City of Edmonton

URBAN FOREST ASSET MANAGEMENT PLAN

Document Control

Version: FINAL

Document Reference No.:

Document Owner:

Date:

Document History and Status

	Date	Revision Details	Author	Reviewers	Approver
1	2021/05/07	Addressing CoE comments on first draft of each AMP chapter	K. Robichaud M Gordon	CoE Team	Not applicable
2	2021/09/09	Addressing CoE comments on draft of UFAMP	K. Robichaud M Gordon	CoE Team	

Table of Contents

1. Executive Summary

Why do we need this plan?

This asset management plan outlines the activities and programs for managing the City's urban forest over the next 50 years, and their forecasted costs. The plan transparently connects investments in assets with services and progress towards achieving strategic goals. It does this by describing the:

- Characteristics and condition of publicly managed urban forest assets;
- Levels of service expected from them;
- Planned actions to achieve the recommended levels of service at the lowest possible life cycle cost; and
- The estimated costs and strategies to implement the planned actions.

The assets within the plan scope are publicly owned trees along the city's roadways, trails, open spaces, and City yards; stands of native trees growing on the tablelands or in ravines and the river valley, city-owned natural areas; and City-owned areas that have been stewarded back to a natural state (i.e. naturalization sites). The plan contains information for the City to work with its stakeholders to decide the optimum levels of service, risks, and costs to achieve its goals.

Why are our assets important?

Urban Forest assets provide services to help the City to achieve its strategic goals. The following table relates specific goals of the urban forest to the City's key strategic goals as described in the 2019-2028 Strategic Plan, Connect(Ed)monton.

Strategic goals	Urban forest specific goals
HEALTHY CITY Edmonton is a neighbourly city with community and personal wellness that embodies and promotes equity for all Edmontonians.	• To promote healthy living and foster wellbeing through diverse kinds of recreation, mobility and environments • To protect native forests and trees
URBAN PLACES Edmonton neighbourhoods are more vibrant as density increases, where people and businesses thrive and where housing and mobility options are plentiful.	• To improve Edmonton's livability by ensuring that public green spaces are attractive and well maintained • To provide an integrated, multifunctional system of green and open spaces to every neighbourhood as the city grows
REGIONAL PROSPERITY Edmonton grows prosperity for our Metro Region by driving innovation, competitiveness and relevance for our businesses at the local and global level.	• To effectively manage and ensure the growth of the urban forest
CLIMATE RESILIENCE Edmonton is a city transitioning to a low-carbon future, has clean air and water and is adapting to a changing climate.	• To have a diverse and sustainable forest • To support and enhance the environment by sustaining healthy and resilient ecosystems

Table 1 City of Edmonton's Strategic Goals

What are the services we provide and who uses them?

Our goals for the publicly managed urban forest will be reached by providing:

- Protection, preservation and connectivity of the urban forest to promote the health and wellness of people, and native flora, and fauna
- Enhanced beauty of Edmonton and contributions to the wellbeing and quality of life of its current and future residents
- Transportation corridors and safe roadside environments that appeal to all users
- Safe and attractive areas for gathering, enjoying nature, relaxing, and recreation
- A forest with diverse native species to improve resilience to climate change
- Improved air and water quality
- Cost effective service provision
- Volunteer opportunities for stewardship

The **service users** are residents, park users, transportation corridor users, visitors, tourists, recreational users, Indigenous peoples, researchers, schools, adjacent landowners, environmental special interest groups, and native flora and fauna.

Other stakeholders in our urban forest assets and services include:

Other service providers - water, power, drainage, telecom, and pipeline utilities; other city departments; school boards; emergency responders

The wider community – developers, the Edmonton Federation of Community Leagues / homeowners associations, business improvement areas, environmental stewardship and conservation organizations, Urban Development Institute, Infill Development in Edmonton Association (IDEA) and other home builder associations

Neighbouring municipalities - Municipalities of Leduc, St. Albert, Fort Saskatchewan, Sherwood Park, Strathcona County, Devon; and the North Saskatchewan Watershed Alliance

A list of stakeholders engaged for urban forest asset management is attached to the plan in Appendix A.

What do we own and what is it worth?

Edmonton's urban forest assets are divided into six categories - maintained trees, naturalization areas, naturally wooded areas, wetlands, naturally non-wooded areas, and naturally non-vegetated areas. The maintained trees, naturalization areas, and naturally wooded areas are covered by this plan. The remaining natural assets will be included in future asset management plans.

Maintained trees are boulevard trees or non-street trees in open spaces and on other city properties that are planted, maintained, removed and replaced by the City. Naturalization areas are areas that were previously landscaped that are now being managed to return to a more natural state. The

naturalization process consists of stopping mowing, planting trees and shrubs on suitable sites, and habitat enhancement. Naturalization areas can also be designed and built as part of new development sites. Unless impacted by surrounding development, Natural areas are stewarded to put nature first by protecting native wildlife habitat and natural processes.

