears to be some correlation with connectivity to the Poudre and water quality issues. Those with greater connectivity have greater turnover, and therefore fewer water quality issues.	1		0.05

ATTACHMENT 4 – URBAN LAKES GEODATABASE AND ATTRIBUTE TABLE

Attachment 4 Table 1. Geodatabase Attribute Table for Fort Collins' Urban Retention Lakes. Unknown and <Null> represent lake attributes where there is currently no information available.

MXASSETNUM	FACILITY ID	NAME	AKA	DEPTH (FEET)	VOLUME	OWNED BY	MAINTAINED BY	PRIMARY MANAGEMENT CATEGORY	SECONDARY MANAGEMENT CATEGORY	ADJACENT LAND USE	WATER QUALITY ISSUE(S)	CAUSE(S) OF WATER QUALITY ISSUE(S)	DOES LAKE RESIDENCE TIME CONTRIBUTE TO WATER QUALITY ISSUES?	CURRENT BMPS	HISTORIC BMPS	BMPS SUCCESSFUL? (Y/N/U)	INVASIVE SPECIES PRESENT? (Y/N/U)	NOTES	FINAL RISK SCORE	RISK RANK
10216270	<Null>	Port of Entry Pond - Arapaho Bend	<Null>	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	Unknown	Unknown	No	Maintain vegetation buffer; herbicide buffer	Monitored for turbidity, metals, nutrients, etc.	Unknown	No	Receives river water during spring runoff	0.3125	Medium
10216282	sw10574	Heatheridge Pond 1	Red Fox Meadows	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	Unknown	Unknown	Yes	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	<Null>	0.375	Medium
10216283	sw9383	Song Sparrow Pond - Cattail Chorus	Spring Creek Trail Orthopedic Pond 2	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	<Null>	0.35	Medium
10216292	<Null>	Rolland Moore Pond	<Null>	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Park/Golf Course	algae blooms; fish kills; weeds; grasscarp	Unknown	No	Aeration; water quality monitoring; 20–30-ft buffer	Unknown	Yes	No	<Null>	0.3625	Medium
10216293	<Null>	Artist Point Pond - Cottonwood Hollow	<Null>	shallow	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	water levels fluctuate massively; have control structure - let the water levels rise in the spring and then release it as there are calls on the river	0.325	Medium
10216308	<Null>	Gadwell Pond - Kingfisher	Kingfisher Park Pond - North	shallow	Unknown	City of Fort Collins	Natural Areas	Wildlife	Recreation	Natural ecology	fish kills	shallow; water levels get low	No	Habitat restoration	Unknown	Unknown	No	Restoration in 2018 to lower banks on north and west side of the pond and establish wetland habitat	0.30625	Medium
10216348	<Null>	Wiper Pond - Riverbend Ponds	<Null>	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Recreation	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	10.83 ac	0.30625	Medium
10443765	<Null>	Resource Recovery Farm Pond - Running Deer	<Null>	5	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	Unknown	Unknown	No	Maintain vegetation buffer; herbicide buffer	Monitored for turbidity, metals, nutrients, etc.	Unknown	No	<Null>	0.3	Medium
10217862	sw10215	Edora Park	Edora Park	N/A	N/A	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	N/A	extremely silted in, depth/ capacity, nutrient loading; odor when pond is low	extremely silted in after 2012 flood	N/A	N/A	Jason Stutsman did quick assessment above silt bed when doing restoration work.	N/A	N/A	RETENTION cfarnes *MOVE TO Retention	0.5625	High
10216409	<Null>	Trout Pond - Riverbend Ponds	<Null>	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Recreation	Natural ecology	fish kills	cold temperatures; low DO	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	9.27 ac, north near walkway, 2 connected by fishing dock	0.30625	Medium
10217810	sw20240	Parks & Rec Westfield Park Pond	Parks & Rec Westfield Park Pond	Unknown	Unknown	City of Fort Collins	Parks and Trails	Stormwater/ Flood Control/ Floodplain Expansion	None	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	confirmed retention by City	0.3875	Medium

MXASSETNUM	FACILITY ID	NAME	AKA	DEPTH (FEET)	VOLUME	OWNED BY	MAINTAINED BY	PRIMARY MANAGEMENT CATEGORY	SECONDARY MANAGEMENT CATEGORY	ADJACENT LAND USE	WATER QUALITY ISSUE(S)	CAUSE(S) OF WATER QUALITY ISSUE(S)	DOES LAKE RESIDENCE TIME CONTRIBUTE TO WATER QUALITY ISSUES?	CURRENT BMPS	HISTORIC BMPS	BMPS SUCCESSFUL? (Y/N/U)	INVASIVE SPECIES PRESENT? (Y/N/U)	NOTES	FINAL RISK SCORE	RISK RANK
10216421	<Null>	Wood Duck Pond - Magpie Meander	Magpie Meander Natural Area Pond 2	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Non-native Fisheries	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	<Null>	0.3575	Medium
10216428	<Null>	Various Ponds - Running Deer	Running Deer Natural Area	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	fish kills	cold temperatures; low DO	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	<Null>	0.325	Medium
10216463	<Null>	Skunk Pond - Prospect Ponds	Prospect Ponds - North	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Recreation	Urban	periodic algae blooms; fish kills; low DO; nutrients	Part of 3 pond complex, northernmost pond on private land fed directly by feedlot with documented fish kills; nutrients; eutrophication; low DO; can be very deep to very shallow; inversion-related fish kills	No	Unknown	Unknown	Unknown	No	old gravel pit; no longer stocked with fish due to poor fishery until mitigation is done or cows are gone; IS THIS PRIVATE OR CITY OWNED? Kyle Battige (CPW) mentioned northern-most pond in complex was on private property, maybe he meant just the feedlot w	0.53125	High
10216899	sw26369	Miramont Park Pond	<Null>	Unknown	Unknown	City of Fort Collins	Parks and Trails	Stormwater/ Water Quality	None	Residential/ Lawns	Unknown	Unknown	No	20–30-ft buffer	Unknown	Unknown	No	<Null>	0.3875	Medium
10217901	sw16201	North College Market Pl Pond	North College Market Pl Pond	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	None	Urban	Unknown	Unknown	Unknown	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	confirmed retention by City	0.35	Medium
10217320	sw22579	Utilities Pond #1	Utilities Pond #1	Unknown	Unknown	City of Fort Collins	Utilities	Stormwater/ Flood Control/ Floodplain Expansion	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	wetland; confirmed retention by City; THIS IS THE 1st wetland that treats sw runoff from 700 Wood Street, NE of the light & power transformer yard.	0.3375	Medium
10217527	sw22580	Utilities Pond #2	Utilities Pond #2	Unknown	Unknown	City of Fort Collins	Utilities	Stormwater/ Water Quality	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	wetland; confirmed retention by City; This is the 2nd wetland that treats sw runoff from 700 Wood Street, NE of the light & power transformer yard.	0.3625	Medium
10216111	sw9378	Heron Pond - Cattail Chorus	Cache la Poudre Industrial Park Pond 3	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	<Null>	0.525	High
10216114	sw11785	Spruce Pond - Udall	Udall Pond #2	Unknown	Unknown	City of Fort Collins	Utilities/Natural Areas	Stormwater/ Water Quality	Wildlife	Unknown	algae blooms	hot and dry; feedlot that drains to pond	Unknown	Sediment grates	Unknown	Unknown	Unknown	<Null>	0.34375	Medium

MXASSETNUM	FACILITY ID	NAME	AKA	DEPTH (FEET)	VOLUME	OWNED BY	MAINTAINED BY	PRIMARY MANAGEMENT CATEGORY	SECONDARY MANAGEMENT CATEGORY	ADJACENT LAND USE	WATER QUALITY ISSUE(S)	CAUSE(S) OF WATER QUALITY ISSUE(S)	DOES LAKE RESIDENCE TIME CONTRIBUTE TO WATER QUALITY ISSUES?	CURRENT BMPS	HISTORIC BMPS	BMPS SUCCESSFUL? (Y/N/U)	INVASIVE SPECIES PRESENT? (Y/N/U)	NOTES	FINAL RISK SCORE	RISK RANK
10216117	sw24093	English Ranch Park	English Ranch Park	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Residential/ Lawns	algae blooms	Unknown	No	Water quality monitoring; cut back willows and vegetation; 20–30-ft buffer	Unknown	Unknown	No	<Null>	0.4125	Medium
10216118	sw11528	Nokomis Pond Evergreen 3	Goose Hollow	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Recreation	Residential/ Lawns	Unknown	Unknown	Yes	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	<Null>	0.35625	Medium
10216123	sw9379	Confluence Pond - Cattail Chorus	Spring Creek Trail Orthopedic Pond 3	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	<Null>	0.325	Medium
10216124	sw10354	Spring Creek Park Pond	Spring Park Pond	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Park/Golf Course	algae blooms	Unknown	No	Aeration; water quality monitoring; 20–30-ft buffer	Unknown	Unknown	No	<Null>	0.5875	High
10216126	sw19003	Cathy Fromme Natural Area Retention Pond	Cathy Fromme Natural Area Retention Pond	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	Yes	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	<Null>	0.575	High
10216127	sw19831	Portner Reservoir	Pond 3 of Fossil Creek Community Park	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Park/Golf Course	Unknown	Unknown	No	20–30-ft buffer	Unknown	Unknown	No	<Null>	0.6125	High
10216129	sw13660	Warren Park Pond	Warren Park Pond	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Park/Golf Course	Unknown	Unknown	No	20–30-ft buffer	Unknown	Unknown	No	<Null>	0.3875	Medium
10216130	sw23593	Twin Silo Park Pond	Fossil Ridge Irrigation/ Detention Pond	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Unknown	none	Unknown	No	Water quality monitoring; 20–30-ft buffer	Unknown	Unknown	No	<Null>	0.4125	Medium
10216137	sw15197	Mountain Ridge Farm Detention Pond 1	Mountain Ridge Farm Detention Pond 1	Unknown	Unknown	City of Fort Collins	Homeowners Association	Stormwater/ Flood Control/ Floodplain Expansion	None	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	<Null>	0.3625	Medium
10216142	sw18093	Portner Reservoir	Pond 2 of Fossil Creek Park -- Portner Res	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Park/Golf Course	fish kills due to cyanobacteria; odor issues; macrophyte musk grass; cyanobacteria blooms; low DO; anoxic; shallow, misshapen bottom so prone to fish kills;	aerators caused sediment to come from bottom and killed fish.	No	Aeration; water quality monitoring; 20–30-ft buffer	Unknown	Unknown	No	<Null>	0.5875	High
10216149	sw8752	West Coy Pond - Gustav Swanson	Coy Ditch Pond A	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Park/Golf Course	Unknown	Unknown	Unknown	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	dying pond, used to be fed by the diversion off of the river into Coy Ditch but that diversion was removed in 2018 and the ditch is not in use	0.35	Medium

MXASSETNUM	FACILITY ID	NAME	AKA	DEPTH (FEET)	VOLUME	OWNED BY	MAINTAINED BY	PRIMARY MANAGEMENT CATEGORY	SECONDARY MANAGEMENT CATEGORY	ADJACENT LAND USE	WATER QUALITY ISSUE(S)	CAUSE(S) OF WATER QUALITY ISSUE(S)	DOES LAKE RESIDENCE TIME CONTRIBUTE TO WATER QUALITY ISSUES?	CURRENT BMPS	HISTORIC BMPS	BMPS SUCCESSFUL? (Y/N/U)	INVASIVE SPECIES PRESENT? (Y/N/U)	NOTES	FINAL RISK SCORE	RISK RANK
10216151	sw9013	Sheldon Lake	Sheldon Lake; City Park Pond	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Park/Golf Course	odor; eutrophication; sediment loading, algae growth; cyanobacteria; fish kills	fish kills due to cold temperatures for too long	No	Aeration; water quality monitoring; 20–30-ft buffer	drained and dredged after 2013 floods	Yes	No	Basil may have water quality data. Riprap buffer	0.5625	High
10216153	sw9381	Blackbird Pond - Cattail Chorus	Spring Creek Trail Icon Pond	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	Has rare aquatic plants species: *Wolffia borealis* (G5 S1, List A CFC) and *Lemna minuta* (List C CFC)	0.525	High
10216159	sw9380	Wigeon Ponds - Cattail Chorus	Veeco Instruments Pond	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	<Null>	0.525	High
10216161	sw9373	Goldeneye Pond - Kingfisher	<Null>	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	No	Unknown	Unknown	Unknown	No	<Null>	0.3	Medium
10216162	sw9752	Overland Park	Overland Park	Unknown	Unknown	City of Fort Collins	Utilities	Storage/ Irrigation	None	Unknown	Unknown	Unknown	Unknown	Aeration; water quality monitoring	Unknown	Unknown	Unknown	<Null>	0.3875	Medium
10216163	sw17280	Courtyard @ Miramont Detention Pond	Courtyard @ Miramont Detention Pond	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Unknown	Unknown	Unknown	No	20–30-ft buffer	Unknown	Unknown	No	See Miramont in Detention Ponds. This flows to Miramont Detention Pond	0.3875	Medium
10216165	sw16644	Timberline Sump	Timberline Sump	Unknown	Unknown	City of Fort Collins	Utilities	Stormwater/ Flood Control/ Floodplain Expansion	None	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	<Null>	0.3125	Medium
10216166	sw14200	Catfish Pond - Prospect Ponds	Prospect Ponds - South	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Recreation	Natural ecology	fish kills; algae blooms; low DO; nutrients	Nutrients from Merganser Pond, Part of 3 pond complex, northernmost pond on private land fed directly by feedlot with documented fish kills; nutrients; eutrophication; low DO	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	12.74 ac, attached to Merganser pond through culvert Part of 2 pond complex, northernmost pond on private land fed directly by feedlot with documented fish kills; nutrients; eutrophication; low DO; can be very deep to very shallow; inversion-related fish	0.50625	High
10216169	sw8753	East Coy Pond - Gustav Swanson	Coy Ditch Pond B	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Park/Golf Course	Unknown	Unknown	Unknown	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	dying pond, used to be fed by the diversion off of the river into Coy Ditch but that diversion was removed in 2018 and the ditch is not in use	0.35	Medium

MXASSETNUM	FACILITY ID	NAME	AKA	DEPTH (FEET)	VOLUME	OWNED BY	MAINTAINED BY	PRIMARY MANAGEMENT CATEGORY	SECONDARY MANAGEMENT CATEGORY	ADJACENT LAND USE	WATER QUALITY ISSUE(S)	CAUSE(S) OF WATER QUALITY ISSUE(S)	DOES LAKE RESIDENCE TIME CONTRIBUTE TO WATER QUALITY ISSUES?	CURRENT BMPS	HISTORIC BMPS	BMPS SUCCESSFUL? (Y/N/U)	INVASIVE SPECIES PRESENT? (Y/N/U)	NOTES	FINAL RISK SCORE	RISK RANK
10216175	sw8405	Evergreen Pond 3rd	Evergreen Pond 3rd	Unknown	Unknown	City of Fort Collins	Utilities	Stormwater/ Flood Control/ Floodplain Expansion	None	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	<Null>	0.3375	Medium
10216187	sw16174	Ridgeview Park Pond	Coventry Detention Pond	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Unknown	Unknown	Unknown	No	20–30-ft buffer	Unknown	Unknown	No	<Null>	0.4125	Medium
10216193	sw12933	Ross Open Space Detention Pond	Ross Open Space Detention Pond	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	Unknown	Unknown	Yes	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	Has rare aquatic plants species: *Acorus calamus*, *Sagittaria brevirostra*, and *Carex lenticularis*	0.35	Medium
10216194	sw14199	Merganser Pond - Prospect Ponds	Prospect Ponds - East	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Recreation	Urban	fish kills; algae blooms	Nutrients from feed lot to the north; Part of 3 pond complex, northernmost pond on private land fed directly by feedlot with documented fish kills; nutrients; eutrophication; low DO; can be very deep to very shallow; inversion-related fish kills	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	13.42 ac, Part of 3 pond complex, northernmost pond on private land fed directly by feedlot with documented fish kills; nutrients; eutrophication; low DO; can be very deep to very shallow; inversion-related fish kills old gravel pit; no longer stocked with	0.50625	High
10216200	sw19830	Pond 1 of Fossil Creek Community Park	Pond 1 of Fossil Creek Community Park	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Park/Golf Course	algae blooms	Unknown	No	Aeration; water quality monitoring; 20–30-ft buffer	Unknown	Unknown	No	<Null>	0.6125	High
10216203	sw11786	Moose Pond - Udall	Udall Pond #3	Unknown	Unknown	City of Fort Collins	Utilities	Stormwater/ Flood Control/ Floodplain Expansion	None	Unknown	algae blooms	hot and dry; feedlot that drains to pond	Unknown	Sediment grates	Unknown	Unknown	Unknown	<Null>	0.3125	Medium
10216207	sw8439	Sunfish Pond - McMurry	McMurry Natural Areas Pond 2	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	Infrequent algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Lowered banks to increase high water flow.	Yes	No	Receives river water during spring runoff	0.525	High
10216196	sw11783	Goose Pond - Udall	Udall Pond #1	Unknown	Unknown	City of Fort Collins	Utilities/ Natural Areas	Stormwater/ Flood Control/ Floodplain Expansion	Wildlife	Unknown	algae blooms	hot and dry; feedlot that drains to pond	Unknown	Sediment grates; Drain every 3-5 years and pull sediment out.	Unknown	Unknown	Unknown	<Null>	0.31875	Medium
10216208	sw11769	Red Wing Pond - Redwing Marsh	Red Wing Marsh Natural Area	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Recreation	Urban	Unknown	Unknown	Yes	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	<Null>	0.35625	Medium
10216210	sw9382	Chorus Frog Pond - Cattail Chorus	Spring Creek Trail Orthopedic North 1	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	Has rare aquatic plants species: *Wolffia borealis* (G5 S1, List A CFC) and *Lemna minuta* (List C CFC)	0.325	Medium

MXASSETNUM	FACILITY ID	NAME	AKA	DEPTH (FEET)	VOLUME	OWNED BY	MAINTAINED BY	PRIMARY MANAGEMENT CATEGORY	SECONDARY MANAGEMENT CATEGORY	ADJACENT LAND USE	WATER QUALITY ISSUE(S)	CAUSE(S) OF WATER QUALITY ISSUE(S)	DOES LAKE RESIDENCE TIME CONTRIBUTE TO WATER QUALITY ISSUES?	CURRENT BMPS	HISTORIC BMPS	BMPS SUCCESSFUL? (Y/N/U)	INVASIVE SPECIES PRESENT? (Y/N/U)	NOTES	FINAL RISK SCORE	RISK RANK
10216216	sw15476	Canvasback Pond - Kingfisher	Cache la Poudre Industrial Park Pond; Kingfisher Park Pond - South	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Recreation	Natural ecology	fish kills; algae blooms	chemicals from beef packaging plant; nutrients from "Bath Garden Nursery", pots and trash in ponds; steep slopes and poor habitat	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	old gravel pit	0.30625	Medium
10216226	<Null>	Sterling Pond - North Shields	<Null>	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	restoration	Unknown	No	Restoration done in 2014 to lower banks on the south side and let the river flood the pond. Only happens occasionally, bank levels couldn't be made lower	0.5	Medium
10216817	<Null>	Pelican Pond - Cottonwood Hollow	Pelican Marsh	9.75	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	<Null>	0.3	Medium
10216836	<Null>	Milne East Pond - Riverbend Ponds	<Null>	8	Unknown	City of Fort Collins	Natural Areas	Wildlife	Recreation	Natural ecology	fish kills	shallow	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	2.01 ac, really clear sometimes; no longer stocked due to fish kills	0.33125	Medium
10216837	<Null>	Bluegill - Riverbend Ponds	<Null>	<Null>	<Null>	City of Fort Collins	Natural Areas	Wildlife	<Null>	Natural ecology	Unknown	Unknown	No	Maintain vegetation buffer; herbicide buffer	<Null>	<Null>	No	<Null>	0.3	Medium
10216266	<Null>	Topminnow	<Null>	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Native Fisheries	Residential/ Lawns	None	Unknown	No	Water elevation controlled via pump	Unknown	Yes	No	Unlined, receives groundwater, pump outlets to HT outfall channel or Rigden Res.	0.14375	Low
10216845	<Null>	Big Pond - Riverbend Ponds	<Null>	5.5	Unknown	City of Fort Collins	Natural Areas	Wildlife	Non-native Fisheries	Natural ecology	turbidity	giant carp; shallow	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	38.25 ac, rare plant species present: *Azolla mexicana* (List A CFC), *Ruppia cirrhosa* (List A CFC)	0.2825	Medium
10216842	<Null>	Unnamed Pond	Unnamed Pond Receives Storm Runoff from Drake Treatment Facility	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	None	Unknown	low DO; nutrients	<Null>	Unknown	Some vegetation buffer	Unknown	Unknown	Unknown	old gravel pit	0.5	Medium
10216411	<Null>	Collindale Golf Course Pond - Northeast	Unnamed Pond at Northeast Corner of Collindale Golf Course	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Park/Golf Course	Unknown	Unknown	No	20–30-ft buffer	Unknown	Unknown	No	0.36 ac	0.4125	Medium