As of Spring 2020, the City of Edmonton owned:

- 374,700 maintained trees;
- 744 ha of naturalized areas; and
- 1,824 ha of naturally wooded stands in natural areas.

The assets were valued using two different approaches. The total replacement or restoration costs are:

- The cost to remove a maintained tree that has reached the end of its life and plant a new, usually smaller tree, including watering it for three years.
- The cost to replant naturalization areas or naturally wooded areas plus watering for three years until the plants are established. While these areas are primarily self-sustaining, they may occasionally require investment by the City for renewal due to poor condition or outside events causing damage.

The other valuation approach recognizes the services provided by a tree or tree stand as it grows and its canopy increases. The values of maintained trees were estimated according to methodologies within the *City of Edmonton's Guidelines for Evaluation of Trees - Boulevard and Open Space Trees, Open Space Operations*. Naturalization and naturally wooded areas were valued based on canopy cover according to methodology stated within the *City of Edmonton's Natural Stand Valuation Guidelines.* Table 3 lists the replacement costs and values in 2020 dollars for each category of assets.

Asset Category	Total Replacement or Restoration Cost in $2020	Total Value in $2020**
Maintained trees	$723 million Includes costs to remove old tree, replace with new tree, and 3 yrs of watering	$1,590 million
Naturalization areas - 300 ha with trees or shrubs - 321 ha of unmowed grass - 123 ha bioswale, riparian and unknown area type	$49 million Includes costs to replant areas with trees and shrubs, and 3 yrs of watering	$74 million
Naturally wooded areas	$299 million Includes costs to replant areas with trees and shrubs, and 3 yrs of watering	$1,003 million
Total	$1,071 million	$2,668 million

**When calculating the total value for this plan a default condition rating of 65% was used for all urban forest assets.

Table 2 Urban asset replacement costs and values

The urban forest assets have an estimated service value of $2,668 million. The most valuable assets are the maintained trees with a value of $1,590 million closely followed by the naturally wooded

areas with a value of $1,003 million. The naturalization areas account for the difference with a value of $723 million.

What do we need to do and when?

Operations and maintenance activities for **maintained trees** include:

- Inspections to assess condition and update the inventory every 2 years;
- Inspections for pest management to assess and address any potential insect or disease issues;
- Inspections by Arborists and Urban Foresters to assess safety issues and concerns as needed - tree risk assessments and risk mitigation;
- Watering new trees for 3 years to 5 years after planting (depending on species type);
- Systematic pruning by neighbourhood every 3 to 7 years depending on species type;
- Destaking trees and removing rodent protection 3 years after planting;
- Removal of dead trees and stump grinding;
- Replacing dead trees;
- Activities to address hazards including storm response and treatment for specific diseases and pests as required.

Figure 1 shows the forecasted number of maintained trees in the existing inventory requiring renewal each year over a 50 year time horizon.

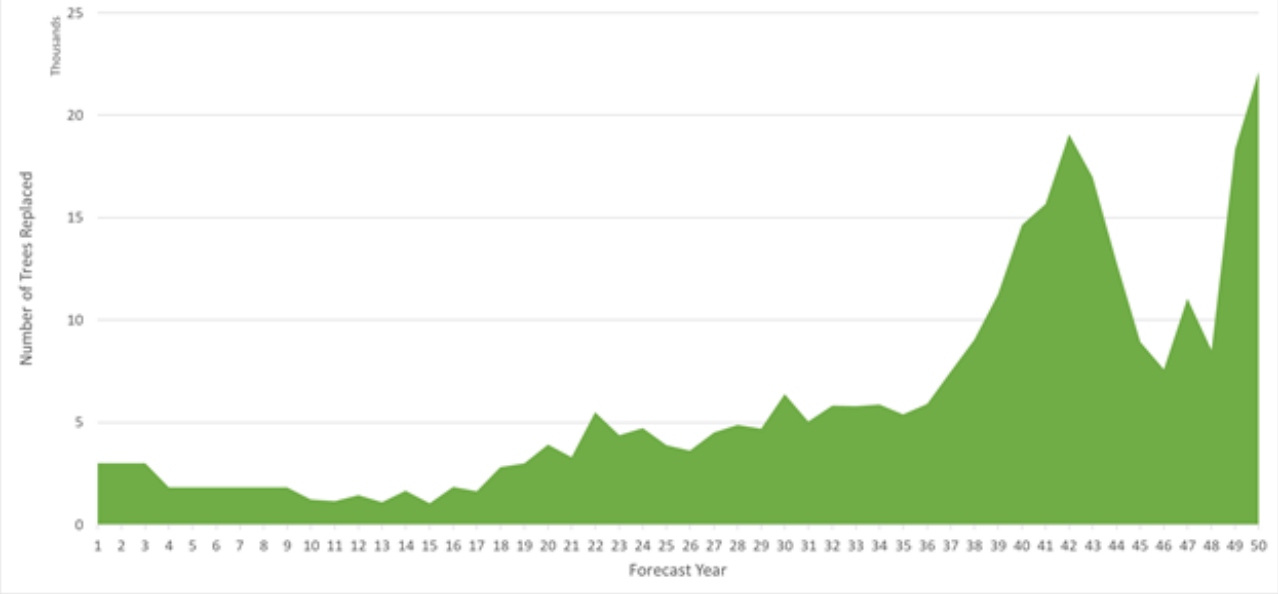


Figure 1 The number of existing trees forecasted to require renewal each year over the next 50 years

As shown in the figure, the model forecasts between 1100 and 3000 existing trees will require replanting per year over the next 15 years for an average of 1,800 per year. This rate of renewal begins rising steadily after Year 15 as the number of existing trees reaching the ends of their lives increases. Renewals peak at 19,000 trees 42 years in the future, and again at 22,000 trees at the end of the 50 year planning horizon. These peaks are the result of large numbers of existing trees

reaching their expected lives. The current inventory of maintained trees is relatively young with an average age of 16 years and an average expected useful life of 59 years.

Annual Assessment records indicate that tree deaths are occurring more frequently in early life than assumed for the forecast. Over the last two years of all the trees assessed requiring removal 24 % of these trees were planted within the last six years. Annual tree death has been observed to be between 3000-3200 trees, 70% higher than the forecast by the model over the next 15 years. This would increase the requirement for replanting that was estimated in the initial model. Causes for early tree mortality are still being investigated to better understand potential causes for trees failure to reach maturity and how survivability of young trees can be improved.

Operations and maintenance activities for **naturalization areas** include:

- Watering newly planted trees for 3 years;
- Annual regulated weed control after stopping to mow or planting trees; IPM Team oversees this step;
- Clearance pruning along formal trail edges, and mowing along curbs, property lines, and trails;
- Unscheduled inspections and actions in response to customer service requests and storms including hazard removals and restoration of disturbed areas;
- Mortality surveys;
- Planted naturalized areas are operated and maintained as naturally wooded areas after trees mature.

Operations and maintenance activities for **naturally wooded areas** include:

- Annual inspections and actions to manage prohibited / noxious weeds and unauthorized activities;
- Insect monitoring;
- Tree risk assessments and risk mitigation:
    - Annually near stationary targets such as picnic tables and playgrounds target
    - Every 10 years along the trail network, roads and property lines for other areas;
- Vegetation clearing every 5 years at designated viewpoints;
- Fire risk mitigation inspections every 1 to 10 yrs to assess and mitigate fuel load levels;
- Ecological health monitoring;
- Clearance pruning along formal trail edges;
- Unscheduled inspections and actions in response to customer service requests and storms including hazard removals and restoration of disturbed stands.

New urban forest assets will also need to be created and managed over their life cycles to meet the future demand for services. Table 3 summarizes the quantities of new assets planned to achieve i) 20% canopy coverage in 50 years, ii) the total amount of Natural Areas identified in the Preferred City Plan scenario, and iii) the goal of planting 2 million trees by 2050.

Asset Category and Type	Quantity of Existing Assets	Quantity of New Assets Created over 50 yrs	Quantity of Assets in 2071
Maintained trees	374,700 trees	421,500 trees	796,500 trees
Naturalized areas with trees or shrubs	300 ha	1,900 ha	2,100 ha
Natural areas - city owned naturally wooded areas	1,800 ha	1,400 ha	3,200 ha
Canopy on non-city owned properties*	4,150 ha	2,900 ha	7,050 ha

** The number of trees that need to be planted on non-city owned properties to create the additional canopy and the associated lifecycle costs are not covered by this plan.*

Table 3 - Quantity of assets planned to meet future demand and performance targets

For this plan, the 20% canopy coverage was assumed to be created through a combination of planting 421,500 new maintained trees and 1,900 ha of naturalization area with shrubs and trees; and incentivizing other property owners to create an additional 2,900 ha of new canopy.

The city will need to plant an additional 356,000 trees per year on average over the next 50 years to create these new assets:

- 900 new maintained trees will need to be created per year on existing boulevards or in open spaces. This is assuming the trend of the city acquiring 7,500 trees per year on average from developers continues.
- 355,000 trees per year will need to be planted on unmowed naturalization areas to create tree stands.

At this rate, the goal of planting 2 million new trees will be reached within 6 years. These quantities do not include the new trees that other property owners will need to plant as well.

How much will it cost and how will we pay for it?

The forecasted costs to renew the existing inventory plus achieve the targeted growth identified in Figure 3 are shown below. The costs represent an 80 to 330 percent increase relative to average past budgets of $11 million per year for these programs. This large increase is predominantly associated with planting the 356,000 trees per year on average needed to achieve the canopy coverage goal within 50 years. The costs also account for clearing the current backlog of replacements, and increases in operational costs such as pruning as the inventory of assets grows.