MXASSETNUM	FACILITY ID	NAME	AKA	DEPTH (FEET)	VOLUME	OWNED BY	MAINTAINED BY	PRIMARY MANAGEMENT CATEGORY	SECONDARY MANAGEMENT CATEGORY	ADJACENT LAND USE	WATER QUALITY ISSUE(S)	CAUSE(S) OF WATER QUALITY ISSUE(S)	DOES LAKE RESIDENCE TIME CONTRIBUTE TO WATER QUALITY ISSUES?	CURRENT BMPS	HISTORIC BMPS	BMPS SUCCESSFUL? (Y/N/U)	INVASIVE SPECIES PRESENT? (Y/N/U)	NOTES	FINAL RISK SCORE	RISK RANK
10216859	<Null>	South Ridge Golf Course Pond - North	Unnamed Pond at North End of South Ridge Golf Course	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	Stormwater/ Flood Control/ Floodplain Expansion	Park/Golf Course	Unknown	Unknown	No	20–30-ft buffer	dredged near hole #5; put liner and anchor trench in near hole #9	Unknown	No	0.75 ac, receives sw runoff from development to the south. Near hole #?	0.4375	Medium
10216150	sw16643	Golden Meadows	Golden Meadows Park Pond	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Residential/ Lawns	cyano-bacteria, fish kills; blue-green algae	Unknown	No	Sludge/mulch eliminators; aeration equipment; water quality monitoring; 20–30-ft buffer	Unknown	Yes	No	<Null>	0.3875	Medium
10216849	<Null>	South Ridge Golf Course Pond - South	Unnamed Pond at South End of South Ridge Golf Course	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	Storage/ Irrigation	Park/Golf Course	Unknown	Unknown	No	20–30-ft buffer	dredged near hole #5; put liner and anchor trench in near hole #10	Unknown	No	1.08 ac, near hole #? There is also an asset just upstream of this but not in this database; Asset# 102167590, 0.23 Ac	0.4375	Medium
10216109	sw15468	Troutman Park Pond - East	Troutman Park	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Park/Golf Course	Unknown	Unknown	No	20–30-ft buffer	Unknown	Unknown	No	<Null>	0.5875	High
10216110	sw15468	Troutman Park Pond - West	Troutman Park	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Park/Golf Course	Unknown	Unknown	No	20–30-ft buffer	Unknown	Unknown	No	<Null>	0.4125	Medium
10216717	<Null>	Snapper Pond - Arapaho Bend	<Null>	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Non-native Fisheries	Natural ecology	occasional algae blooms	<Null>	No	Maintain vegetation buffer; herbicide buffer	<Null>	<Null>	No	<Null>	0.3325	Medium
10216513	<Null>	Duck Lake - Fossil Creek Reservoir	<Null>	4	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Agriculture (other)	severe odor; becomes anoxic; e. coli; warm temperature	Mud Lake (odor issues) feeds to Duck Lake, feedlot and corn fields drain to lake; nutrient loading; shallow; small outlet; no flushing; shallow; waterfowl major source of nutrient loading; sulfur in benthic bottom;	Yes	Sonde taking measurements; water quality monitoring (Aquatic Associates); aeration	biochar	Yes	No	More known by Mark Sears and Tami; not yet implemented in other lakes	0.525	High
10216580	<Null>	Muskrat Pond - Cottonwood Hollow	<Null>	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	5.87 ac	0.5	Medium
10216674	<Null>	Beaver Pond - Arapaho Bend	<Null>	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Non-native Fisheries	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	34.8 ac	0.4825	Medium

MXASSETNUM	FACILITY ID	NAME	AKA	DEPTH (FEET)	VOLUME	OWNED BY	MAINTAINED BY	PRIMARY MANAGEMENT CATEGORY	SECONDARY MANAGEMENT CATEGORY	ADJACENT LAND USE	WATER QUALITY ISSUE(S)	CAUSE(S) OF WATER QUALITY ISSUE(S)	DOES LAKE RESIDENCE TIME CONTRIBUTE TO WATER QUALITY ISSUES?	CURRENT BMPS	HISTORIC BMPS	BMPS SUCCESSFUL? (Y/N/U)	INVASIVE SPECIES PRESENT? (Y/N/U)	NOTES	FINAL RISK SCORE	RISK RANK
10216501	<Null>	Cottonwood Glen Pond	<Null>	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Park/Golf Course	algae blooms; macrophytes	farms use algaecide	No	No-mow buffer around lake; pest management; water quality monitoring; 20–30-ft buffer	copper sulfide	Unknown	No	<Null>	0.3875	Medium
10216507	<Null>	Little and Big Bass Ponds - Arapaho Bend	<Null>	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Non-native Fisheries	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	18.6 ac, big bass pond receives river water during spring runoff	0.5075	High
10216557	<Null>	Robert Benson Lake - Pelican Marsh	Robert Benson Reservoir	Unknown	Unknown	City of Fort Collins	Natural Areas	Storage/ Irrigation	Wildlife	Natural ecology	algae blooms	shallow	Yes	Maintain vegetation buffer; herbicide buffer	water quality monitoring	Unknown	No	College and 287	0.36875	Medium
10216474	<Null>	Collindale Golf Course Pond - Southwest	Golden Meadows Pond	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Park/Golf Course	Unknown	Unknown	No	20–30-ft buffer	Unknown	Unknown	No	1.11 ac, named Golden Meadows Pond in View	0.3875	Medium
10216481	<Null>	Greenbriar Park Pond	<Null>	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Park/Golf Course	Unknown	Unknown	No	20–30-ft buffer	Unknown	Unknown	No	0.53 ac	0.4125	Medium
10216496	<Null>	Rigden Reservoir	<Null>	22	1,900 acre-feet	City of Fort Collins	Utilities/ Natural Areas	Storage/ Irrigation	None	Other (specify in Notes)	cyanobacteria and algae blooms	some wastewater treatment plant effluent and nutrient loading	Unknown	5 solar bees; 2 delivery systems for minimizing capture of wastewater treatment plant effluent; temporal management (avoid storing during poor water quality (e.g., take spring runoff on receding limb of hydrograph, avoid late season high-temperature water	Unknown	Unknown	Unknown	133.14 ac, collecting water quality data since 2016; anoxic at bottom; ask Donnie about BMPs; water quality issues dependent on how they operate the reservoir	0.35	Medium
10216632	<Null>	North Shields Pond	<Null>	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	Pond and water levels may be shrinking. Has rare plant species: *Spirodela polyrrhiza* (List A CFC), *Carex lasiocarpa* (G5 S2, list A CFC), *Cyperus bipartitus* (list A CFC)	0.5	Medium
10216398	<Null>	I-25 Pond - Arapaho Bend	<Null>	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	7.83 ac	0.5375	High

MXASSETNUM	FACILITY ID	NAME	AKA	DEPTH (FEET)	VOLUME	OWNED BY	MAINTAINED BY	PRIMARY MANAGEMENT CATEGORY	SECONDARY MANAGEMENT CATEGORY	ADJACENT LAND USE	WATER QUALITY ISSUE(S)	CAUSE(S) OF WATER QUALITY ISSUE(S)	DOES LAKE RESIDENCE TIME CONTRIBUTE TO WATER QUALITY ISSUES?	CURRENT BMPS	HISTORIC BMPS	BMPS SUCCESSFUL? (Y/N/U)	INVASIVE SPECIES PRESENT? (Y/N/U)	NOTES	FINAL RISK SCORE	RISK RANK
10216365	<Null>	Collindale Golf Course Pond - Northwest	Fort Collins Golf Course Pond	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Park/Golf Course	Unknown	Unknown	No	20–30-ft buffer	Unknown	Unknown	No	1.12 ac, named Fort Collins Golf Course Pond in View	0.3875	Medium
10216177	sw17699	Harmony Park Pond 5015 Corbett Drive	Preston Jr. High Detention Pond	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Park/Golf Course	Unknown	Unknown	No	20–30-ft buffer	Unknown	Unknown	No	was unable to open vector map; see MAX HARMONY DETENTION in Detention Ponds, same or different?	0.4375	Medium
10216280	sw19384	Fossil Lake Irrigation Pond	Fossil Lake Irrigation Pond; Fossil Creek Lake Park; Fossil Creek Lake at Portner Reservoir	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Residential/ Lawns	fish kills due to cyanobacteria; odor issues; macrophyte musk grass; cyanobacteria blooms; low DO; anoxic; shallow, misshapen bottom so prone to fish kills;	aerators caused sediment to come from bottom and killed fish.	No	Aeration; water quality monitoring; 20–30-ft buffer	Unknown	Unknown	No	<Null>	0.4125	Medium
10216487	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	Not Assessed (more data needed)
10216103	sw9376	Dragonfly Pond - Kingfisher	Cattail Chorus Ponds	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	<Null>	0.3375	Medium
10216827	<Null>	Turtle Pond - Riverbend Ponds	<Null>	Unknown	Unknown	City of Fort Collins	Natural Areas	Storage/ Irrigation	Non-native Fisheries	Natural ecology	fish kills; low DO; odor	very small; cold temperatures; quick turnover of anoxic layer; low DO; sulfur	No	Considering aeration	sink holiday trees for fish habitat	Unknown	No	2.87 ac. All Riverbend Ponds have some sort of turbidity in them, but this one is crystal clear.	0.37	Medium
10228230	<Null>	Lee Martinez Farm Pond	<Null>	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Unknown	Unknown	Unknown	No	20–30-ft buffer	Unknown	Unknown	No	<Null>	0.3875	Medium
10216589	<Null>	Whitetail Pond - Arapaho Bend (E of I-25)	Unnamed in View	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	5.6 ac	0.5	Medium
10216642	<Null>	Cormorant Pond - Arapaho Bend	<Null>	Unknown	Unknown	City of Fort Collins	Natural Areas	Wildlife	Non-native Fisheries	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	2.94 ac	0.3325	Medium
10216147	sw8438	McMurry Pond 1 - McMurry	McMurry Natural Area Pond 1	5.5	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Natural ecology	Infrequent algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	Receives river water during spring runoff. Has rare plant species: *Lysimachia thyrsiflora* (G5 S1, List A CFC)	0.5	Medium

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10216180	sw9333	Avery Pond	<Null>	4	Unknown	City of Fort Collins	Utilities	Stormwater/ Flood Control/ Floodplain Expansion	None	Unknown	algae blooms; fish kills; odor	low water levels = low DO; inlet from local neighborhood	Unknown	Copper sulfide last year for algae	Unknown	Unknown	Unknown	Parks and Wildlife manages fisheries here.	0.3625	Medium
10216361	<Null>	Milne West Pond - Riverbend Ponds	<Null>	8.3	Unknown	City of Fort Collins	Natural Areas	Wildlife	Recreation	Natural ecology	occasional algae blooms	Unknown	No	Maintain vegetation buffer; herbicide buffer	Unknown	Unknown	No	7.02 ac	0.30625	Medium
10216480	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216534	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216581	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216789	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216816	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216243	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216356	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216368	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216470	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)

MXASSETNUM	FACILITY ID	NAME	AKA	DEPTH (FEET)	VOLUME	OWNED BY	MAINTAINED BY	PRIMARY MANAGEMENT CATEGORY	SECONDARY MANAGEMENT CATEGORY	ADJACENT LAND USE	WATER QUALITY ISSUE(S)	CAUSE(S) OF WATER QUALITY ISSUE(S)	DOES LAKE RESIDENCE TIME CONTRIBUTE TO WATER QUALITY ISSUES?	CURRENT BMPS	HISTORIC BMPS	BMPS SUCCESSFUL? (Y/N/U)	INVASIVE SPECIES PRESENT? (Y/N/U)	NOTES	FINAL RISK SCORE	RISK RANK
10216582	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10443961	<Null>	Cresent Park	Maple Hill Park	Unknown	Unknown	City of Fort Collins	Parks and Trails	Storage/ Irrigation	None	Residential/ Lawns	Unknown	Unknown	No	Aeration; water quality monitoring; 20–30-ft buffer	Unknown	Unknown	No	2401 Bar Harbor; confirmed retention by City	0.4125	Medium
10216819	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216820	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216821	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216822	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216823	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216829	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216831	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216834	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216818	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)

MXASSETNUM	FACILITY ID	NAME	AKA	DEPTH (FEET)	VOLUME	OWNED BY	MAINTAINED BY	PRIMARY MANAGEMENT CATEGORY	SECONDARY MANAGEMENT CATEGORY	ADJACENT LAND USE	WATER QUALITY ISSUE(S)	CAUSE(S) OF WATER QUALITY ISSUE(S)	DOES LAKE RESIDENCE TIME CONTRIBUTE TO WATER QUALITY ISSUES?	CURRENT BMPS	HISTORIC BMPS	BMPS SUCCESSFUL? (Y/N/U)	INVASIVE SPECIES PRESENT? (Y/N/U)	NOTES	FINAL RISK SCORE	RISK RANK
10216841	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216853	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216613	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216828	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216835	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216198	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216238	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216307	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216317	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216322	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216359	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)

MXASSETNUM	FACILITY ID	NAME	AKA	DEPTH (FEET)	VOLUME	OWNED BY	MAINTAINED BY	PRIMARY MANAGEMENT CATEGORY	SECONDARY MANAGEMENT CATEGORY	ADJACENT LAND USE	WATER QUALITY ISSUE(S)	CAUSE(S) OF WATER QUALITY ISSUE(S)	DOES LAKE RESIDENCE TIME CONTRIBUTE TO WATER QUALITY ISSUES?	CURRENT BMPS	HISTORIC BMPS	BMPS SUCCESSFUL? (Y/N/U)	INVASIVE SPECIES PRESENT? (Y/N/U)	NOTES	FINAL RISK SCORE	RISK RANK
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10216371	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216475	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216537	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216579	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216612	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
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10216656	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216223	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216239	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216286	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)

MXASSETNUM	FACILITY ID	NAME	AKA	DEPTH (FEET)	VOLUME	OWNED BY	MAINTAINED BY	PRIMARY MANAGEMENT CATEGORY	SECONDARY MANAGEMENT CATEGORY	ADJACENT LAND USE	WATER QUALITY ISSUE(S)	CAUSE(S) OF WATER QUALITY ISSUE(S)	DOES LAKE RESIDENCE TIME CONTRIBUTE TO WATER QUALITY ISSUES?	CURRENT BMPS	HISTORIC BMPS	BMPS SUCCESSFUL? (Y/N/U)	INVASIVE SPECIES PRESENT? (Y/N/U)	NOTES	FINAL RISK SCORE	RISK RANK
10216318	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216319	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216325	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216326	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216336	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216339	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216357	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216367	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
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10216383	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216393	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)

MXASSETNUM	FACILITY ID	NAME	AKA	DEPTH (FEET)	VOLUME	OWNED BY	MAINTAINED BY	PRIMARY MANAGEMENT CATEGORY	SECONDARY MANAGEMENT CATEGORY	ADJACENT LAND USE	WATER QUALITY ISSUE(S)	CAUSE(S) OF WATER QUALITY ISSUE(S)	DOES LAKE RESIDENCE TIME CONTRIBUTE TO WATER QUALITY ISSUES?	CURRENT BMPS	HISTORIC BMPS	BMPS SUCCESSFUL? (Y/N/U)	INVASIVE SPECIES PRESENT? (Y/N/U)	NOTES	FINAL RISK SCORE	RISK RANK
10216419	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216420	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216431	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216464	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10216664	<Null>	Homestead Pond	<Null>	5.5	Unknown	City of Fort Collins	Natural Areas	Wildlife	Stormwater/ Flood Control/ Floodplain Expansion	Urban	Unknown	Unknown	No	Unknown	Used to be golf course converted to Natural Area.	Unknown	No	<Null>	0.55	High
10216204	sw22580	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	0	Not Assessed (more data needed)
10214213	sw23793	Spring Canyon Dog Park Pond	Dog Park Pond	<Null>	<Null>	City of Fort Collins	Parks and Trails	Storage/ Irrigation	Urban/Other	<Null>	E. coli, other potential enteric pathogens based to complaints from dog owners, algae when water is retained, but downstream WQ pond is being designed so dog park pond can be operated as designed.	dog waste, pond is filled with raw water from Dixon reservoir and may contain pathogens due to wildlife	No	draining and refilling with fresh water; water quality monitoring; 20-30ft buffer	<Null>	<Null>	No	For dog swimming. See SPRING CANYON COMMUNITY PARK and SPRING CANYON COMMUNITY PARK POND C in Detention Ponds. Is this the same as one of those? NO - This drains to #10217953 (SP CAN COMM PARK POND);	0.6125	High

Fort Collins Detention Lakes

MXASSETNUM	POINT_X	POINT_Y	NAME	MAINTAINED BY
10217064	-105.09162	40.541164	5 OAKS VILLAGE	Utilities (FC)
10217462	-105.08974	40.595261	700 WOOD EAST POND	Utilities (FC)
10217202	-105.08993	40.595266	700 WOOD ST WEST POND	Utilities (FC)
10218011	-105.07629	40.597136	740 N. COLLEGE FUTURE DETENTION BASIN	Utilities (FC)
10217686	-105.06878	40.600115	ASPEN HEIGHTS DETENTION	Utilities (FC)
10224037	-105.10955	40.57189	AVERY PARK POND	Utilities (FC)
10224452	-105.07578	40.593117	AZTLAN GRAVEL PARKING	Colorado State University
10225478	-105.07586	40.592564	AZTLAN MID PAVER	Colorado State University
10225477	-105.07595	40.59292	AZTLAN NORTH PAVER	Colorado State University
10225480	-105.07577	40.592574	AZTLAN PARKING DETENTION	Colorado State University
10225479	-105.07586	40.592265	AZTLAN SOUTH PAVER	Colorado State University
10216989	-105.11808	40.593096	BELLWETHER DETENTION POND C	Homeowners Association
10217805	-105.08725	40.542215	BLUE MESA	Utilities (FC)
10217884	-105.06125	40.543412	BOLTZ POND CHANNEL	Utilities (FC)
10217102	-105.12545	40.559947	BROWN FARM POND # 2	Utilities (FC)
10217036	-105.12456	40.557178	BROWN FARM POND # 3	Utilities (FC)
10216933	-105.12695	40.562391	BROWN FARM POND #1	Utilities (FC)
10217502	-105.04965	40.526985	CAPE COD	Utilities (FC)
10217090	-105.03973	40.528002	CARIBOU APARTMENTS POND 2	Homeowners Association

MXASSETNUM	POINT_X	POINT_Y	NAME	MAINTAINED BY
10216901	-105.04116	40.528901	CARIBOU APARTMENTS POND 3	Homeowners Association
10216190	-105.10895	40.551679	CEDAR VILLAGE	Utilities (FC)
10217772	-105.07956	40.590088	CIVIC CENTER POND	Parks and Trails (FC)
10217329	-105.0409	40.563199	COMMUNITY RECYCLING DETENTION	Operations Services (FC)
10217868	-105.07507	40.594413	CSU ENGINES POND	Homeowners Association
10217887	-105.02582	40.54189	DAKOTA RIDGE 2ND	Utilities (FC)
10217263	-105.12602	40.571724	DEERFIELD POND	Utilities (FC)
10217195	-105.07785	40.594275	DISCOVERY MUSEUM NORTH POND	Operations Services (FC)
10216980	-105.07835	40.592458	DISCOVERY MUSEUM SOUTH POND	Operations Services (FC)
10217440	-105.09754	40.597438	EAST POND GRANADA HEIGHTS	Utilities (FC)
10217521	-105.06043	40.576466	EAST SIDE PARK POND	Parks and Trails (FC)
10217728	-105.05398	40.549507	EASTBOROUGH	Utilities (FC)
10217294	-105.02713	40.537551	ENGLISH RANCH #1	Utilities (FC)
10217694	-105.02518	40.537524	ENGLISH RANCH #2	Utilities (FC)
10217963	-105.02317	40.537528	ENGLISH RANCH #3	Utilities (FC)
10217789	-105.02119	40.537511	ENGLISH RANCH #4	Utilities (FC)
10217397	-105.04405	40.562818	EPIC DETENTION POND	Utilities (FC) Maybe Parks?
10217120	-105.11675	40.565994	FAIRBROOK POND	Natural Areas (FC)
10217134	-105.11619	40.566806	FAIRBROOKE POND A	Natural Areas (FC)
10217636	-105.12833	40.569941	FLEETWOOD COURT	Utilities (FC)