AMP

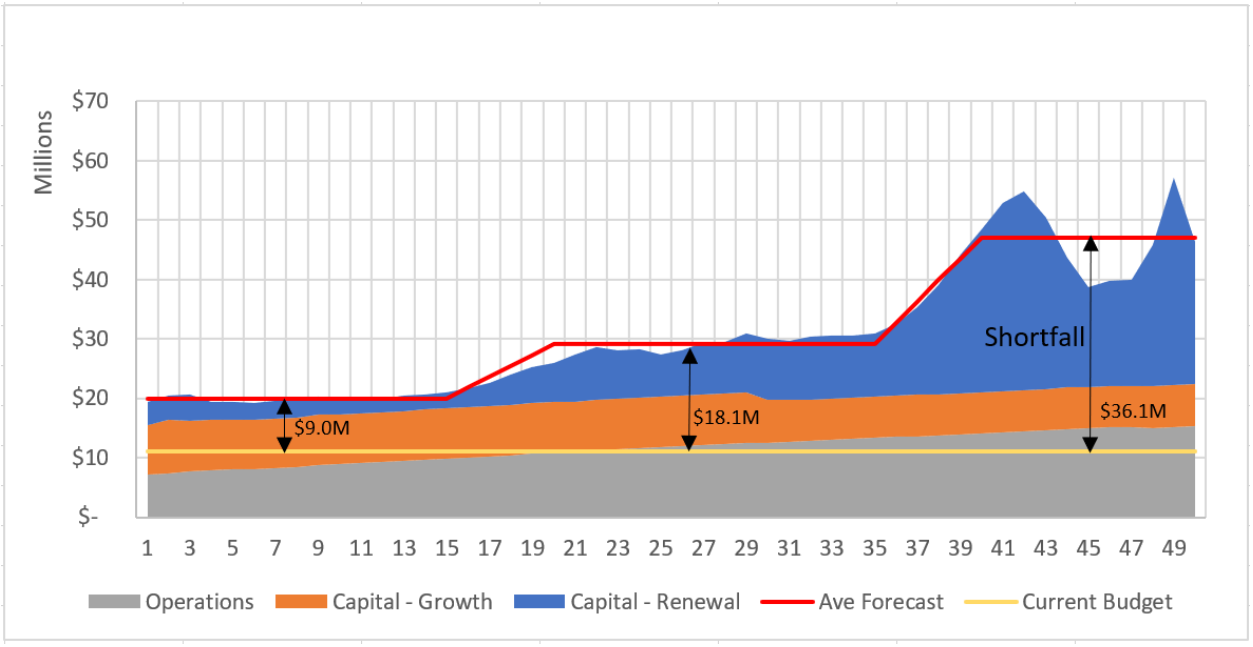


Figure 3. Forecasted costs for all asset categories to achieve 20% canopy coverage and gap compared to current budget ($2020)

closing the funding gap incrementally, rather than through a reserve fund mechanism aligns with the principle of service delivery. Future citizens will enjoy a larger urban forest, and this justifies a larger investment in the future as the canopy of the city expands. In the near term, the $9.0M gap must be closed to establish tree planting rates that allow the City's forest to mature and expand to achieve performance targets in the future.

Currently operational budgets are funded through taxation revenues. The required increase in revenue to close the funding gap over the next 10 to 20 years ranges from $0.94 to $2.75 per capita. The capital budget shortfall has been split between forecasted costs for renewals and forecasted costs for growth. The required increase over the next 20 years was forecasted to be $7.49 per capita. Capital funding is available from multiple sources including Pay-As-You-Go taxation following a process managed by the finance team. The capital budget funding process will be followed in the future and opportunities for closing the gap will be granted as they arise.

Assumptions and Limitations

This AMP has been prepared based on the best information available regarding adequate maintenance and renewal of assets using a 'whole of lifecycle' approach. Financial sustainability has been evaluated by comparing the investment needs of the life cycle strategies with current funding levels in the 20-year plan, assuming that this level of funding remains for the full planning horizon.

Being the first version of the asset management plan, several limitations are known to exist:

- Limited data were available for this plan on the condition and age of maintained trees. As a result, the estimated remaining useful life and timing of renewals for existing trees will be less accurate than if the data was available. The City started collecting more detailed condition data as this plan was being prepared. Forecasted operational costs include data

collection costs for maintained trees every 2 years. The condition of each maintained tree will be updated and available for the next version of the Urban Forest AMP.

- Annual tree assessment results indicate that tree deaths are occurring even more frequently in early life than assumed for the forecast. Annual tree death has been observed to be between 3000-3200 trees, 70% higher than the forecast by the model over the next 15 years. Of all trees assessed to require removal over the last two years 24% were planted within the last six years. This would increase the requirement for replanting that was estimated in the initial model. Causes for early tree mortality are still being investigated to better understand potential causes for trees failure to reach maturity and how to improve young tree survivability. Renewal funding should not be considered using this plan alone; this plan should be used to guide and provide context in preparing for funding requests. Real-time, current tree health assessment and inventory data should be used as the source to determine the number of trees requiring replacement annually.