MXASSETNUM	POINT_X	POINT_Y	NAME	MAINTAINED BY
10217047	-105.05953	40.506808	FLEETWOOD CT DETENTION POND	Utilities (FC)
10217582	-105.1127	40.59339	FORNEY POND	Utilities (FC)
10217447	-105.10885	40.575386	FORT RAM	Utilities (FC)
10217644	-105.06683	40.507816	FOSSIL CREEK 1	Homeowners Association
10218037	-105.06465	40.507965	FOSSIL CREEK 2	Homeowners Association
10217258	-105.05891	40.505314	FOSSIL CREEK COMMUNITY PARK EAST	Parks and Trails (FC)
10217748	-105.06417	40.506602	FOSSIL CREEK COMMUNITY PARK WEST	Parks and Trails (FC)
10217640	-105.03095	40.537408	FOX MEADOWS DETENTION POND	Utilities (FC)
10217978	-105.07344	40.587752	GARAGE ALLEY NORTH RG	Operations Services (FC)
10217346	-105.0732	40.587976	GARAGE ENTRANCE NORTH RG	Operations Services (FC)
10217076	-105.07329	40.587892	GARAGE ENTRANCE SOUTH RG	Operations Services (FC)
10216911	-105.07306	40.588066	GARAGE JEFFERSON RG	Operations Services (FC)
10217937	-105.09957	40.595707	GLADIOLA FARM	Utilities (FC)
10217707	-105.11405	40.577077	GLENMOOR DETENTION BASIN	Utilities (FC)
10217021	-105.06152	40.610869	GREENBRIAR NORTH	Utilities (FC)
10217732	-105.0589	40.607145	GREENBRIAR SOUTH	Utilities (FC)
10217129	-105.08021	40.565656	GRIFFIN PLAZA DETENTION	Colorado State University
10216902	-105.11755	40.549975	HAMSHIRE DETENTION POND	Utilities (FC)
10217169	-105.09741	40.596173	HANNA	Utilities (FC)
10217337	-105.016	40.60168	HARTSHORN PROPERTY (CRUMB POND) .	Utilities (FC)
10434337	-105.05253	40.576058	HOFFMAN MILL DETENTION	Streets (FC)

MXASSETNUM	POINT_X	POINT_Y	NAME	MAINTAINED BY
10434134	-105.0524	40.576191	HOFFMAN MILL SAND FILTER	Streets (FC)
10217977	-105.0599	40.578994	HOUSKA DETENTION POND	Utilities (FC)
10217352	-105.11383	40.5661	KANE POND	Natural Areas (FC)
10217186	-105.10407	40.552356	KENSINGTON SOUTH POND	Utilities (FC)
10218010	-105.12692	40.577817	KIMBALL	Utilities (FC)
10217504	-105.08162	40.527547	LARKBOROUGH	Utilities (FC)
10218068	-105.0731	40.584933	LIBRARY PARK DETENTION	Operations Services (FC)
10216972	-105.06054	40.580836	LOCUST OUTFALL	Utilities (FC)
10217850	-105.08564	40.60403	MAGPIE MEANDER NATURAL AREA POND 1	Parks and Trails (FC)
10217945	-105.11558	40.556644	MANCHESTER DETENTION POND	Utilities (FC)
10217429	-105.08168	40.533716	MANHATTAN POND	Utilities (FC)
10216969	-105.08058	40.523973	MAX HARMONY DETENTION	Operations Services (FC)
10217763	-105.11144	40.575579	MCALLISTER	Utilities (FC)
10217243	-105.0779	40.609731	MCDONALDS DETENTION POND 2	Utilities (FC)
10217345	-105.08648	40.521629	MCGRAW ELEMENTARY NORTH POND	Parks and Trails (FC)
10217544	-105.08123	40.54366	MEADOWLARK HEIGHTS A	Utilities (FC)
10218012	-105.08154	40.541888	MEADOWLARK HEIGHTS B	Utilities (FC)
10217609	-105.03993	40.550817	MEADOWS EAST	Utilities (FC)
10217198	-105.13497	40.567187	MILLER DET BASIN/ OLD SUBSTATION	Utilities (FC)
10216899	-105.06127	40.514951	MIRAMONT PARK DETENTION POND	Parks and Trails (FC)
10217577	-105.07455	40.587234	MOUNTAIN AVE POND	Parks and Trails (FC)

MXASSETNUM	POINT_X	POINT_Y	NAME	MAINTAINED BY
10217434	-105.09968	40.532142	MOUNTAIN RIDGE FARM DETENTION POND 2	Homeowners Association
10217147	-105.09717	40.53191	MOUNTAIN RIDGE FARM DETENTION POND 3	Homeowners Association
10217403	-105.07703	40.596009	N COLLEGE IMPROVEMENTS SOUTH POND	Utilities (FC) Not sure witch one this is referring
10217220	-105.0771	40.596934	N COLLEGE RD IMPROVEMENTS NORTH POND	Utilities (FC) Not sure witch one this is referring
10216221	-105.04447	40.542457	NELSON FARM	Utilities (FC)
10217340	-105.04463	40.573919	NIX FARM DETENTION POND	Natural Areas (FC)
10217799	-105.06004	40.516557	OAKRDIGE WEST DETENTION POND	Parks and Trails (FC)
10217941	-104.99695	40.52477	PARK N RIDE POND	Colorado Department of Transportation
10217399	-105.04429	40.553533	PARKWOOD EAST	Utilities (FC)
10217638	-105.12451	40.577895	PEAR COURT	Utilities (FC)
10217734	-105.06239	40.61376	PHEASANT RIDGE NORTH	Utilities (FC)
10217653	-105.06363	40.611512	PHEASANT RIDGE SOUTH	Utilities (FC)
10217620	-105.03966	40.556465	POLICE BUILDING POND 1 EAST	Parks and Trails (FC)
10217113	-105.04067	40.556426	POLICE BUILDING POND 2 WEST	Parks and Trails (FC)
10224036	-105.13571	40.573874	PONDS AT OVERLAND NORTH DETENTION	Utilities (FC)
10217904	-105.12816	40.550411	QUAIL HOLLOW #1	Utilities (FC)
10217986	-105.13198	40.549183	QUAIL HOLLOW #2	Utilities (FC)
10217768	-105.12688	40.546875	QUAIL HOLLOW #3	Utilities (FC)
10217778	-105.129	40.545926	QUAIL HOLLOW #4- -CATTAILS.	Utilities (FC)
10217811	-105.09901	40.556279	RAINTREE DETENTION POND A	Parks and Trails (FC)

MXASSETNUM	POINT_X	POINT_Y	NAME	MAINTAINED BY
10217070	-105.10929	40.564688	RED FOX MEADOWS. CIPO OUTFALL.	Utilities (FC)
10217580	-105.06637	40.602695	REDWOOD POND	Utilities (FC)
10217656	-105.1012	40.525849	REGENCY	Utilities (FC)
10217313	-105.11002	40.563657	RIDGEWOOD POND	Utilities (FC)
10217004	-105.13561	40.55881	RODEO ARENA	Colorado State University
10217157	-105.10703	40.544454	ROSSBOROUGH PARK	Parks and Trails (FC)
10216909	-105.10025	40.555329	SENIOR CENTER DETENTION	Parks and Trails (FC)
10218019	-105.09151	40.598255	SERVICE CENTER	Utilities (FC)
10217191	-105.09109	40.599258	SERVICE CENTER NORTH	Utilities (FC)
10217117	-105.10787	40.548747	SILVERPLUME	Utilities (FC)
10217864	-105.10356	40.546471	SILVERPLUME DETENTION POND NO. 2	Utilities (FC)
10217124	-105.1034	40.547051	SILVERTON CT.	Utilities (FC)
10217720	-105.05911	40.542902	SOUTH LEMAY	Utilities (FC)
10216993	-105.06476	40.496553	SOUTH TRANSFORT DETENTION	Operations Services (FC)
10217068	-105.01418	40.51011	SOUTHEAST COMMUNITY PARK	Parks and Trails (FC)
10217953	-105.12806	40.540931	SPRING CANYON COMMUNITY PARK POND	Parks and Trails (FC)
10217426	-105.12471	40.539795	SPRING CANYON COMMUNITY PARK POND C	Parks and Trails (FC)
10217568	-105.12609	40.544615	SPRING CANYON COMMUNITY PARK.	Parks and Trails (FC)
10217386	-105.04279	40.564514	SPRING CREEK DIASTER MITIGATION EAST POND	Parks and Trails (FC)
10217627	-105.04385	40.56487	SPRING CREEK DIASTER MITIGATION WEST POND	Parks and Trails (FC)

MXASSETNUM	POINT_X	POINT_Y	NAME	MAINTAINED BY
10217309	-105.03386	40.54471	STEWART CASE PARK	Parks and Trails (FC); joint management w/ESD
10217655	-105.05864	40.595001	STREETS FACILITY PARK	Streets (FC)
10217267	-105.06039	40.594994	STREETS FACILITY POND 2	Streets (FC)
10217115	-105.09117	40.541459	SUNDISK	Utilities (FC)
10216938	-105.03898	40.527005	SUNSTONE EIGHTH DETENTION POND	Utilities (FC)
10216990	-105.03488	40.529172	SUNSTONE FIFTH DETENTION POND	Utilities (FC)
10217985	-105.1059	40.547276	TELLURIDE COURT DETENTION POND	Utilities (FC)
10217566	-105.04	40.544207	TIMBERLINE APARTMENTS	Utilities (FC)
10217946	-105.04204	40.543655	TIMBERLINE VILLAGE POND	Utilities (FC)
10217158	-105.08017	40.518071	TRANSIT CENTER	Operations Services (FC)
10217039	-105.07857	40.590537	TRANSIT CENTER DETENTION POND	Operations Services (FC)
10217947	-105.07881	40.609665	UNION PLACE POND	Homeowners Association
10217966	-105.0968	40.598406	Unnamed Pond	Parks and Trails (FC)
10225449	-105.0127	40.510785	Unnamed Pond	Parks and Trails (FC)
10217286	-105.08035	40.589138	UTILITIES ADMIN DETENTION 1	Parks and Trails (FC)
10217308	-105.08028	40.589471	UTILITIES ADMIN DETENTION 2	Parks and Trails (FC)
10216925	-105.07982	40.589538	UTILITIES ADMIN DETENTION 3	Parks and Trails (FC)
10217114	-105.09215	40.597344	VEHICLE STORAGE	Utilities (FC)
10217141	-105.09733	40.544995	WAGON WHEEL	Utilities (FC)
10217932	-105.07481	40.587499	WALNUT NW POND	Homeowners Association
10217385	-105.07462	40.587359	WALNUT SE POND	Homeowners Association

MXASSETNUM	POINT_X	POINT_Y	NAME	MAINTAINED BY
10217104	-105.08112	40.538731	WARREN FARMS	Utilities (FC)
10217163	-105.08377	40.562005	WATER QUALITY POND A 1A	Operations Services (FC)
10217010	-105.08476	40.562675	WATER QUALITY POND A 1B	Parks and Trails (FC)
10217154	-105.08568	40.560798	WATER QUALITY POND A 3B	Operations Services (FC)
10217249	-105.0787	40.604897	WEST OF ADDRESS	Utilities (FC)
10217588	-105.09859	40.598751	WEST POND GRANADA HEIGHTS	Utilities (FC)
10218064	-105.10244	40.536543	WESTFIELD PARK PUD	Utilities (FC)
10218002	-105.08357	40.562908	WETLANDS BASIN A1	Operations Services (FC)
10217384	-105.08694	40.527493	WILLOW PARK DETENTION POND/ TABLE MOUNTAIN POND	Utilities (FC)
10217234	-105.10354	40.56059	WINFIELD	Utilities (FC)
10217029	-105.0873	40.551224	WOOD WEST DETENTION POND	Utilities (FC)
10217557	-105.08699	40.524743	WOODLANDS WAY DETENTION POND	Utilities (FC)
10217602	-105.1216	40.555341	WYANDOTTE # 1	Utilities (FC)
10218025	-105.1219	40.554005	WYANDOTTE # 2	Utilities (FC)

ATTACHMENT 5 – MAPBOOK OF CITY-OWNED URBAN LAKES

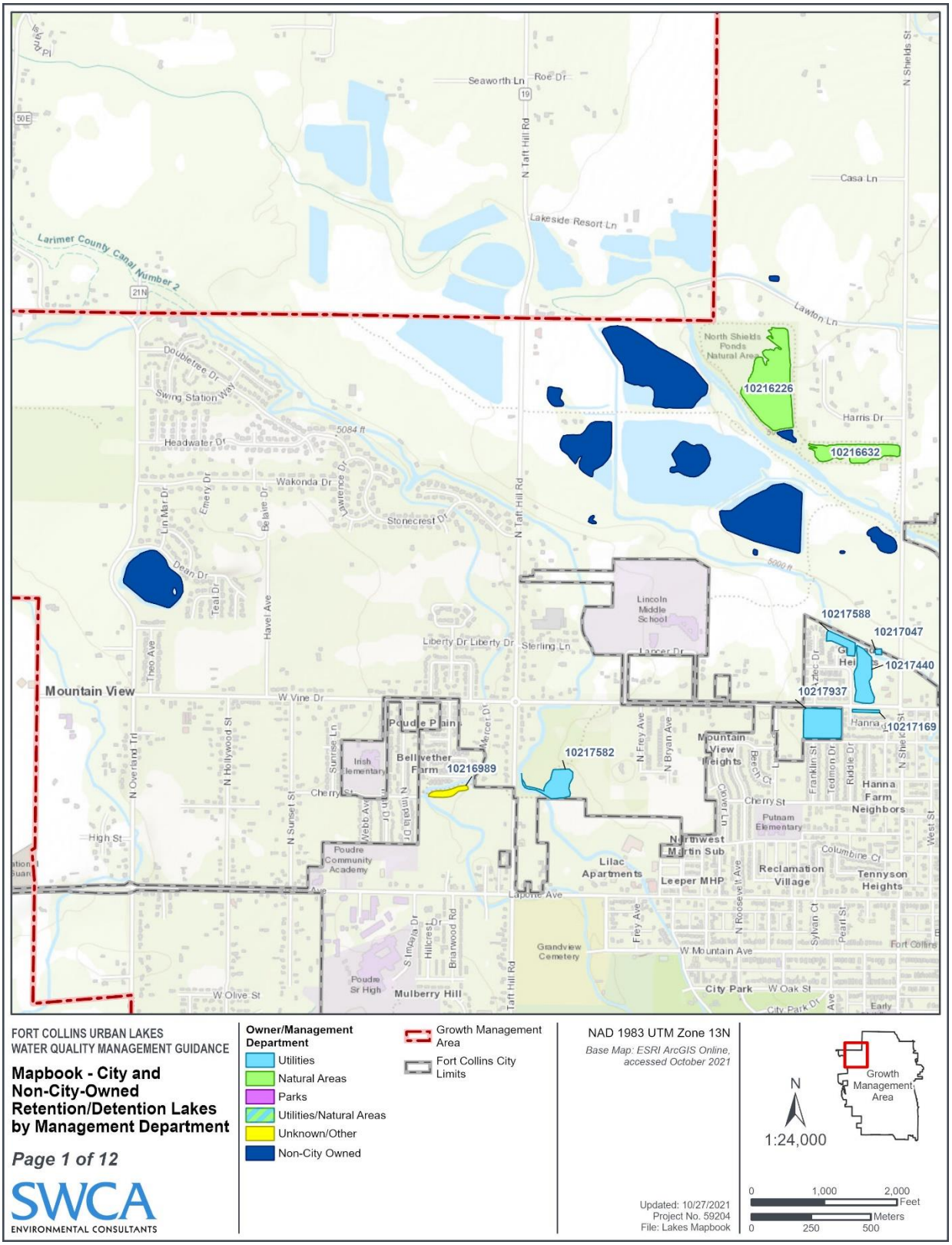

Figure 5-1. Fort Collins' urban lakes, managing department and MAXASSETNUM (image 1 of 12).

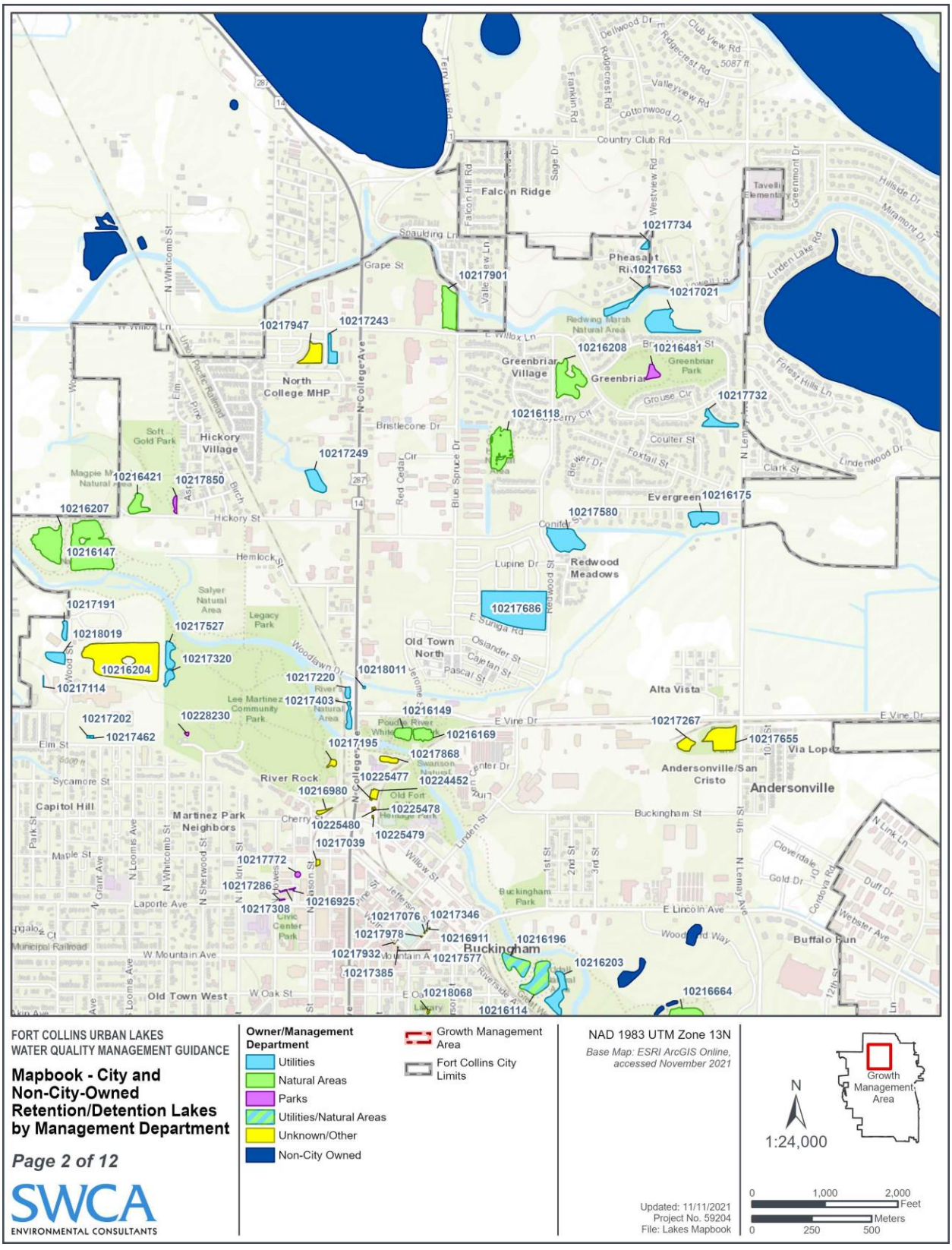

Figure 5-2. Fort Collins' urban lakes, managing department and MAXASSETNUM (image 2 of 12).