- Data on performance measures was not available for assessing connectivity, biodiversity including native plants, and specific canopy coverage targets for city owned assets. As a result, strategies for achieving the asset specific goals were not well defined.

- The City has several strategic objectives and goals related to the growth of the urban forest. However, the Urban Forest Management Plan that sets the direction for achieving this growth is outdated. As a result, broad assumptions were made to estimate future quantities of the different types of urban assets that could be created to meet future demand.

- Strategies for achieving canopy coverage goals were based on several broad assumptions including:
    - Maintained trees have an average canopy of 40 m^2;
    - Non-city owned properties have a current canopy of 4,150 ha; and
    - Owners of non-city properties can be incentivized to increase the canopy on their properties by 70% over the next 50 years.

  Section 5 and Appendix E contain additional details on the assumptions.

- The plan does not include wetlands, naturally non-wooded areas, and naturally non-vegetated areas.

How can we improve?

The improvement items identified for action within the next year are to:

- Update the master plans for the urban forest assets to more accurately estimate the quantities of new assets and additional funding needed to achieve long term goals for canopy coverage, number of new trees planted, and total amounts of natural and naturalized areas. The plans should also:
    - Identify primary demand factors for forecasting future quantities of urban assets
    - Confirm assumptions underlying demand forecasts in this plan
- Develop a data management strategy and plan including collecting data on the attributes of the below ground infrastructure, soil and soil volume for maintained trees and additional data on trees that are removed (e.g. age and reason for removal).
- Develop a condition assessment approach and collect data for natural and naturalized areas.
- Develop performance measures for ecological connectivity and diversity of native species
- Plan for and improve the Emergency Response Plan.
- Prepare a risk framework for assessing and identifying unacceptable risks to infrastructure assets.
- Work with utility companies and developers to find new ways to create and share green space

2. Introduction and Context

The City of Edmonton (the City) is committed to taking a consistent, strategic approach to asset planning and asset management, so we deliver the services our customers need, while maximizing value-for-money. Urban forest assets clean the air and water, and create an environment with safe, interactive, and attractive neighbourhoods for our customers. The urban forest also provides environmental benefits such as preventing erosion, removing CO^2 and other contaminants from the air, and reducing noise. Improving our ability to extend our public dollars and make informed decisions about our urban forest assets is a core function of our asset management program.

This chapter provides an overview of the services being supported by the assets and how they fit with the City's obligations, goals and objectives. It also defines the scope of the asset classes and context of the Asset Management Plan (AMP).

The following icons have been included throughout this AMP:

Sustainability

The leaf symbol appears in the left margin beside sections that directly address sustainability. This provides a link back to the City's overarching Infrastructure Management Strategy objectives.

Continuous Improvement Indicator

The symbol indicates an area where the City has identified the need to track and measure Continuous Improvement of asset management practices and outcomes.

Purpose of This Plan

This AMP is a tactical plan describing how the urban forest assets within the green infrastructure portfolio will be managed over the medium to long term. The plan describes the characteristics and condition of infrastructure assets, the levels of service expected from them, planned actions to ensure the assets are providing the expected levels of service at the lowest possible lifecycle cost, to implement the planned actions.

The purpose of this Asset Management Plan is to demonstrate how we are managing our assets by:

- Communicating the relationship between the City's physical assets and the services delivered to the community;
- Providing a common, and authoritative, reference point for conversations with stakeholders about service standards and outcomes;
- Providing evidence for decision making and ensure the resulting plan is appropriately funded, prioritized and scheduled;
- Improving access to infrastructure assets funding from other levels of government;
- Providing an approach to managing the assets over the short, medium, and long term;
- Outlining a long-term plan for the assets including service expectations, timelines, funding, and resource requirements.

Scope of This Plan

The assets within the scope of the plan are:

- Publicly owned maintained trees along the city's streets and open spaces
- Stands of primarily native trees growing in tableland, ravine, river valley, and other city-owned natural areas, and
- City-owned areas that have been managed back to a natural state (i.e. naturalization sites).

Individual trees and other vegetation may be planted or naturally occurring. This initial urban forest asset management plan does not include wetlands, naturally non-wooded areas, or naturally non-vegetated areas.

The urban forest assets provide environmental, ecological, economic and social benefits to the city and surrounding communities. They preserve and sustain Edmonton's environment by improving air quality, reducing stormwater runoff, and creating habitats for native plants and animals. They improve liveability and public health by creating spaces for passively and actively enjoying nature.