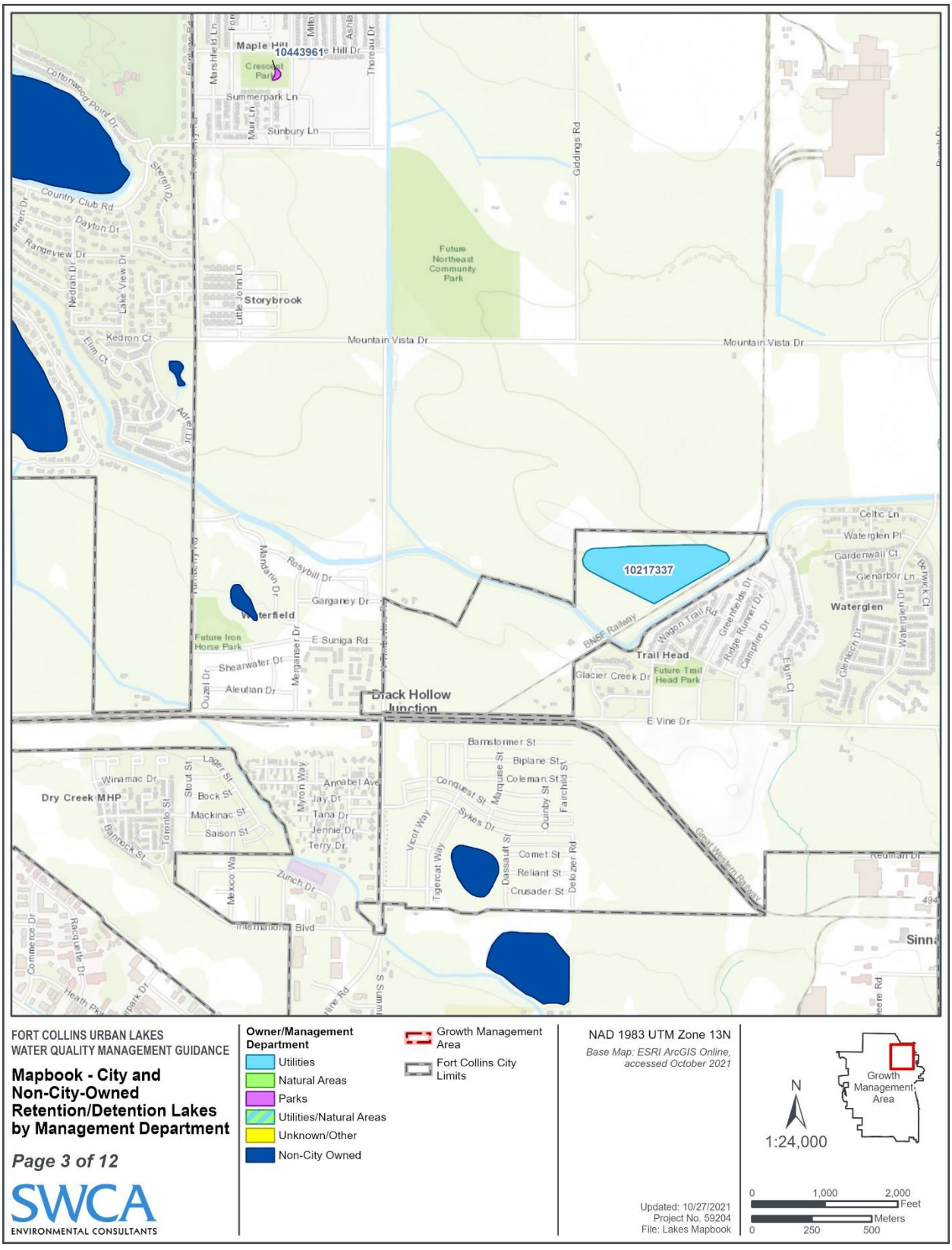

Figure 5-3. Fort Collins' urban lakes, managing department and MAXASSETNUM (image 3 of 12).

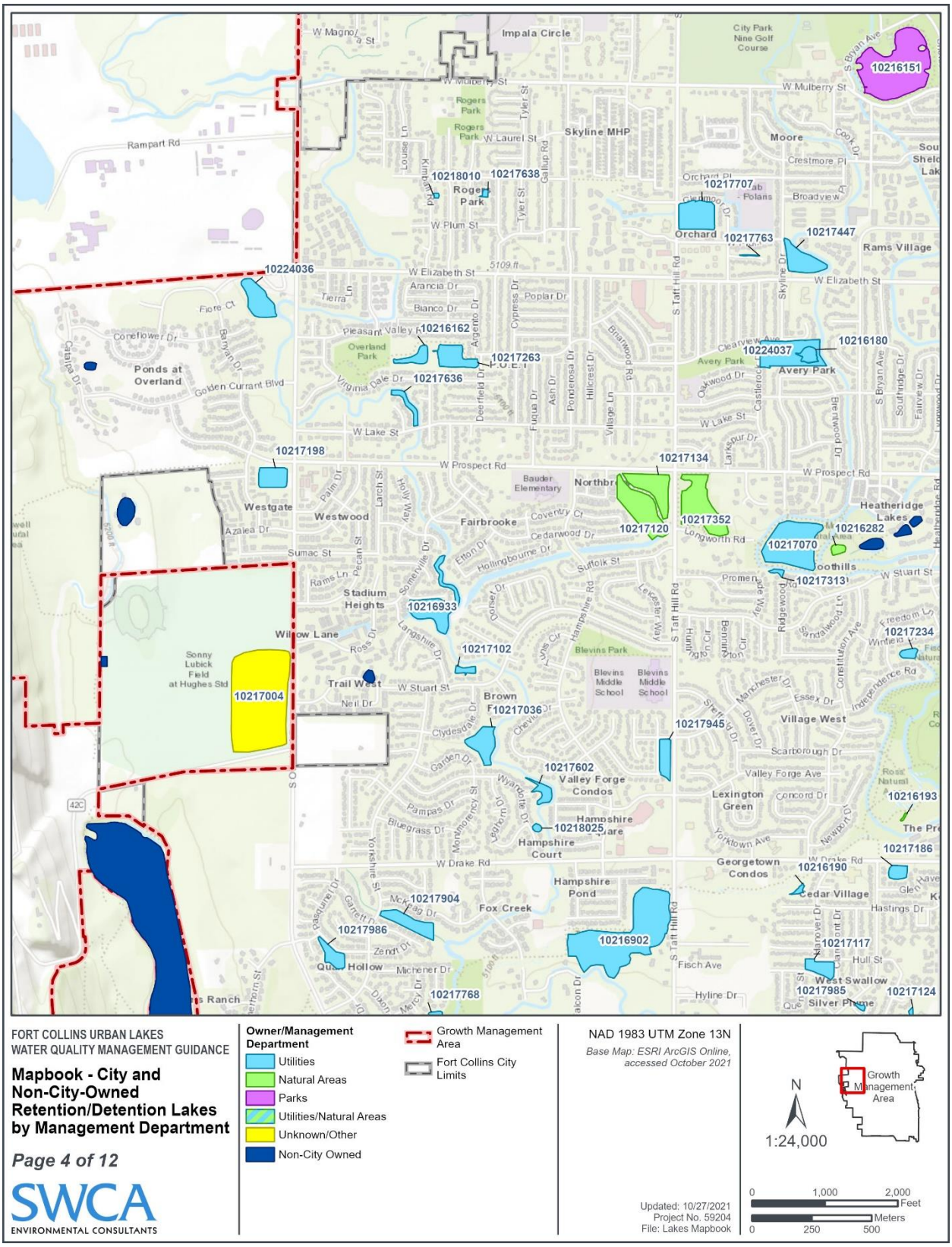

Figure 5-4. Fort Collins' urban lakes, managing department and MAXASSETNUM (image 4 of 12).

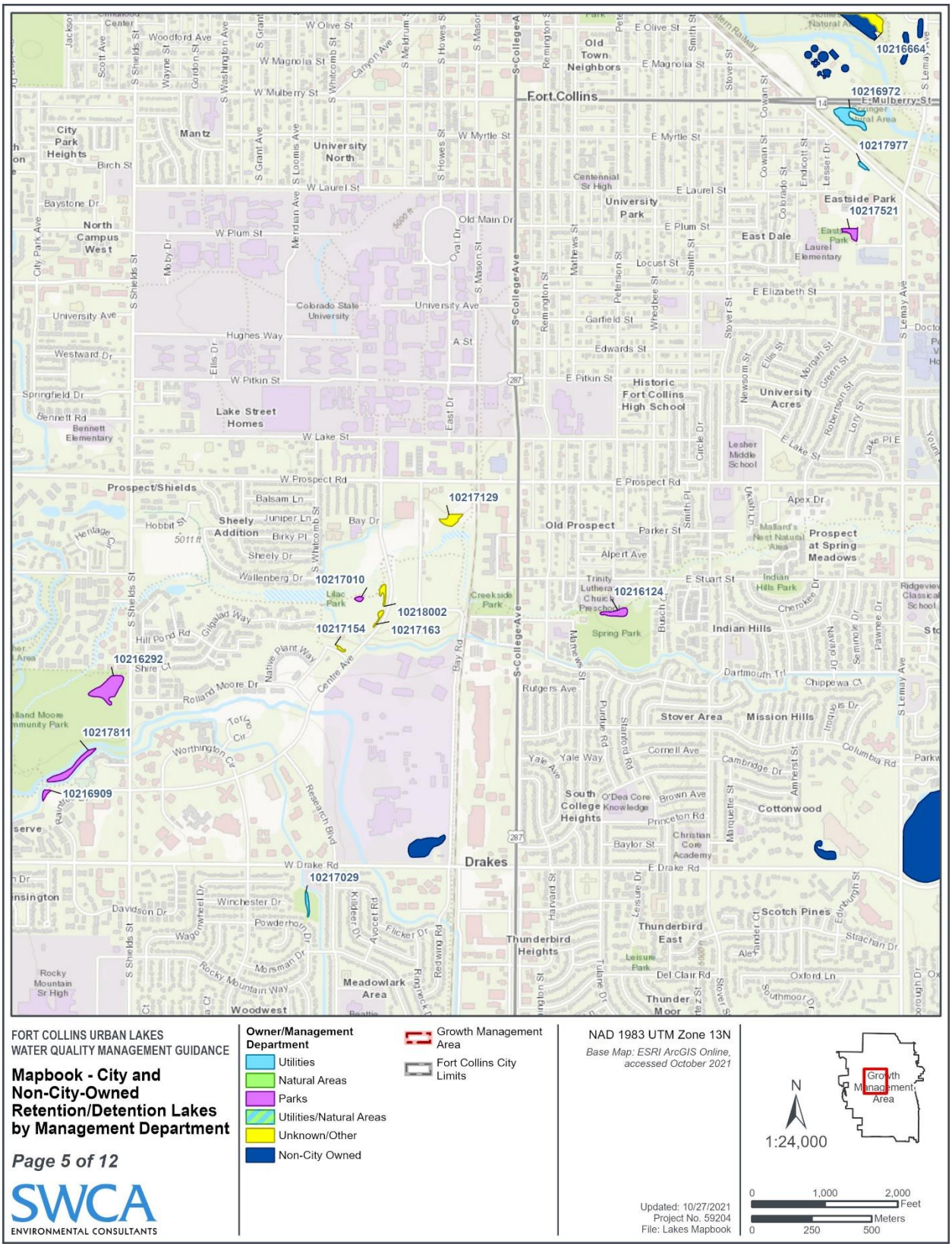

Figure 5-5. Fort Collins' urban lakes, managing department and MAXASSETNUM (image 5 of 12).

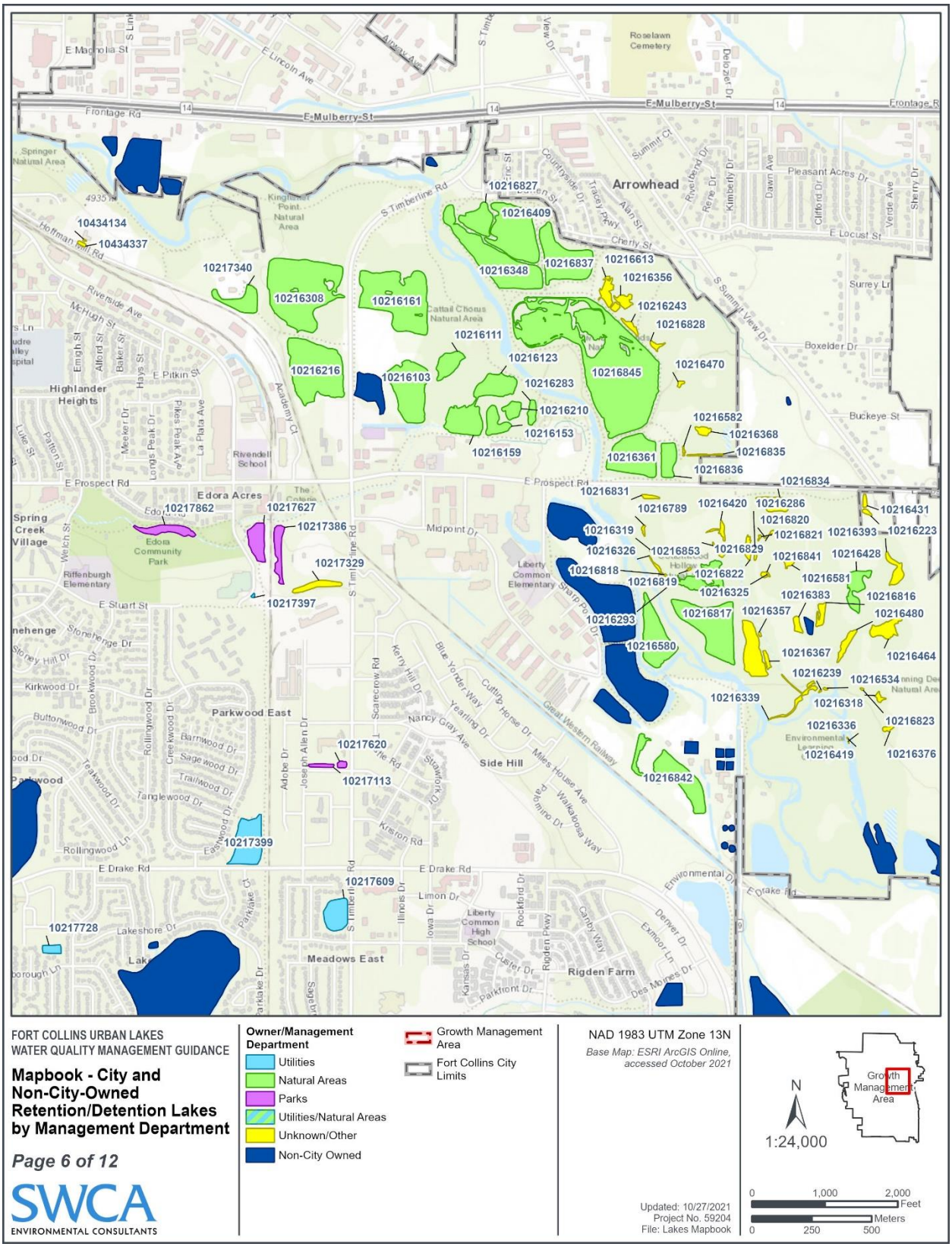

Figure 5-6. Fort Collins' urban lakes, managing department and MAXASSETNUM (image 6 of 12).

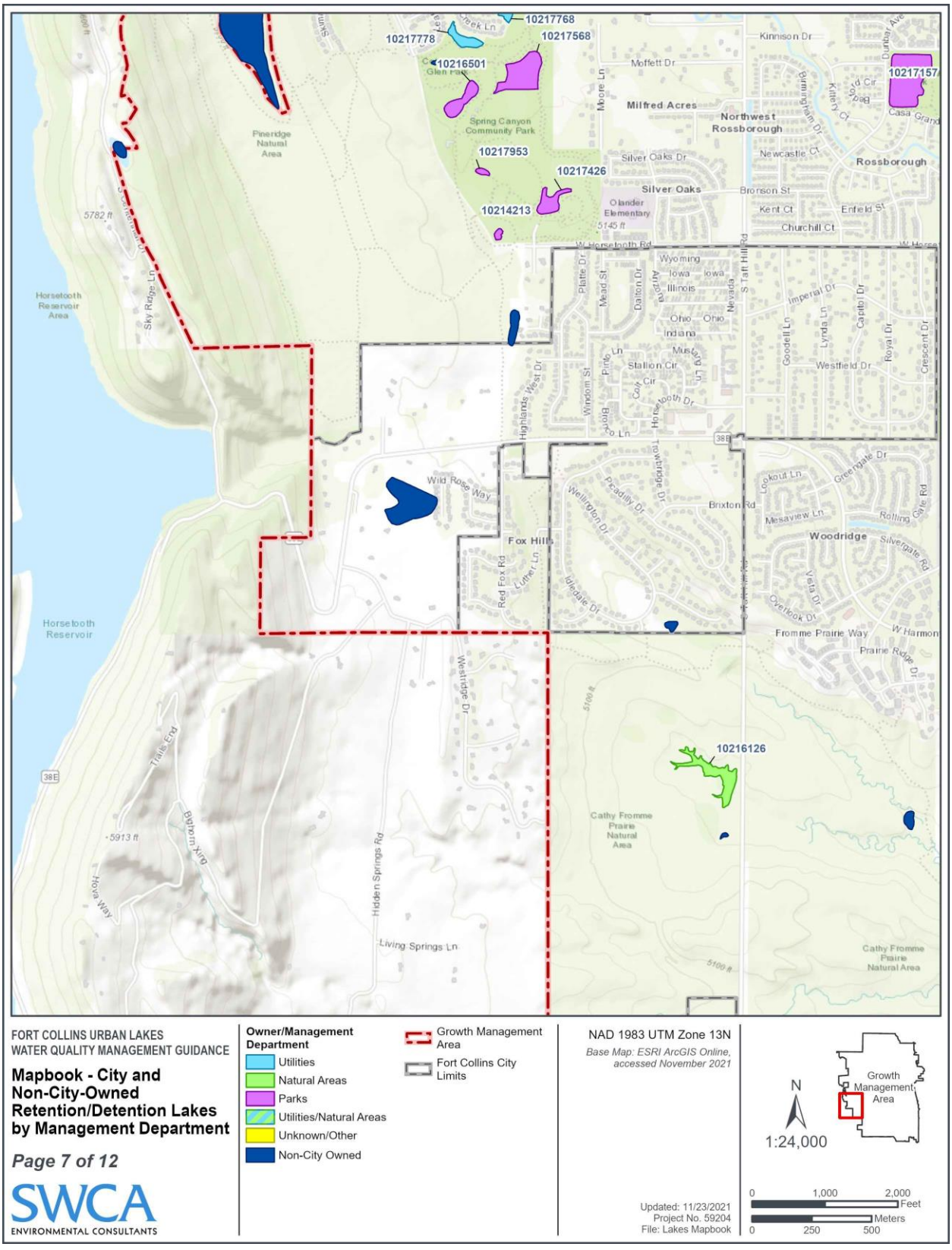

Figure 5-7. Fort Collins' urban lakes, managing department and MAXASSETNUM (image 7 of 12).