The content of the plan includes:

- How we assess and measure service delivery according to defined levels of service;
- A summary of the current asset inventory, valuation and condition;
- How assets are inspected, what data needs to be captured, and how it is used to support decision making;
- Our asset decision model methods, processes and criteria that support life cycle planning;
- Who is responsible for delivering services;
- Identification of critical assets;
- What the anticipated annual costs will be to meet the desired levels of service as well as a 20-year long term financial plan;
- How the results are evaluated and what actions we are taking to improve.

This plan is not an operational plan that provides details on implementing strategies and projects. It provides information on asset performance, trends, and targets to meet future goals and objectives.

Goals & Objectives of Asset Ownership

How the City's assets are managed and operated plays a key role in achieving the City's four goals as described in the 2019-2028 Strategic Plan, Connect(Ed)monton. The goals focus on our people, place, region and environment. The City is achieving them through delivering services to Edmontonians. To enable service delivery to the public, the City manages seven supporting programs capturing how we as an organization will work collaboratively with internal and external stakeholders. Asset Management is one important supporting program, as it provides overarching management of the City of Edmonton's capital assets with accountability for service delivery.

The City's goal for Asset Management is to build an effective, transparent, data-driven asset management system that connects asset investment with progress towards strategic goals and service level outcomes. The Asset Management Plans lay a critical foundation for long-term actions to advance this goal. The outputs of these plans have a broad impact on the city; in how it impacts

operations, infrastructure planning, and the role of asset management in the provision of services to citizens.

The following table relates specific goals of the urban forest to the City's key strategic goals as described in the 2019-2028 Strategic Plan, Connect(Ed)monton. **Appendix B** includes the full scope of Corporate Strategic Actions, Programs and Services.

Strategic goals	Urban forest specific goals
HEALTHY CITY Edmonton is a neighbourly city with community and personal wellness that embodies and promotes equity for all Edmontonians.	• To promote healthy living and foster wellbeing through diverse kinds of recreation, mobility and environments • To protect native forest and tree stands
URBAN PLACES Edmonton neighbourhoods are more vibrant as density increases, where people and businesses thrive and where housing and mobility options are plentiful.	• To improve Edmonton's livability by ensuring that public green spaces are attractive and well maintained • To provide an integrated, multifunctional system of green and open spaces to every neighbourhood as the city grows
REGIONAL PROSPERITY Edmonton grows prosperity for our Metro Region by driving innovation, competitiveness and relevance for our businesses at the local and global level.	• To effectively manage and ensure the growth of the urban forest
CLIMATE RESILIENCE Edmonton is a city transitioning to a low-carbon future, has clean air and water and is adapting to a changing climate.	• To have a diverse and sustainable forest • To support and enhance the environment by sustaining healthy and resilient ecosystems

Table 2.1 City of Edmonton's Strategic Goals from the 2019-2028 Strategic Plan, Connect(Ed)monton

Sustainability

Sustainability is the key theme underlying all the City's strategic goals and corporate outcomes. The City plan provides strategic direction in environmental planning, social planning, and economic development to create a future city that still has the benefits of today, plus new opportunities for the future. The City Plan includes the Greener as We Grow commitment to continue developing a healthy city, while also protecting and enhancing land, air, water, and biodiversity. The health benefits and regulating services provided by the urban forest assets including pollutant filtration, carbon storage, water cycling, disaster protection,and mitigation of heat-island effects will be key services for the city to meet its sustainable commitment.

Key policies and directives from the City Plan supported by the urban forest services and assets include:

- Protect, restore, maintain and enhance a system of conserved natural areas within a functioning and interconnected ecological network.

- Manage the impact of environmental stressors on people and natural systems including excessive noise, air and light pollution.
- Conserve, restore and reconnect natural areas and ecological networks within the built environment for ecosystem health.
- Improve the quality and function of habitat greenways and ecological connections within the Green and Blue Network
- Expand and diversify Edmonton's urban tree canopy and native vegetation.
- The community and Administration are increasingly knowledgeable about the value of natural areas, and actively involved in their stewardship.
- Conservation of Edmonton’s natural areas is increasingly achieved through partnerships.
- Steward ecological networks and systems to ensure ongoing function, long-term sustainability and ecological connectivity within Edmonton and the region.
- Acquire lands within the North Saskatchewan River Valley and Ravine system for natural areas protection, open space connectivity and use.
- Edmonton protects, expands and improves access to its natural systems and open spaces in support of biodiversity and the health and enjoyment of all Edmontonians.
- Use environmental reserve to protect land and water bodies that meet the definition of environmental reserve but are not claimed by the Province in a manner that balances interests and enables contiguous and efficient urban development.
- Design new and retrofit existing open spaces to encompass wellness, celebration and ecology at the district level.
- Improve local open space and public amenities to support density increases.
- Maintain the North Saskatchewan River Valley and Ravine system's key role as an environmental protection area and for open space, cultural and recreational uses.
- Incorporate nature and natural systems into the built environment

Relationship to Other Corporate Documents

This AMP is a tactical plan. Figure 2.1 shows the “line of sight” hierarchical relationship from the City’s corporate goals and objectives, Infrastructure Asset Management Policy (C598) and Infrastructure Strategy through to all service level AMPs. The City’s Corporate Business Plan and the asset management policy, strategy, and plans form a framework for asset management. These documents link “top-down” organizational mandates and objectives with the “bottom-up” operational activities.

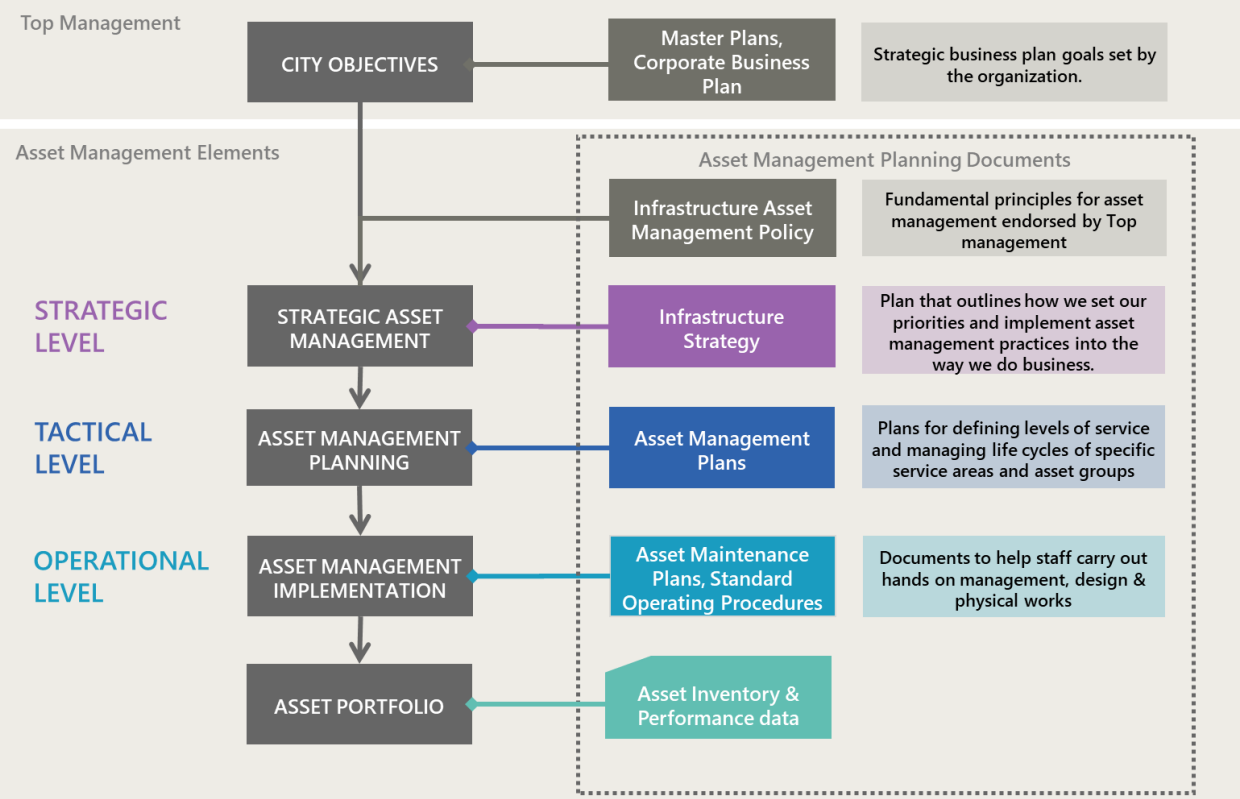


Figure 2.2 Relationship of AMPs to other Corporate Documents

Table 2.2 lists top management plans that are supported by the Urban Forest Asset Management Plan.

Document name	Relevant information
CONNECT-EDMONTON (2019)	• Four strategic goals of a Healthy City, Urban Places, Regional Prosperity, and Climate Resilience to move Edmonton towards its vision for the future
City Plan (2020)	• Sets the strategic direction for the way Edmonton grows including open spaces. The plan is presented in terms of population thresholds (1.25, 1.5, 1.75, and 2.0 million people). • For use by City Administrators to guide land use, built form, mobility decisions and prioritize strategic initiatives and services to help achieve City goals. • Greener As We Grow puts Edmontonians at the forefront of two important trends for our region—continuing to develop a healthy city while also paying attention to what will surely be one of the great challenges of our future: protecting and enhancing our land, air, water and biodiversity • Includes a target of 2 million new urban trees being planted • Identifies strategic measures for the urban forest, areas designated for natural protection, and green areas per 100,000 population • Describes the current and future Green and Blue Network. This network sustains us and provides places to recreate, celebrate and recharge. It is integrated with our built environment through parks, waterways and water bodies, greenways and urban trees. Our Green and Blue Network traverses both urban and natural areas, and provides habitat that connects well beyond our boundaries. It supports biodiversity and provides physical and mental benefits we appreciate and enjoy.