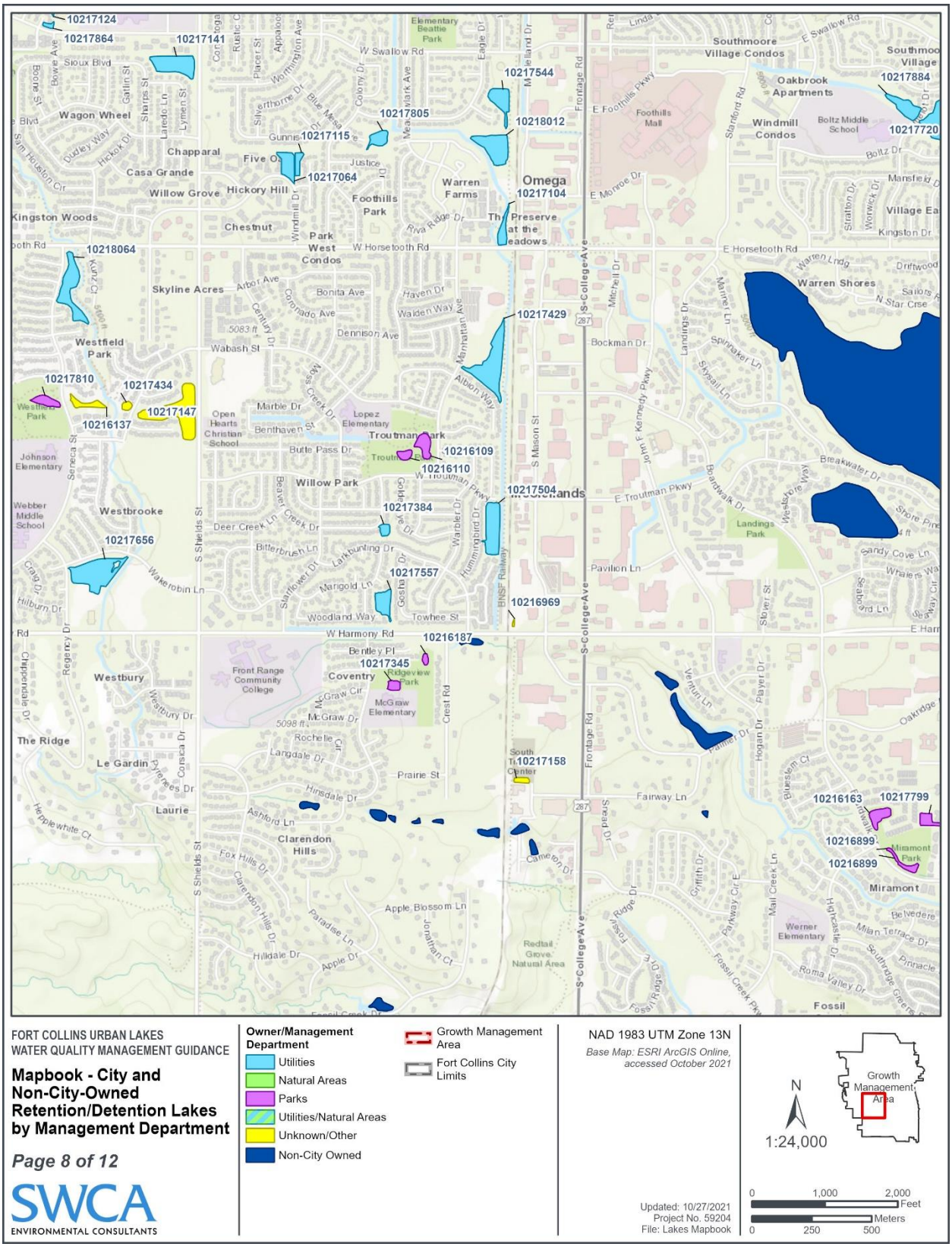

Figure 5-8. Fort Collins' urban lakes, managing department and MAXASSETNUM (image 8 of 12).

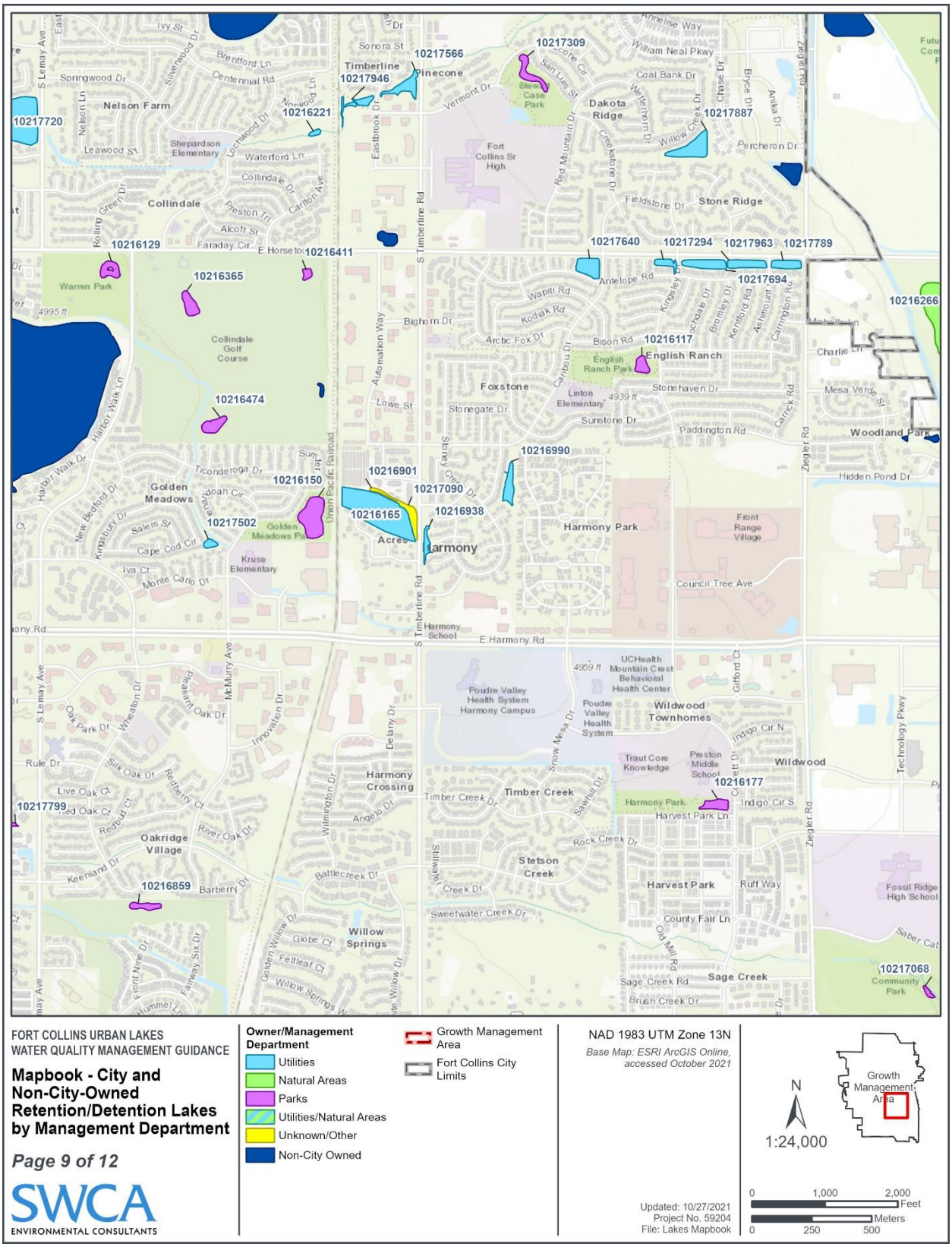

Figure 5-9. Fort Collins' urban lakes, managing department and MAXASSETNUM (image 9 of 12).

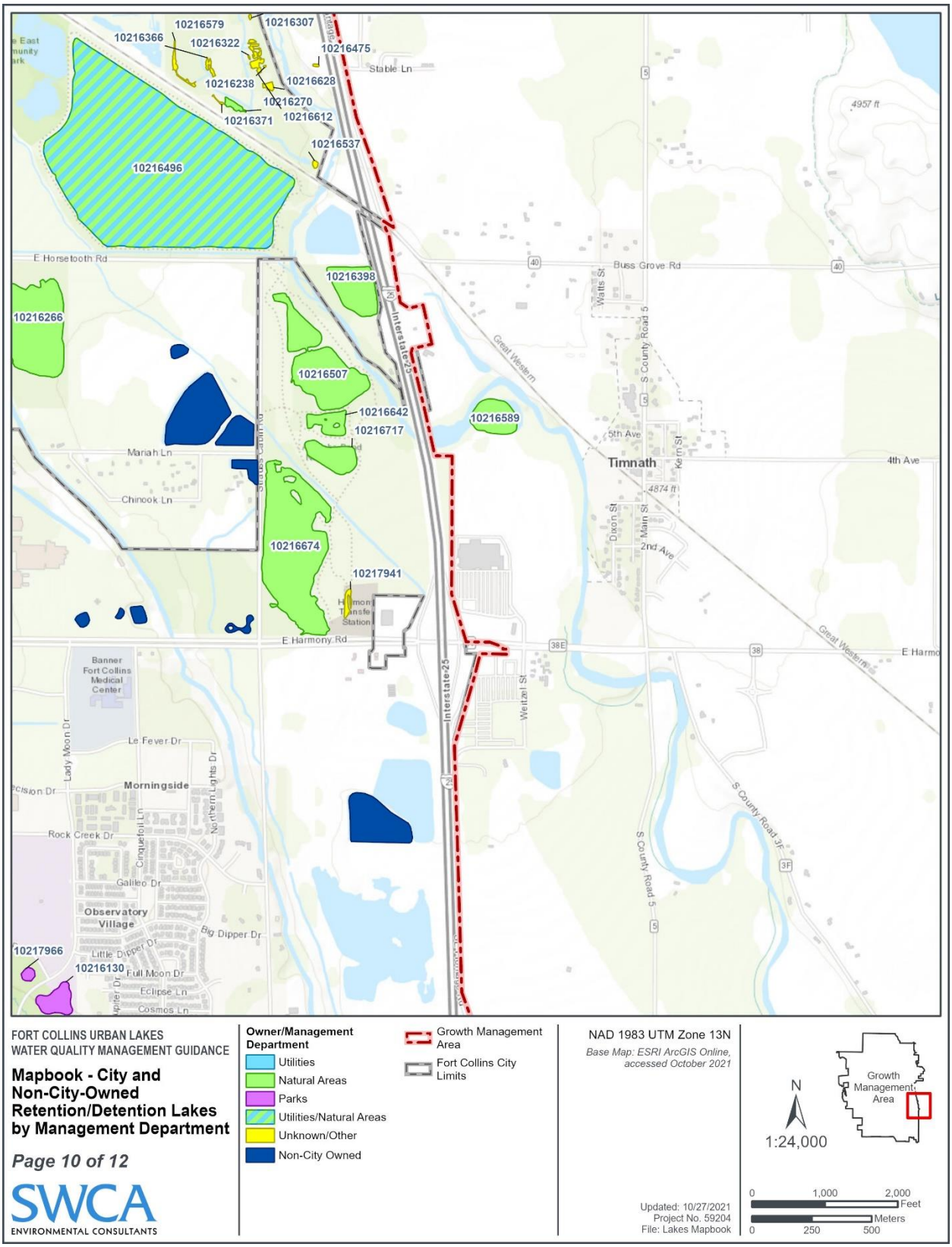

Figure 5-10. Fort Collins' urban lakes, managing department and MAXASSETNUM (image 10 of 12).

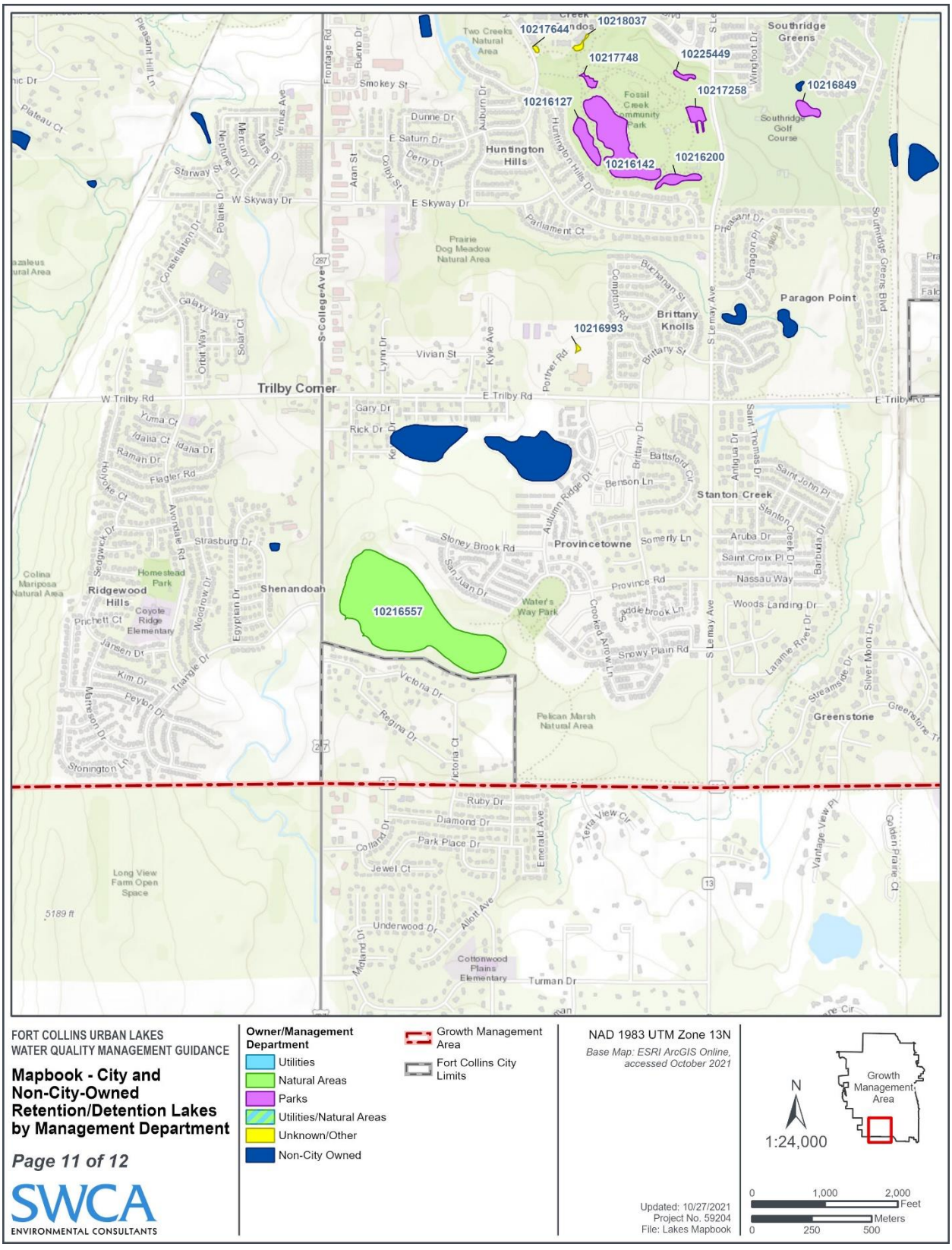

Figure 5-11. Fort Collins' urban lakes, managing department and MAXASSETNUM (image 11 of 12).

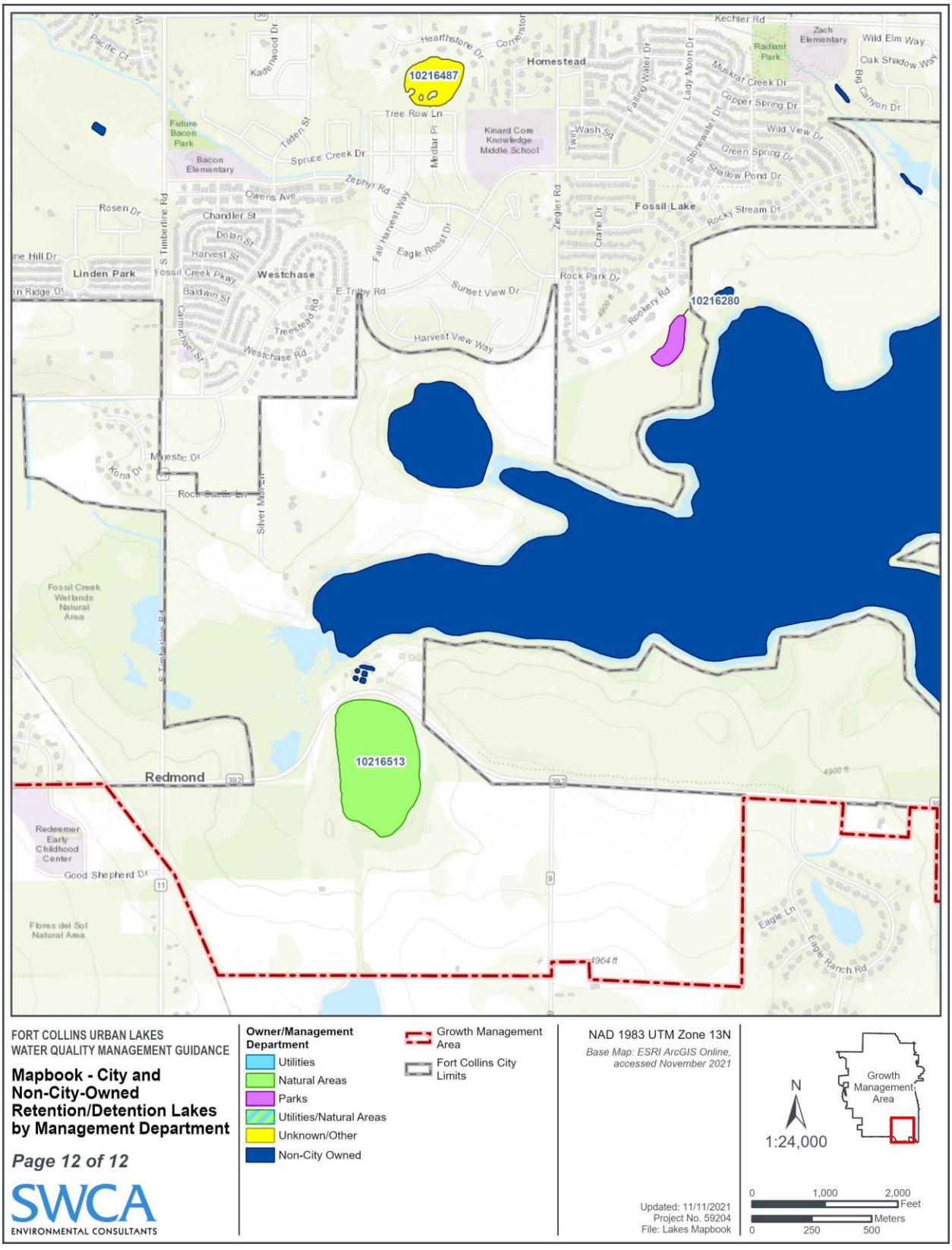

Figure 5-12. Fort Collins' urban lakes, managing department and MAXASSETNUM (image 12 of 12).

ATTACHMENT 6 – WATER QUALITY ISSUES DATABASE

UNIQUE ID	WATER QUALITY ISSUE	DESCRIPTION	CAUSE(S)	RESULTS/CHALLENGES	ADDITIONAL RESOURCES	REFERENCES
WQ-01	clarity	A water quality issue that negatively affects the users senses and perception of the body of water. These issues can potentially lead to ill effects on aquatic life and users.	Turbidity	Turbid water tend to look dirty and uninviting to users. Turbid water can limit plant growth, cause stress to aquatic species and can be a sign that nutrient rich sediment has been agitated.	*http://sedifilt.com/drinking_water/aesthetic_water_quality_problems.html*	GSR1 (who.int)
WQ-02	cleanliness	A water quality issue that negatively affects the users senses and perception of the body of water. These issues can potentially lead to ill effects on aquatic life and users.	Garbage, lack of maintenance	Keeping lakes and lakes and their surroundings clean requires input from both the users and the maintenance staff. Garbage can kill aquatic life, clog outlet works and give the water body a bad look.	*http://sedifilt.com/drinking_water/aesthetic_water_quality_problems.html*	GSR1 (who.int)
WQ-03	odor	A water quality issue that negatively affects the user's senses and perception of the body of water. These issues can potentially lead to ill effects on aquatic life and users.	Stagnant water, eutrophication, wastewater treatment effluent	Water bodies that have unpleasant odor will not be a desirable place for human interaction with the water, in turn leaving the area without any stewards.	*http://sedifilt.com/drinking_water/aesthetic_water_quality_problems.html*	GSR1 (who.int)
WQ-04	algae blooms	Excessive algae growth.	Eutrophication	Algae blooms can reduce water clarity, inhibit other plant growth, deplete oxygen, result in fish die-off, odor, and/or decrease aesthetics.	Managing Lakes and Reservoirs, 2001.	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier.
WQ-06	algae blooms	Excessive algae growth coupled with the byproduct of cyanotoxins that reach dangerous concentrations.	Eutrophication	HABs will result in water bodies being closed to recreation and can be a liability to the managing parties of the lake or lake. HABs can last for long periods of time and can be costly to difficult and costly to monitor and treat if the underlying issues are not addressed.	Toxic algae blooms spotted in lake on Colorado's Front Range | OutThere Colorado	Facts about Cyanobacterial harmful algae blooms for Poison CENTER PROFESSIONALS. (2018, August 24). Retrieved from https://www.cdc.gov/habs/materials/factsheet-cyanobacterial-habs.html
WQ-07	aquatic nuisance species-animals	Organisms that disrupt the ecological balance of a water body, causing damage and impairing the functional uses of the lake.	External introduction	Any ANS that is introduced to a water body will have some type of negative affect to the aquatic environment. Either out competing local species or becoming over populated to the point creating major and expensive fixes.	NZ mudsnail (fws.gov)	State of Colorado Aquatic Nuisance Species Management Plan
WQ-08	aquatic nuisance species-plants	Unchecked growth or infestation of aquatic weeds and invasive species that interferes with the functionality and health of the lake.	External introduction	ANS, plants, can take over a water body by enveloping the surface area with overgrowth while outcompeting beneficial species and impacting DO. The species can be costly to treat and require extensive efforts to eradicate.	9 Nuisance Aquatic Weed and Algae Species to Look Out For in Your lake (solitudelakemanagement.com)	Biology and Control of Aquatic Plants
WQ-09	contaminants of concern (COCs)	Chemicals and toxins that can pose health risks to humans and aquatic life, that have standardized water quality standards.	External introduction	Certain COCs can cause harm to aquatic species, giving them birth defects or inhibiting successful spawning. COCs can also cause health risks to humans. As well as being highly persistent even in small quantities.	https://www.epa.gov/fish-tech/contaminants-emerging-concern-fish-fact-sheets	Contaminants of Emerging Concern including Pharmaceuticals and Personal Care Products | Water Quality Criteria | US EPA
WQ-10	contaminants of emerging concern (CECs)	Chemicals and toxins that can pose health risks to humans and aquatic life, that are yet to have standardized water quality standards.	Wastewater treatment effluent	CECs often entire our water bodies after being digested and passed by humans. Substances such as birth control, acetaminophen and prescription drugs are commonly found and unregulated in wastewater effluent.	https://www.epa.gov/fish-tech/contaminants-emerging-concern-fish-fact-sheets	Contaminants of Emerging Concern including Pharmaceuticals and Personal Care Products | Water Quality Criteria | US EPA
WQ-11	Escherichia coli (E. coli)	Coliform bacteria associated with waste from warm blooded animals (humans, cattle, geese etc.).	Waterfowl feces; septic leaks, pet waste, other warm-blooded wildlife, wastewater treatment effluent.	E. coli can cause digestive tract issues with both humans and their pets. When E. coli exceeds water quality standards for recreational use, water bodies need to be shut down and can cause issues with further managing a successful lake our lake that is meant to be used.	E. coli fouls 100 Colorado waterways. But managers aren't sure how big the threat is to people playing in streams. (coloradosun.com)	Lake Management (denvergov.org) Shiga toxin producing E. coli (STEC) including E. coli 0157:H7, Colorado Communicable Disease Manual. (2004, November 08). Retrieved from https://drive.google.com/file/d/11Y6ABRk5NBycv8MDuReDQa1k_3-ZQZog/view
WQ-13	Escherichia coli (E. coli)	Coliform bacteria associated with waste from warm blooded animals (humans, cattle, geese etc.).	Agricultural runoff	E. coli can cause digestive tract issues with both humans and their pets. When E. coli is present, water bodies need to be shut down and can cause issues with further managing a successful lake our lake that is meant to be used.	E. coli fouls 100 Colorado waterways. But managers aren't sure how big the threat is to people playing in streams. (coloradosun.com)	Shiga toxin producing E. coli (STEC) including E. coli 0157:H7, Colorado Communicable Disease Manual. (2004, November 08). Retrieved from https://drive.google.com/file/d/11Y6ABRk5NBycv8MDuReDQa1k_3-ZQZog/view

UNIQUE ID	WATER QUALITY ISSUE	DESCRIPTION	CAUSE(S)	RESULTS/CHALLENGES	ADDITIONAL RESOURCES	REFERENCES
WQ-14	heavy metals	Introduction or mobilization of heavy metals in concentrations that are harmful to aquatic species.	Stormwater runoff; metal foundries and smelting; mining; natural causes such as rock weathering, post-fire runoff.	Fish kills can be caused by acute and chronic heavy metal concentrations in water. Certain heavy metals are also regulated at low quantities for human health.	State and federal officials determine fish kill in Left Hand Creek is related to Captain Jack Mine site | Department of Public Health & Environment (colorado.gov). After the Napa Fires, Toxic Ash Threatens Soil, Streams, and San Francisco Bay | WIRED	https://www.kmizeolite.com/wp-content/uploads/2016/12/Reddy_Heavy-Metal-from-Urban-Runoff-1.pdf Water quality after wildfire. (n.d.). Retrieved from https://www.usgs.gov/mission-areas/water-resources/science/water-quality-after-wildfire?qt-science_center_objects=0#qt-science_center_objects; Code of Colorado Regulations (state.co.us)
WQ-16	herbicides	Any substance used to control unwanted plants species.	Runoff; direct application of algaecides to water bodies; herbicides applied to tree canopy above water body or along water's edge.	Herbicides that are not meant for aquatic use can cause harm for both aquatic plant and animal species. They can also remain in sediment and become a problem with turnover and mixing events.	Environmental Indicators of Pesticide Leaching and Runoff from Farm Fields | NRCS (usda.gov)	https://www.nalms.org/nalms-position-papers/use-of-herbicides-in-lakes/
WQ-17	residence time	High flow (also known as short residence time) can lead to other water body impairments.	Too much in-flow, too short of residence time; nearby irrigation/water runoff increased; inline irrigation flows	High flow through a lake or lake can create unbalance in all the systems that the lake and its managers try to keep balanced. From microorganisms to aquatic life, high flows and flushing events can disrupt these systems and cause unwanted cascading events.	Hydraulic Flushing – hcb (itrcweb.org)	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier.
WQ-18	residence time	Low flow (also known as long residence time) can lead to other water body impairments.	Not enough in-flow, too long of residence time; nearby irrigation/water runoff reduced	Low flow can cause high temperatures, low DO and other issues such as anoxia and odors. Low flow can be difficult to address during the late summer early fall season when water supply becomes stressed and limited.	Water Quality Risks to Lakes and Rivers | National Climate Assessment (globalchange.gov)	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier.
WQ-19	low dissolved oxygen	Dissolved oxygen limits below benchmarks.	High Biological Oxygen Demand (BOD); organic pollution; nutrient enrichment; aquatic plant overgrowth; runoff carrying urban pollutants (i.e., pet waste, fertilizers, grass clippings, etc.)	High BOD can affect all forms of aquatic life. From fish kills to upsetting the balance of microorganisms. High BOD can be a short-term problem, from a storm event, or it can be caused by a more persistent issue.	Why are there dead fish in Denver's lakes? Experts weigh in — The Know (denverpost.com)	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier; Code of Colorado Regulations (state.co.us)
WQ-20	low dissolved oxygen	Dissolved oxygen limits below benchmarks.	High temperatures	When water temperature increases, the molecular ability of the water to hold dissolved oxygen molecules decreases. This means that increasing water temperatures mean less dissolved oxygen for aquatic life. This is a physical parameter that would need to be mitigated with shade or supplemental oxygen.	Why are there dead fish in Denver's lakes? Experts weigh in — The Know (denverpost.com)	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier; Code of Colorado Regulations (state.co.us)
WQ-21	low dissolved oxygen-anoxia	Dissolved oxygen below 0.5 milligrams per liter.	High Biological Oxygen Demand (BOD) and/or high temperatures; organic pollution; nutrient enrichment; aquatic plant overgrowth; runoff carrying urban pollutants (i.e., pet waste, fertilizers, grass clippings, etc.)	Absence of oxygen; anaerobic reactions lead to buildup of ammonia, hydrogen sulfide, carbonaceous gases; iron; manganese; phosphorus; habitat impairment.	Course Handout on Limnology.doc (mtu.edu)	Code of Colorado Regulations (state.co.us)
WQ-22	low water level	Low or nearly absent water levels; can be stagnant water.	Not enough in-flow, too long of residence time; nearby irrigation water or runoff reduced; waterbodies lacking an inlet or outlet	Low water levels can aid in increasing water temperatures and lower DO. Low water levels can also expose aquatic vegetation with both positive and or negative outcomes, depending on the management priorities.	Climate Change Impacts On Lakes – North American Lake Management Society (NALMS)	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier.
WQ-23	aquatic nuisance species-insect	A nuisance insect from the order Diptera, that present a public health threat through the transmission of pathogens and viruses.	Standing / stagnant water	Lakes and lakes are ideal breeding grounds for mosquitoes. Even with aquatic predators and moving water, stagnant water around the lake's permitter can still aid in hatching of mosquitoes.	Controlling Mosquitoes at the Larval Stage | Mosquito Control | US EPA	Biology and Control of Aquatic Plants

UNIQUE ID	WATER QUALITY ISSUE	DESCRIPTION	CAUSE(S)	RESULTS/CHALLENGES	ADDITIONAL RESOURCES	REFERENCES
WQ-24	aquatic nuisance species-insect	A nuisance insect from the order Diptera, that present a public health threat through the transmission of pathogens and viruses.	Flood water	Rain events and high flow events of leave enough water for mosquito larva to hatch into adults. Mitigating these waters can be cumbersome and may require both physical design to limit stagnate waters and larvicides. Stormwater design criteria also include a draw-down time in order to treat stormwater runoff, so difficult to fully eliminate standing water.	Controlling Mosquitoes at the Larval Stage | Mosquito Control | US EPA	Biology and Control of Aquatic Plants
WQ-25	nutrients	High levels of phosphorus or nitrogen.	Waterfowl feces	1) Goose droppings contain nitrogen and phosphorus and can result in nutrient loading to the lakes directly or through runoff from nearby surfaces. Direct point-source loading may require permitting, and when from surfaces, it is considered a non-point source of pollution. 2) Washing goose droppings off into a water body is prohibited by municipal code and MS4 regulations. 3) Fecal contamination can contribute to exceedances of the state recreational water quality standard. 4) Aesthetics, goose droppings can be unsightly and raise public concern over contact issues.	Goose_Manual-Habitat-Modification.pdf (maine.gov)	Lake Management (denvergov.org)
WQ-26	nutrients	High levels of phosphorus or nitrogen.	Agricultural runoff	Mitigating agricultural runoff is a challenge because the source occurs on private lands within the watershed where lake managers have no control. Education and outreach are the best methods to try and limit the negative effects of excess nutrients coming off of agricultural lands.	Colorado Regulation 85 & Water Quality FAQs (colostate.edu)	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier.
WQ-27	nutrients	High levels of phosphorus or nitrogen.	Wastewater treatment effluent	Colorado regulation 85 is now in place to help mitigate point source nutrient discharge. However, low levels of nutrients can still accumulate in lakes and lakes causing management problems.	Code of Colorado Regulations (state.co.us)	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier.
WQ-28	nutrients	High levels of phosphorus or nitrogen.	Turf Maintenance / Fertilizer	Turf maintenance is easier to adjust for lake managers, as the caretakers of the turf are often working for the same entity as the lake. Having a holistic plan in place to take care of the turf and limit the negative effects to adjacent waterbodies can be effective. Regulation 85 requires the City, through its MS4 permit, to address fertilizer storage and application practices and can be a part of the turf management plan.	Maintaining Waterfront Turf to Preserve Water Quality (E0011) - MSU Extension	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier.
WQ-29	odor	Rotten smell.	Decomposition of organic material, low DO.	Organic material will inevitably end up in lakes and lakes. Their decomposition can lead to low DO and issues with odor. The season experienced in Colorado provide a recuring source of detritus that should be considered with management strategies.	lake and Lake Odors - Why Your Water Smells Bad and How to Fix It (ezinearticles.com)	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier.
WQ-31	parasites	Protozoa that can cause severe gastrointestinal issues when ingested by humans.	External introduction	Protozoa can be introduced from upstream sources and fecal matter. This can cause problems in recreation waters and the water becomes unsafe for human contact due to the chance of the protozoa being digested by the users.	https://www.cdc.gov/healthywater/drinking/public/water_diseases.html	Indicators for waterborne pathogens. (2004). Washington: National Academies Press.
WQ-32	pesticides	Any substance used to control unwanted animal species.	Runoff	Pesticides used outside of lake management can persist in the watershed and be introduced through storm run-off. These substances can cause harm to aquatic life, they can be hard to identify, and can be difficult to remove from the system.	https://www.epa.gov/npdes/pesticide-permitting	https://www.epa.gov/sdwa/human-health-benchmarks-pesticides-drinking-water

UNIQUE ID	WATER QUALITY ISSUE	DESCRIPTION	CAUSE(S)	RESULTS/CHALLENGES	ADDITIONAL RESOURCES	REFERENCES
WQ-33	pH	Acute or chronic pH levels outside of the suitable range for healthy aquatic life.	Stormwater runoff; natural causes such as decomposition of limestone, anthropogenic sources such as chemicals added to raise pH, post-fire runoff, lake mixing.	Fish kills; organism die-off.	Managing high pH in freshwater lakes | The Fish Site	COR400000 stormwater DISCHARGE. (n.d.). Retrieved from https://cdphe.colorado.gov/cor400000-stormwater-discharge; Code of Colorado Regulations (state.co.us) Water quality after wildfire. (n.d.). Retrieved from https://www.usgs.gov/mission-areas/water-resources/science/water-quality-after-wildfire?qt-science_center_objects=0#qt-science_center_objects; Code of Colorado Regulations (state.co.us) Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier; Code of Colorado Regulations (state.co.us)
WQ-36	pH	Reduced or fluctuating water pH below 7.	Acid rain	Changes to pH-mediated water quality and ecological processes; habitat impairment.	Acid Rain and Water (usgs.gov)	What is Acid Rain? | Acid Rain | US EPA
WQ-37	salinity	The amount of dissolved salts in a body of water.	Agricultural runoff	Salinity itself is often not harmful to aquatic life in low quantities. However, in acute situations, salts will interact with the water chemistry and can bring quick and drastic changes to pH, heavy metal mobilization, and other secondary effects. Chronic saline levels that exceed certain thresholds will also play a role in health effects to aquatic life and vegetation.	Filtering agricultural runoff with constructed and restored wetlands - Rural California Report (cirsinc.org)	Urban salinity – causes and impacts (nsw.gov.au)
WQ-38	salinity	The amount of dissolved salts in a body of water with concentrations linked to Chloride, an anion formed from Chlorine.	Road salts	Road salts are applied either as a liquid or solid as a de-icer to make roadways safe during the winter months. These salts often make their way to our waterways. In large amounts these salts can bring unwanted effects to a managed lake. Fish kills, pH changes, vegetation degradation and other effects are possible.	Comparison of Contributions to Chloride in Urban Stormwater from Winter Brine and Rock Salt Application | Environmental Science & Technology (acs.org)	Haake, D. M., & Knouft, J. H. (n.d.). Comparison of contributions to chloride in Urban Stormwater from Winter brine and rock SALT APPLICATION. Environmental Science and Technology. doi:10.1021/acs.est.9b02864.s001
WQ-39	sediment-sedimentation	Sediment suspended in water column settles to the bottom and builds over time.	Erosion and runoff of sediments from construction in stormwater runoff or sediment mobilized by storms or flushing into streams and waterways, that usually settle out in lower-flow waters, such as lakes and lakes.	Loss of lake/lake depth and storage capacity; undesirable sediment composition; nutrient loading; habitat loss	Effects of Sediment on the Aquatic Environment: | NRCS (usda.gov)	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier.
WQ-40	sediment-water interactions	Sediments interaction with the water and its contribution to a negative water quality issue.	Wetted perimeter of the lake being in constant contact with the water causing for biological and chemical interactions.	Sediment can act as a sponge to a multitude of constituents. It then can have prolonged interactions with the water, both year-round and during mixing events. The effects are dependent on the constituents that are stored and the surrounding water chemistry.	Effects of Sediment on the Aquatic Environment: | NRCS (usda.gov)	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier.
WQ-41	polluted stormwater runoff	Stormwater coming into contact with, dissolving, and/or carrying fecal, chemical, nutrient, sediment, or other pollutants into waterbodies.	Warm-blooded animal waste, anthropogenic sources, such as pesticides, fertilizers, metals, petroleum products, organic matter, sediment, and mining activities. Urbanization with increased impervious surfaces allow stormwater to carry anthropogenic and natural sources to water bodies.	Excessive waste from any source can be harmful to water bodies and cause a variety of water quality issues. Storm sewers can be acute point source contributors, and stormwater runoff from surrounding surfaces can be non-point source contributors. The effects can have health concerns to recreational users and wildlife. Managers should be aware of the potential risk posed by stormwater pollution from surrounding areas. Stormwater design criteria is required for new and re-development.	Keep It Clean Partnership | Stormwater Pollution Prevention » Scoop the Poop	Environmental Contamination by Dog's Feces: A Public Health Problem? (nih.gov)
WQ-42	temperature-cold	Prolonged cold ambient air temperatures can lead to lake/lake ice-over.	Cold temperatures	In shallow lakes where substantial volumes of ice-free water are un-available, ice-over can result in decreased DO resulting in fish kills.	Climate Change Impacts On Lakes – North American Lake Management Society (NALMS)	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier.

UNIQUE ID	WATER QUALITY ISSUE	DESCRIPTION	CAUSE(S)	RESULTS/CHALLENGES	ADDITIONAL RESOURCES	REFERENCES
WQ-43	temperature-high	Temperatures that promote eutrophication, low DO and are harmful to aquatic species.	Shallow lake	Shallow lakes can absorb more radiation energy, especially if the benthic surface is retaining solar heat. These lakes are much more susceptible to low DO and even temperatures by themselves that will harm aquatic life.	World's Leading Aquatic Scientific Societies Urgently Call for Cuts to Global Greenhouse Gas Emissions – North American Lake Management Society (NALMS)	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier.
WQ-44	temperature-high	Temperatures that promote eutrophication, low DO and are harmful to aquatic species.	Warming climate, long residence time; shallow, small lake/lake size; no shading	With fully allocated river systems and a climate that is currently trending towards warmer temperatures, lake managers are facing difficult problems. In some instances, fish species and vegetation choices may need to change to reflect these new conditions. This may also necessitate more mechanical intervention to keep water clean and oxygenated. When water temperature gets too high or is too high for too long, algae productivity may increase, DO may drop, fish may die due to low DO or heat stress.	Climate Change: Global Temperature | NOAA Climate.gov Climate Change Impacts On Lakes – North American Lake Management Society (NALMS)	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier.
WQ-46	turbidity	High levels of suspended solids in the water column.	Stormwater runoff; sediment from construction in stormwater runoff, or sediment mobilized by intense storms or flushing irrigation flows.	Stormwater can resuspend settled sediment creating for turbid water conditions. High turbidity can make breathing harder for fish as they filter dirty water through their gills during the oxygen exchange. These turbidity events can also add to increased temperature, nutrient releases, and heavy metal mobilizations. Lake managers never know what stormwater will bring in. Having good control of your sediment / sludge and microorganisms can help lessen the impacts of these flashy events.	Turbidity and Water (usgs.gov)	5.5 turbidity. (2012, March 06). Retrieved from https://archive.epa.gov/water/archive/web/html/vms55.html
WQ-47	turbidity	High levels of suspended solids in the water column.	Post-fire runoff	Post-fire runoff can bring different problems to a lake than normal urban run-off. Depending on the location of the fire, there can be high concentrations of mercury, heavy metals, ash, and organic carbons. Lakes higher in the watershed will be more prone to negative impacts and managers should try to have a proactive plan in place should post-fire runoff become a potential concern.	Turbidity and Water (usgs.gov)	Water quality after wildfire. (n.d.). Retrieved from https://www.usgs.gov/mission-areas/water-resources/science/water-quality-after-wildfire?qt-science_center_objects=0#qt-science_center_objects
WQ-48	turbidity	High levels of suspended solids in the water column.	Mixing	Mixing events can be caused from turnovers in larger lakes and high winds in smaller lakes. Suspending sediments re-introduce dormant issues.	Turbidity and Water (usgs.gov)	Wetzel, R. G. (2015). Limnology: Lake and river ecosystems. San Diego etc.: Academic Press, an imprint of Elsevier.
WQ-49	aquatic nuisance species-macrophyte	Cattails have filled in all or a significant portion of the lake and have formed a monoculture.	Cattail populations are left to overgrow or are receiving nutrient inputs that support excessive growth.	Once cattails have reached this level of overgrowth, few other plants species can coexist with them and little to no open water is left in the lake. Thick stands may also lower available DO.		

ATTACHMENT 7 – BEST MANAGEMENT PRACTICES (BMPS) TOOLBOX

UNIQUE ID	BMP	DESCRIPTION	BMP TYPE	BMP MECHANISM	TARGET WATER BODY ISSUE	APPLICABLE LAKE CONDITIONS	POTENTIAL CONCERNS	PERMITTING AND WATER RIGHTS	CO-BENEFIT(S)	CAPITAL COSTS	O&M COSTS PER YEAR (ADJUSTED FOR 20-YEAR BMP LIFESPAN)	ADDITIONAL RESOURCE(S)	REFERENCE(S)
BMP_01	Aeration	Mechanical addition/ maintenance of oxygen levels.	Capital Improvement/ Maintenance	Mechanical	low dissolved oxygen; algae blooms; low quality fish habitat; nutrients	Any lake or lake that has low dissolved oxygen.	May harm cold water fisheries; interfere with recreation; resuspend benthic sediments	CWA Section 401	aesthetics; mitigate odor	$90-100k	$5-30k		http://aquatics.org/bmpchapters/3.4%20Cultural%20and%20Physical%20Control%20of%20Aquatic%20Weeds.pdf; https://www.epa.gov/sites/production/files/2015-04/documents/nutrient-economics-report-2015.pdf
BMP_02	Aquatic Algaecide	A chemical treatment applied with a specific technique at specific times to target a specific problem with an aquatic plant.	Maintenance	Chemical	aquatic nuisance species-plants	Any lake or lake with excessive algae growth that does not have any aquatic species that would be negatively impacted by application of algaecide.	Low DO event after application; mortality of desirable vegetation	Application permitting may be required; CDPHE Aquatic Pesticides Permit (General Permit COG860000); NPDES permits; CWA Section 401; applicator may need to be licensed.	Increased biodiversity Lowered BOD Increased aesthetics	$100-3k	Variable depending on treatment frequency.	*https://www.thelakeguy.com/category/aquatic-algicides*	Debunking Myths: A Professional's Take on Herbicides and Algaecides (solitudelakemanagement.com)
BMP_03	Aquatic Dye	EPA-registered dyes or surface covers used to limit light penetration and restrict the depth at which rooted plants can grow.	Maintenance	Chemical	aquatic nuisance species-plants; aquatic invasive species-plants; algae blooms	Generally used for golf courses and artificial aesthetic lakes.	May make water look artificial; downstream impacts; permit may be required; limits access in recreational lakes; increased surface water temperature due to solar absorption of dye; impacts to desirable species	Application permitting may be required; CDPHE Aquatic Pesticides Permit (General Permit COG860000); NPDES permits; CWA Section 401; applicator must be licensed?	Aesthetics; limit vegetation growth	$10-300	Variable depending on treatment frequency.		https://aquaticcontrol.com/product-category/lake-dyes/
BMP_04	Aquatic Herbicide	A chemical treatment applied with a specific technique at specific times to target a specific problem with algae growth. Aquatic Herbicides can be categorized as contact or systematic. Contact herbicides tend to result in rapid injury or death of the contacted plat tissues. Systematic herbicides are translocated throughout the plant tissue and roots once taken up by the plant.	Maintenance	Chemical	aquatic nuisance species-plants	When a certain aquatic plant species can be targeted with a specific herbicide, without impacting other aquatic resources.	Low DO event after application Contact: Do not use on emergent plant without expert advice. Systematic: Concentration and time of exposure are crucial for proper application.	Application permitting may be required; CDPHE Aquatic Pesticides Permit (General Permit COG860000; NPDES permits; CWA Section 401; applicator must be licensed?	Increased biodiversity Lowered BOD Increased aesthetics	$15-30k	Variable depending on treatment frequency.	https://www.epa.gov/sites/production/files/2015-04/documents/nutrient-economics-report-2015.pdf	Debunking Myths: A Professional's Take on Herbicides and Algaecides (solitudelakemanagement.com); https://www.sfei.org/sites/default/files/biblio_files/PestAlternatives_review.pdf

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BMP_05	Artificial Habitat Structures	Implementing a variety of structures that create space for aquatic life to hide, rest and feed.	Capital Improvement/Maintenance	Mechanical	aquatic habitat	Placement in areas that will not endanger or interfere recreationists or lake/lake maintenance.	Endangerment or interference with recreationists or maintenance activities.	CPW may require permit; CWA Section 401	targets invasive plants; allows for more biodiversity	$100-3k	$0	Fish Habitat — lake King, Inc.; https://www.solitudelakemanagement.com/blog/helpful-tips-when-installing-artificial-habitat/	Fish Habitat Management | Solitude Lake Management
BMP_06	Barley Extract	Similar to barley straw but in a concentrated liquid. This liquid works the same as barley straw, however it is faster acting. The concentrate needs to be precisely measured otherwise it can become harmful to the aquatic life in the lake.	Maintenance	Biological	algae blooms	Any lake with a known volume and controlled residence time, as the application is fast acting and needs to be precise.	Increasing oxygen demand; if used in large quantities it could be harmful to fisheries; classified as a home remedy, not a true pesticide	CDPHE permitting may be required; CPW may require permit; CWA Section 402	increased biodiversity; increased aesthetics; low maintenance; long term efficacy; eco-friendly	$10-$100	Variable depending on treatment frequency.	https://www.thelakeguy.com/product/the-lake-guy-barley-extract/water-garden-fish-lakes-natural-barley-treatments; https://www.thelakeguy.com/product/the-lake-guy-barley-extract/water-garden-fish-lakes-natural-barley-treatments?p=PPCGOOGA&gclid=Cj0KCQjwp86EBhD7ARIsAFkgakgKPHJiauYNdLvUWiitbDmUY1d4eOa8plMz7-HrhX5sE4xb4WIgLH8aAlhNEALw_wcB	How to Use lake Barley Straw for Algae (Does it Actually Work?) - lake Informer
BMP_07	Barley Straw	Bundles of barley straw are suspended in the lake, near the surface. As a by-product of the slow decomposition of the straw, low levels of hydrogen peroxide are released into the water. Hydrogen peroxide limits or prevents the growth of algae. It does not kill or remove pre-existing algae. Barley straw works best in a well oxygenated lakes without other underlying water quality issues. For this reason, barley straw is better suited as a preventative method. In other words, it is better suited as an algaestat than an algaecide. This method works best when deployed in the spring and allowed to work throughout the summer.	Maintenance	Biological	algae blooms	Any lake known to have algae blooms, in the summer as barley straw works slow and is best used as a preventative measure	Increasing oxygen demand; if used in large quantities it could be harmful to fisheries; classified as a home remedy, not a true pesticide	CPW may require permit; CWA Section 403	increased biodiversity; increased aesthetics; low maintenance; long term efficacy; eco-friendly	$100-1k	Variable depending on treatment frequency.	FS1171: lake and Lake Management Part VI: Using Barley Straw to Control Algae (Rutgers NJAES)	How to Use lake Barley Straw for Algae (Does it Actually Work?) - lake Informer

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BMP_08	Benthic Barriers	Used for localized control of benthic aquatic plants. Blocks sunlight needed for photosynthesis, good in areas <1 acre. Deeper than 4ft often requires scuba diver installation. May impact fish and other benthic organisms.	Maintenance	Mechanical	aquatic nuisance species-plants; aquatic invasive species-plants	target areas < 500 square feet	Lack of natural aquatic vegetation. Repairs and cost of instillation	Application permitting may be required; CWA Section 402 or 404.	Control muck, sediment, turbidity. Can give more control over many factors driving lake health.	$6k+/acre; $14k-26,200/acre	Variable depending on treatment frequency.	http://www.apms.org/japm/vol50/2-17716%20p101-105%20APMdj.pdf; https://lakestewardsofmaine.org/wp-content/uploads/2018/01/Benthic-Barriers.pdf; https://www.epa.gov/sites/production/files/2015-04/documents/nutrient-economics-report-2015.pdf	http://aquatics.org/bmpchapters/3.4%20Cultural%20and%20Physical%20Control%20of%20Aquatic%20Weeds.pdf
BMP_09	Biocide	Chemicals/substances added to inhibit/eliminate target species.	Maintenance	Chemical	algae blooms; vascular plants; Aquatic Nuisance Species - Insect; fish kills	Any size lake that has a specific species that is a nuisance in its current setting.	may impact water quality; oxygen levels; released/available nutrients; impact desirable species; downstream impacts; may result in decaying vegetation/algae mass.	Application permitting may be required; CDPHE Aquatic Pesticides Permit (General Permit COG860000); NPDES permits; CWA Section 401; applicator must be licensed?	Increase biodiversity. Site specific application. Control of overgrowth can help aquatic habitat and overall health of the lake.	Variable; cost dependent on type, manufacturer costs, shipping, application time, and monitoring strategy.	Variable depending on treatment frequency and monitoring strategy.		BiocidesforIndustrial Use.pdf (anl.gov)
BMP_10	Biocontrol - Classical	Use of natural enemy (biocontrol agent) of the nuisance specie (target) from their native range are introduced to control the nuisance specie. Biocontrol agents are usually insects.	Maintenance	Biological	aquatic nuisance species-plants; aquatic invasive species-plants	Anywhere where there is a specific species that can be targeted by a native bio-control measure.	Establishment of the biocontrol agent and suppression of the target species are not guaranteed; the introduced agent may impact species that are not the target	Application permitting may be required; CPW approval may be required	Less expensive option, if suitable. No maintenance. Increased bug abundance can help the food abundance for fisheries.	Variable; cost dependent on type, manufacturer or rearing costs, shipping and delivery, application time, and monitoring strategy.	Variable depending on treatment frequency and monitoring strategy.		Introduction - Biological Control: Management Methods - Managing Invasive Plants (fws.gov)
BMP_11	Biocontrol - Non-classical	Use of a non-natural enemy (biocontrol agent) of the nuisance specie (target) are introduced to control the nuisance specie. Biocontrol agents are usually insects.	Maintenance	Biological	aquatic nuisance species-plants; aquatic invasive species-plants	Non-classical bio-control can be harder to find matches for insects and species to be controlled. However, when the insect to be used will not prove to become a nuisance, the conditions are then met.	Establishment of the biocontrol agent and suppression of the target species are not guaranteed; the introduced agent may impact species that are not the target	Application permitting may be required; CPW approval may be required	Less expensive option, if suitable. No maintenance. Increased bug abundance can help the food abundance for fisheries.	Variable; cost dependent on type, manufacturer or rearing costs, shipping and delivery, application time, and monitoring strategy.	Variable depending on treatment frequency and monitoring strategy.		3.6 Introduction to Biological Control of Aquatic Weeds.pdf (aquatics.org)

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BMP_12	Biomanipulation	Targeted manipulation of ecological interactions to alter ecosystem processes.	Maintenance	Biological	algae blooms; vascular plants; fish kills; aquatic nuisance species-animals; habitat enhancement	lakes or lakes where making adjustments to biological interactions with have positive cascading affects. Lakes or lakes that have time to adjust and see results of manipulation, which can take longer than other options	introduced species may impact water quality; ecosystem functions; unintended migration; introduced species impact on lake users; impacts on non-target desirable species; impact longevity	Application permitting may be required; CPW approval may be required	A more natural option that can restore ecological balance and long-term success of lake health. Can reduce management inputs, when implemented properly.	$1k-10k	Variable depending on treatment frequency and monitoring strategy.		Reference: https://www.epa.gov/sites/production/files/2015-04/documents/nutrient-economics-report-2015.pdf
BMP_13	Biopesticides	Biopesticides include naturally occurring substances that control pests (biochemical pesticides), microorganisms that control pests (microbial pesticides), and pesticidal substances produced by plants containing added genetic material (plant-incorporated protectants) or PIPs with less risk to non-target organisms.	Maintenance	Biological	aquatic nuisance species-insects; sludge/muck; algae blooms	lake and lakes that would be sensitive to chemical applications. Areas that are more sensitive to flow through conditions or other conditions not conducive to chemical applications.	Slower rate of target species control compared to conventional pesticides, shorter persistence in the environment, susceptibility to unfavorable environmental conditions.	Application permitting may be required; CDPHE Aquatic Pesticides Permit (General Permit COG860000); NPDES permits; CWA Section 401; applicator must be licensed?	Can be targeted applications that are low maintenance. Can use plant or insects, so your options can be tailored.	Variable; cost dependent on type, manufacturer costs, shipping, application time, and monitoring strategy.	Variable depending on treatment frequency and monitoring strategy.	https://www.pctonline.com/article/make-way-for--biopesticides/ ; https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3130386/	Biopesticides | pesticides | US EPA
BMP_14	Cattle Fencing	Cattle fencing can help ensure that grazing livestock is deterred from any overgrazing or degradation to riparian areas surrounding lakes.	Capital Improvement	Mechanical	water quality	Any surface water body that can be accessible to any livestock.	May limit or impede human access to water resources. Primary water resource for cattle may need to be implemented elsewhere.	Permitting may be required if there is a land use, ownership issue.	Re-establish riparian habitat, maintain a health buffer zone, limit disturbances and nutrient loading.	$1600-2,500	$100-$500		ConfProceeding (tamu.edu)
BMP_15	Chemical Treatments - Other	Addition of chemicals to adjust pH, oxidize compounds, flocculate and settle solids, or affect chemical habitat features.	Maintenance	Chemical	particulate settling; algae blooms; pH; oxidation; disinfection	water quality impacts; impact sediment-water interactions; sediment pollutant release; impact desirable species and habitat; impact community assemblages; may require permitting	Chemicals can persist in water bodies which can be of concern to downstream entities, the fishery if people consume their catches or human contact of water.	Application permitting may be required; CDPHE Aquatic Pesticides Permit (General Permit COG860000)	Chemicals can be tailored for specific goals. Many chemicals adjust major baseline factors affecting overall aquatic health. Restoring base line conditions can help all aspects of lake health.	Variable; dependent on chemical type.	Variable depending on treatment frequency and monitoring strategy.		https://www.sfei.org/sites/default/files/biblio_files/PestAlternatives_review.pdf

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BMP_16	Circulation	Mechanical movement of water to enhance mixing and/or prevent stratification.	Maintenance	Mechanical	stagnation; stratification; low-to-no mixing; low surface aeration; algae blooms	Bodies of water that can have access to electrical connections to run pumps. lake where consistent turnover will not affect aquatic organisms that do better with seasonal stratification.	Resuspension of benthic sediment; may disrupt habitat or lifecycles of desirable species; may interfere with recreation;	Water rights should be considered.	Increased Dissolved Oxygen, less algae formation, optional chance to use UV light for disinfection during circulation process.	$200-100k	Variable depending on equipment selected and maintenance schedule. Consider costs of electricity and winterization.		ttps://www.epa.gov/sites/production/files/2015-04/documents/nutrient-economics-report-2015.pdf
BMP_17	Drainage Management	Create swales or other graded areas to promote stormwater infiltration to avoid direct discharge into water bodies.	Capital Improvement	Mechanical	sediment-sedimentation; nutrients; pesticides	Land around lake is large enough for drainage management structures.	Water being diverted needs a safe path to travel without harming others. Infrastructure may require maintenance.	USACE Section 404; CWA Section 401	Mitigate incoming water and any constituents that may be coming with it.	$3k-7k/acre	$500-$1,500		ttps://www.epa.gov/sites/production/files/2015-04/documents/nutrient-economics-report-2015.pdf; http://www.malvern.org/wp-content/uploads/2013/03/vegswale.pdf
BMP_18	Drawdown - Full	Physically remove all water from lake.	Maintenance	Mechanical	infrastructure	lakes that need heavy maintenance or have conditions that cannot be managed through other means.	Ability to refill waterbody in a timely manner.	CWA Section 401; CPW Permit to kill fish, if drawdown will cause mortality in natural waters; Water rights should be considered.	Can allow for a whole new lake with great conditions to be established. A time to introduce new habitat, new riparian zones and more depth.	$200-$500 (generally just labor)	Variable depending on ease of opening outlet or need to pump out and haul water. $ to $$$	http://ricelake.homestead.com/files/Facts_about_lake_drawdowns.htm	https://cfpub.epa.gov/si/si_public_record_Report.cfm?Lab=ORD&dirEntryID=33336
BMP_19	Drawdown - Partial	Expose submerged species to freezing or drying conditions. Best for species that propagate by root structures or fragmentation. Maintain draw down for at least 6-8 weeks.	Maintenance	Mechanical	aquatic nuisance species-plants; aquatic invasive species-plants	lakes that have issues that will be accessed with partial drawdown and a bank slope that allows partial drawdown access while also keeping the rest of the aquatic health in good shape.	Ability to refill waterbody in a timely manner.	CWA Section 401; CPW Permit to kill fish, if drawdown will cause mortality in natural waters; water rights should be considered.	sediment compaction; changes in substrate composition; reduce damage to structures; allow for shoreline cleanup access	$200-$500 (generally just labor)	Variable depending on ease of opening outlet or need to pump out and haul water.	http://ricelake.homestead.com/files/Facts_about_lake_drawdowns.htm	http://aquatics.org/bmpchapters/3.4%20Cultural%20and%20Physical%20Control%20of%20Aquatic%20Weeds.pdf
BMP_20	Dredging - Excavation	Several feet of lake bottom sediment are removed through machine excavation, especially from shallow lakes and lakes that have filled with silt and organic matter over time.	Maintenance	Mechanical	variable depth; sediment-sedimentation; nutrients; improve habitat; low dissolved oxygen; algae blooms; FE control; MN control; rooted plant control	Excavation can be applied to any lake as long as budget is not restrictive. All lakes and lakes lose depth to sediment over time. Maintaining optimal depth in a lake may require excavation.	Increased turbidity; downstream impacts; suspend possible contaminants; disposal of dredged material; biotic community composition; desirable species; desirable habitats; impact longevity	CPW; USACE Section 404; CWA Section 401	aquatic weed control	$250k+	Variable depending on treatment frequency.	https://www.epa.gov/sites/production/files/2015-04/documents/nutrient-economics-report-2015.pdf	Interview w/Aquatic Associates; http://aquatics.org/bmpchapters/3.2%20Developing%20a%20Lake%20Management%20Plan.pdf

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BMP_21	Dredging - Vacuum / Suction	Vacuum dredging can help remove sediment from a lake or lake with less disturbance than excavation. This requires either a dredging barge or suction truck with enough power to dislodge sediment.	Maintenance	Mechanical	sludge/muck	lakes with a benthic make up that is conducive to suction, i.e., muck, fine sands, small rocks.	Dredging can be expensive and depth limited if suction is from lake edges. Suction barges require boat ramp infrastructure.	CPW; USACE Section 404; CWA Section 401	Removal of built-up nutrients, heavy metals and reduction of suspended particles.	$250k+; diver dredging: $1,100-2k	Variable depending on treatment frequency.		Interview w/Aquatic Associates; https://www.sfei.org/sites/default/files/biblio_files/PestAlternatives_review.pdf
BMP_22	Erosion Control	Treatments that reduce the amount of erosion and associated sedimentation from areas surrounding or upstream of a lake. Controlling erosion helps prevent the increase in sedimentation. Erosion control can also stabilize and increase the efficacy of riparian and littoral zones.	Capital Improvement/Maintenance	Mechanical	sediment-sedimentation; nutrients; contaminants of concern (COCs)	Hillslopes, roads or channels that are accessible for mitigation efforts.	Erosion control often requires continually upkeep and sediment management if sediment is captured upstream of lake.	USACE Section 404; CWA Section 401	Maintain lake depth, less contamination from sediment transported constituents.	$500-$6k; variable depending on treatment used. $1-2/ft (for things like straw wattles, biodegradable mesh, and silt fence) + installation labor cost	Variable depending on treatment used and maintenance frequency.		*https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2015WR018014* *https://www.uwsp.edu/cnr-ap/UWEXLakes/Documents/programs/LakeShoreTraining/21.0_developing_a_cost_estimate/2006_erosion_control_costs_mn.pdf*
BMP_23	Fish Introduction - Catfish	Catfish have a wide variety of species that have a wide range of benefits to lakes and lakes. They can help with vegetation overgrowth issues. They are adapted to warmer waters, making them ideal inhabitants for urban areas. They can increase the productivity of a recreational fishery.	Maintenance	Biological	aquatic nuisance species-plants; low productivity	lakes that can handle a large aquatic fish species that will become a key part to ecological balance in the lake.	May not be permitted in water bodies with sensitive species; may increase turbidity	CWA Section 401; CPW Stocking Permit	Increased fishing opportunities, outcompete unwanted fish species, can handle increasing water temperatures.	$1k-10k	Variable	https://www.epa.gov/sites/production/files/2015-04/documents/nutrient-economics-report-2015.pdf	http://www.dunnsfishfarm.com/fish_pricing.htm
BMP_24	Fish Introduction - Grass carp (Cteno-pharyngodon idella Cuvier and Valenciennes)	Fish species native to Russia and China with high lake grass herbivory capability. Can be bred to be non-reproductive.	Maintenance	Biological	aquatic nuisance species-plants; aquatic invasive species-plants	lakes that can handle a large aquatic fish species that will become a key part to ecological balance in the lake.	Only stock in closed systems; DO NOT stock in open systems connected to other lakes, lakes, streams, or rivers. Lake conditions must meet requirements for carp survival; increase in algae; decrease in water clarity; not allowed in some states or may require permit	CWA Section 401; CPW Stocking Permit	reintroduce nutrients held in vegetation to water column; increase algae	$45-$125/acre	Variable depending on treatment frequency.		https://www.sfei.org/sites/default/files/biblio_files/PestAlternatives_review.pdf

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BMP_25	Flooding	Flooding target areas to aid or eliminate species.	Maintenance	Biological	aquatic nuisance species-plants; access for maintenance/construction; access for dredging; sediment-sedimentation; rooted plant control; fish productivity;	lakes that have access to enough water upstream required to meet project goals for a controlled flooding event.	downstream impacts; flood storage; impacts to nutrient levels; DO; pH; sloughing; erosion; compaction; odor; access and public safety; impacts to desirable species and habitat; connectivity with groundwater/wells; aesthetics	CWA Section 401; CPW Permit to kill fish, if flooding will cause mortality in natural waters or introduce unwanted species into other water bodies; Water rights should be considered.	Can allow for a rebalance of aquatic life, restore a functioning system that requires less input.	$500-$25k/acre, depending on water source, gravitational piping or pumping.	Variable depending on treatment frequency.		https://www.mass.gov/files/documents/2016/08/sd/eutrophication-and-aquatic-plant-management-in-massachusetts-final-generic-environmental-impact-report-mattson.pdf
BMP_26	Flushing	Increasing flow while decreasing residence time to reduce or minimize the concentrations of any unwanted substance(s).	Maintenance	Mechanical	residence time; pollutants; contaminants of concern (COCs); algae blooms	N/A	water supply quantity/quality variability; downstream impacts; may resuspend benthic sediments; may impact fish productivity and/or habitat; recreator safety; could cause un-natural turn over event	Water rights and downstream water quality regulations should be considered.	minimizes detention, response to pollutants may be reduced	$500-$25k/acre, depending on water source, gravitational piping or pumping.	Variable depending on treatment frequency.		https://www.mass.gov/files/documents/2016/08/sd/eutrophication-and-aquatic-plant-management-in-massachusetts-final-generic-environmental-impact-report-mattson.pdf
BMP_27	Hydro-Raking and Rotovation	Disruption of sediments and disruption of aquatic rooted plants.	Maintenance	Mechanical	aquatic nuisance species-plants; aquatic invasive species-plants; unwanted features/structures	Not practical for some smaller lakes	DO NOT use on vegetation that spreads by fragmentation; may disrupt fish or benthic organisms; increased turbidity; sediment-water interactions; may resuspend benthic sediments; may impact habitat;	CPW; USACE Section 404; CWA Section 401; certified operator may be required	where there is severe weed infestation, this technique could be appropriate	$2k-10k; $1,200-$2k per acre; mechanical cutting: $100-11,000/acre	Variable depending on treatment frequency.		https://www.solitudelakemanagement.com/blog/hydro-raking-restore-open-water-prolong-dredging/; https://www.sfei.org/sites/default/files/biblio_files/PestAlternatives_review.pdf
BMP_28	Lining - Natural	Seal the bottom of the lake/lake with bentonite, sands, gravel, or other natural sealants.	Capital Improvement	Mechanical	rooted plant growth; sediment-water interactions; algae blooms; recreation appeal	N/A	sealant impact on water column; impact longevity	CPW may require permit	retains water and nutrients	$25-50k	$0		*https://www.homeadvisor.com/cost/landscape/lake-liner-prices/* https://reader.elsevier.com/reader/sd/pii/S136403212030006X?token=73D47C8159BD642011F22A94C7D27A14F0C53B5AE966671F48CDF4A07D0F8A090CF7BF3D2F76FA66EDCD9A00E98F3F58&originRegion=us-east-

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BMP_29	Lining - Synthetic	Seal the bottom of the lake/lake with a synthetic barrier to help prevent water loss and vegetation growth.	Capital Improvement	Mechanical	water loss; aquatic nuisance species-plants	Not practical for some larger lakes.	sealant impact on water column; impact longevity; challenges associated with high groundwater (e.g., floating liner if groundwater is high and lake surface is low); loss of inflows from groundwater	CPW may require permit	retains water and nutrients	$3k-8k/acre	$0		*https://www.lakemanagementinc.net/lake-liner-lifespan/* https://www.homeadvisor.com/cost/landscape/install-a-lake/
BMP_30	Microbe Treatment	There are seven groups of microbes; bacteria, archaea, protozoa, algae, fungi, viruses, and parasites. The most common means of lake treatment utilizing microbes is the use of beneficial bacteria. This bacteria can help the overall health of most lakes by aiding in clarity, sludge reduction and purification.	Maintenance	Biological	nutrients	N/A	could increase bacteria in water if incorrect microbes used for treatment	Application permitting may be required; CDPHE Aquatic Pesticides Permit (General Permit COG860000)	Decrease need for algaecides	$50-1k	Variable depending on treatment frequency.		Interview w/Aquatic Associates; *https://www.aquascapeinc.com/produ* https://aosts.com/role-microbes-microorganisms-used-wastewater-sewage-treatment/
BMP_31	Nutrient Reduction - Biochar	Biochar is charcoal produced from biomass. It is a stable solid, rich in carbon and has properties that allow biochar to absorb nutrients that come into contact with the material.	Maintenance	Biological	nutrients	N/A	erosion and potential reduction in nutrient and pesticide use efficiency	Application permitting may be required.	reduces nitrogen leaching into groundwater and runoff into surface water. Extremely absorbent.	$50-$500	Variable depending on treatment frequency and monitoring strategy.	Biochar: Filter and Physically Excess lake nutrients (solitudelakemanagement.com)	https://extension.psu.edu/using-biochar-for-water-quality; https://farm-energy.extension.org/biochar-prospects-of-commercialization/

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BMP_32	Nutrient Reduction - Buffered Liquid Allum	Alum (aluminum sulfate) is a non-toxic chemical treatment for lakes that precipitates out a floc when applied to the water, allowing for the alum to bind with phosphate. The aluminum phosphate compound is insoluble in water and drops out of the water column onto the benthic surface.	Maintenance	Chemical	nutrients	N/A	potential toxicity on aquatic species	Application permitting may be required, NPDES permits; CWA Section 401; applicator must be licensed?	Cheaper than other methods.	$280-$700/acre	0	*Alum Brochure.doc (wi.gov); https://www.pca.state.mn.us/water/lake-protection-and-management*	Interview w/Aquatic Associates; https://www.epa.gov/sites/production/files/2015-04/documents/nutrient-economics-report-2015.pdf
BMP_33	Nutrient Reduction - Phoslock®	Phoslock® is a patented product that binds free reactive phosphorus (FRP). This compound settles out of the water column, similar to the alum application.	Maintenance	Chemical	nutrients	N/A	can act as a source of NH4+	Application permitting may be required; NPDES permits; CWA Section 401; applicator must be licensed?	management of blue green algae blooms	$400-1k	Variable depending on treatment frequency.	Phoslock | SePRO Corporation	Interview w/Aquatic Associates https://www.sciencedirect.com/science/article/pii/S2589914721000086
BMP_34	Nutrient Supplementation	Addition of nutrients to increase productivity or alter nutrient ratios.	Maintenance	Chemical	low productivity; algae blooms; improve fish habitat	N/A	water quality impacts; may change sedimentation rate; food web structure; shifts to undesirable algae composition; decreased water clarity	303d and/or 401 compliance may be required.	can improve forage conditions for microzooplankton	$30-$500	Variable depending on treatment frequency.	https://www.thelakeguy.com/	https://fisheries.org/docs/books/x54034xm/14.pdf
BMP_35	Pet Waste Program	Install pet waste stations for local citizens to gather and dispose of pet waste before it enters the lake.	Capital Improvement/Maintenance/Administrative	Biological	Escherichia coli (E. coli)	N/A	would require maintenance	Permitting may be required depending on land use and/or ownership.	reduces nutrients and pathogenic bacteria that could enter the water	$70-$350 per station	$500-$1k		https://www.epa.gov/sites/production/files/2015-04/documents/nutrient-economics-report-2015.pdf; file:///C:/Users/jennifer.mccarty/OneDrive%20-%20SWCA/Desktop/jra-cost-memo-june-update.pdf
BMP_36	Phytoremediation	Create natural water quality buffer areas near to or in lakes, such as wetland habitat, using plants to remove, stabilize, and/or destroy contaminants.	Capital Improvement	Biological	contaminants of concern (COCs); contaminants of emerging concern (CECs); sediment-sedimentation; fish habitat	lakes large enough to accommodate or near to available space that may be converted for phytoremediation.	requires some maintenance, not as disruptive to the natural ecosystem	USACE Section 404; CWA Section 401	does not generate contaminated secondary waste, enhances soil fertility, low cost	$9-300/m3; $2k-6k	$1k-$3k		https://www.lrrb.org/pdf/200523.pdf; https://www.pca.state.mn.us/sites/default/files/p-gen3-13x.pdf; https://www.epa.gov/sites/production/files/2015-04/documents/nutrient-economics-report-2015.pdf ; https://www.pca.state.mn.us/sites/default/files/p-gen3-13x.pdf

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BMP_37	Sediment Treatment	Chemicals/substances added to alter sediment features to limit plant growth or control chemical exchange reactions.	Maintenance	Chemical	sediment-water interactions; nutrients; algae blooms	N/A	impact on water column; impact longevity; may impact benthic and water column biota;	Herbicide and pesticide chemical application to waterbodies requires a City Pesticide Discharge Permit. Other application permitting may be required; NPDES permits; CWA Section 401; applicator must be licensed?	Can reduce internal P loading.	Variable depending on treatment type.	Variable depending on treatment type and application frequency.		Effects of alum treatment on water quality and sediment in the Minneapolis Chain of Lakes, Minnesota (tandfonline.com)
BMP_38	Shredder Boat and Removal Harvester	Used on larger lakes to cut up surface or shallow water vegetation.	Maintenance	Mechanical	aquatic nuisance species-plants; aquatic invasive species-plants	Not practical for smaller lakes.	Not practical for smaller lakes; DO NOT use on vegetation that spreads by fragmentation; may disrupt fish or other organisms	CWA Section 401; may require CPW approval	Can remove large amounts of aquatic vegetation in short amount of time.	Variable depending on type of shredder boat/harvester used and treatment frequency.	Variable depending on type of shredder boat/ harvester used and treatment frequency.		http://www.ijetjournal.org/Volume2/Issue2/IJET-V2I2P14.pdf
BMP_39	Sludge Reducer	A combination of beneficial bacteria and enzymes that help accelerate the solubilization and digestion of organic solids.	Maintenance	Biological	sludge/muck	N/A	water has to be at least 60 degrees to apply	Herbicide and pesticide chemical application to waterbodies requires a City Pesticide Discharge Permit. Other application permitting may be required; NPDES permits; CWA Section 401; applicator must be licensed?	not consumed by the water column, low maintenance	$50-$300	Variable depending on treatment frequency.		Interview w/Aquatic Associates; https://webbsonline.com/Item/40017
BMP_40	Supplemental Flow	Supplement flow with increased flow from inlet or other source.	Maintenance	Mechanical	low dissolved oxygen; algae blooms, sludge/muck, aquatic nuisance species-plants	N/A	has the potential to change water temperature and effect aquatic life present in waterbodies	CWA Section 401; Water rights should be considered	has the potential to improve water quality depending on the quality of the water being used	Variable depending on water source.	Variable depending on water source and treatment frequency.		http://www.leginfo.ca.gov/pub/15-16/bill/sen/sb_0551-0600/sb_564_bill_20160916_chaptered.pdf

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BMP_41	UV Light	UV is an effective, safe and environmentally friendly way to disinfect water. UV can be used to limit algae growth, eliminate E.coli, eliminate parasites and treat recycled water, incoming water or discharged waters.	Capital Improvement	Mechanical	algae blooms	Best for aesthetic lakes and free-floating algae.	Not ideal for stormwater or irrigation lakes or stringy or immobile algae that would not flow through a filter. Flow must be precise to allow enough time for UV treatment of passing water. Additional piping for pumping increases initial cost of unit and requires routine maintenance. Bulbs and tubing prone to breakage during routine maintenance.	Device must be regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	May increase aeration.	$25k-$250k per unit.	$1k+ per unit	*https://homeguides.sfgate.com/waterfall-uv-light-installation-59283.html*	An-Introduction-to-UV-Wastewater-Disinfection-eBook-FINAL.pdf (trojanuv.com); https://www.buyultraviolet.com/ecologic-lake-lake-reclamation-systems https://www.epa.gov/sites/production/files/2020-10/documents/uvlight-complianceadvisory.pdf
BMP_42	Vegetation - Littoral Zone Bioaugmentation	Plant a mixture of productive plants that thrive in the littoral zone.	Capital Improvement	Biological	water quality; aquatic habitat; sediment-sedimentation; organic material, nutrients; pesticides	lakes big enough to accommodate plants. Avoid areas where plants may conflict with recreation.	Access to water	May require CPW approval	Restore littoral plant communities; increase carbon storage.	$1-6k	$300-$400	https://www.colliercountyfl.gov/your-government/divisions-f-r/natural-resources/littoral-zones; https://www.broward.org/NatureScape/CreateNaturescape/Documents/landscaping_on_edge.pdf; https://www.nrem.iastate.edu/bmpcosttools/files/page/files/2016%20Cost%20Sheet%20for%20Riparian%20Buffer%20or%20Filter%20Strip.pdf	Quantifying the Effect of a Vegetated Littoral Zone on Wet Detention lake Pollutant Load Reduction (2005) (ucf.edu); https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2015WR018014

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BMP_43	Vegetation - Selective Harvesting	Hand cutting, pulling and selective harvesting are highly selective vegetation removal techniques that target easily identified species. They are usually used to target new infestations with low plant density (generally less than 500 stems per acre). These methods can be used to remove more dense plant growth over small areas, but benthic barriers or suction harvesting may be more effective. These methods can also be used as important follow-up to herbicide treatment.	Maintenance	Mechanical	aquatic nuisance species-plants; aquatic invasive species-plants; algae blooms	Not practical for larger lakes or larger effected areas.	root pieces and fragments left by self-propagating plants may exacerbate the problem; hand-pulling can disturb sediment and make it difficult to identify other plants; DO NOT use hand rakes for weed control without expert guidance; sediment-water interactions; resuspension of benthic sediments; may disturb desirable organisms and habitats	CWA Section 401; certification required if SCUBA used	in shallow waters, it requires little skill or equipment and can therefore be cost-effective. Can be used to target specific weeds in an area.	$500-$2,400/acre	Variable depending on treatment frequency.		
BMP_44	Vegetation - Riparian Bioaugmentation	Implementation of a riparian buffer or vegetative zone adjacent to inlets and lakes. No-mow buffers can improve water quality and reduce nutrients to lake. Riparian ecosystems can be established through seed planting, transplanting or a combination.	Capital Improvement	Biological	water quality; aquatic habitat; sediment-sedimentation; organic material, nutrients; pesticides; Escherichia coli (E. coli)	N/A	Establishing vegetation Maintenance and upkeep	USACE Section 404; CWA Section 401	Sediment control Ecological habitat Increased aesthetics; geese control	$1-6k	$200-$400	Chapter_6-7-1.pdf (stormwaterpa.org)	Riparian buffer width, vegetative cover, and nitrogen removal effectiveness: A review of current science and regulations (epa.gov); https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1002/2015WR018014
BMP_45	Vegetation - Tree Bioaugmentation	Planting trees can help with bank stabilization, shade and aesthetics of lakes and lakes.	Capital Improvement	Biological	restore riparian plant communities; sediment-sedimentation; organic material; nutrients; pesticides	N/A	short term increased sediment during planting that could add sediment to the waterbody	Non-WOTUS do not require a permit; visual obstruction permissions may be required.	Restore riparian plant communities; increase carbon storage.	$300-11k	$300-$500 per acre		https://www.parklandcounty.com/en/live-and-play/resources/Documents/PRC/iceheave/Shoreline-Stabilization-Sample-Plans.pdf
BMP_46	water quality Monitoring	Implement water quality monitoring to determine baseline and changing water quality standards for adaptive and responsive management.	Maintenance	N/A	any	All	can be expensive to develop and maintain over a long period of time, requires long period of time to draw conclusions from data	N/A	can provide more data than is currently available, are able to target areas of concern to monitor over a short or long period of time	Variable depending on monitoring type and frequency.	Variable depending on monitoring type and frequency.		https://www.usgs.gov/centers/umid-water/science/lake-monitoring-and-research?qt-science_center_objects=0#qt-science_center_objects

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BMP_47	Weed rollers	Rollers can be up to 30 feet long and sit on the lake bottom powered by an electric motor. Travel forward and reverse in up to a 270-degree arc around a pivot point. Typically installed at the end of a dock. Plants become wrapped around the roller and are dislodged from the sediment. Roller motion disrupts and compresses the bottom sediments, which prevents plants from becoming re-established.	Maintenance	Mechanical	aquatic nuisance species-plants; aquatic invasive species-plants	Not practical for smaller lakes.	Not practical for large areas; may disrupt fish and other benthic organisms; may require permit	CPW; USACE Section 404; CWA Section 401; certified operator may be required	Compresses benthic sediment	$2k/acre	Variable depending on treatment frequency.		https://www.sfei.org/sites/default/files/biblio_files/PestAlternatives_review.pdf
BMP_48	Forebay Construction	Sediment capture area upstream along inlet waterway to target waterbody where sediment settles out prior to entering the waterbody. May include road access for easy dredging and maintenance of forebay. Reduces sediment maintenance of waterbody.	Capital Improvement/Maintenance	Mechanical	sediment-sedimentation; nutrients; pesticides	N/A	requires periodic dredging, invasive weeds can become an issue to downstream water quality	USACE Section 404; CWA Section 401	can help to trap the incoming sediments and prolong the benefits of dredging	$1,000-$2,000/acre	$800-$4,000		https://www.mass.gov/files/documents/2016/08/sd/eutrophication-and-aquatic-plant-management-in-massachusetts-final-generic-environmental-impact-report-mattson.pdf
BMP_49	Hypolimnetic Withdrawal	Damming surface water outflow and withdrawing hypolimnetic water.	Capital Improvement/Maintenance	Mechanical	low dissolved oxygen-anoxia; nutrients	lakes that have an outlet that may be modified to drain hypolimnetic water or access for pumping hypolimnetic water.	summer drawdown, disruption of stratification, and downstream water quality. Effectiveness requires long-term use of this BMP	CWA Section 401; CPW Permit to kill fish if withdrawal will cause mortality in natural waters; water rights should be considered.		$3k-45k for withdrawal pipes	$50-1k		https://upstreamtechnologies.us/docs/SAFL_Baffle_Vs_Forebay.pdf; https://www.epa.gov/sites/production/files/2015-04/documents/nutrient-economics-report-2015.pdf page III-13
BMP_50	SAFL Baffle	Stormwater pretreatment system that filters sediment from inflowing water prior to entering downstream waterbodies.	Capital Improvement/Maintenance	Mechanical	sediment-sedimentation	N/A	N/A	USACE Section 404; CWA Section 401		$670/acre	$500-$1,000		https://upstreamtechnologies.us/docs/SAFL-Baffle-Design-Guide.pdf
BMP_51	Landscape Fertilizer Application	Best practice to provide education to the public related to landscape fertilizer application to reduce nutrient runoff to waterways.	Education	Chemical	Nutrients	N/A	N/A			Variable	Variable		*https://extension.colostate.edu/docs/pubs/garden/xcm222.pdf*

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BMP_52	Polyfluoroalkyl substances (PFAS)	Background information	Education	N/A	PFAS	N/A	Toxicity to aquatic life	N/A		N/A	N/A		*https://www.epa.gov/pfas/pfas-explained* *https://cdphe.colorado.gov/pfas-water*