Corporate Business Plan 2019-2022	• Actions to achieve Edmonton's Vision of making the city "*an attractive, vibrant place to live, grow a business, raise a family, get an education, pursue new ideas, and visit*".
	• Context for the asset management plan
	• Strategic objectives of:
	  ○ Transforming Edmonton into a healthier, increasingly urban, and more climate resilient city that continues to support a prosperous region
	  ○ Delivering excellent services to the community.
	  ○ Managing the corporation to deliver services, to steward the City's assets appropriately, and to provide proper oversight of tax dollars so that they are allocated for greatest benefit.

Urban Forest Management Plan (2012)	• Contains asset specific goals that can be aligned with the strategic goals in CONNECT-EDMONTON • Short, medium, and long-term strategies for sustainably managing and enhancing the urban forest • Performance measures on the urban forest's contribution to city
Breathe Strategic Plan (2017)	• A strategy for providing a well-connected set of multifunctional open spaces. The spaces include urban forest assets such as trees and ecological areas. • Includes an open space classification system, levels of service and performance measures, and guidelines for new assets.

Document name	Relevant information
Corporate Tree Management Policy C456C	• Recognizes that trees are valuable assets that require dedicated stewardship. • Provides for a tree reserve account for recovering and distributing funds received from losses or damages to City trees • Describes responsibilities for Corporate Tree Management and Tree Reserve Procedures
City Wide Natural Area Management Plan (2014)	• Presents the objectives and strategies for managing and restoring the natural areas owned by the City • Recognizes that management priorities go beyond human use and access • States that the city is committed to an "integrated approach" rather than site-by-site management
Natural Connections Strategic Plan (2007)	• Focuses on strengthening connections: between natural areas, in the form of diverse, functional biological corridors that support critical natural processes and the movement of wildlife; and between people, in the form of supportive, creative partnerships that empower • Edmontonians to work cooperatively to protect and sustain Edmonton's natural systems.
Naturalization Master Plan (1994)	• Presents the objectives of naturalization Lists the policies, standards, and responsibilities for the naturalization program • Describes the criteria for selecting and prioritizing naturalization sites and a five year implementation plan.

Table 2.2 Strategic Plans supported by the Urban Forest Asset Management Plan

Our Context

Edmonton's urban forest represents a significant portfolio of municipal assets. A total of 374,700 publicly owned trees enhance Edmonton's roadways and open spaces. The urban forest also includes 1,824 ha of publicly owned naturally wooded areas in tablelands, ravines, and the river valley; and 744 ha undergoing a naturalization process to revert them to a more natural state.

Table 2.3 lists the critical opportunities and issues from the city's 2019-2022 Corporate Business Plan expected to influence achievement of its strategic goals. The table also identifies the potential impacts on managing the urban forest over the next 20 years.

Opportunities and issues	Relevance for the Urban Forest AMP
Population and demographics • The 2019 Municipal Census found that Edmonton is home to approximately 972,000 people, up from 932,500 people in the 2016 census and 812,200 people in the 2011 census. • On average, the population is forecasted to grow by 1.7% per year over the next 20 years. • Edmonton's population is expected to surpass two million within the next 30 years if the current trend continues.	• A growing population and changing demographics will increase demands for current services or highlight the need for new ones. • There will be demand for new trees and areas to create attractive neighbourhoods and a network of connected green and open spaces as the city grows. • Natural areas will be lost as new development occurs.
Economic swings • Changes in the economy will affect Edmontonians and their demand for City services, and affect revenues and expenses.	• The financial plan for providing urban forest assets and services over the next 20 years will need to be flexible allowing for a range of budgets.
Funding decisions of other orders of government • Funding, policy and legislative decisions of other orders of government will affect the size, scope and feasibility of projects and initiatives the City undertakes.	• The asset management plan should include a range of investment options and a decision-making process for prioritizing investments within funding constraints and opportunities.
Sustainable growth • Citizens, stakeholders, and experts who helped to develop The Way We Green identified "sprawl" as a top challenge facing the city in the next 30 years. • Current patterns of growth and development could negatively affect Edmonton's environment through loss of ecosystem services, resulting from the loss of agricultural lands, the urban forest, natural areas, natural connections, and biodiversity.	• Growth will need to be accommodated by making better use of existing land. • There may be increased pressure to reduce the area of natural and naturalized spaces as the city grows. • It may become more challenging to sustain trees along roadways as urban density increases.

Opportunities and issues	Relevance for the Urban Forest AMP
Disruptive innovations and new technologies • New technologies and uses for data will change citizens' expectations and change how we design and deliver services and infrastructure.	• New technologies may allow for better monitoring of asset performance. For example LiDAR technology has been used for estimating tree canopy coverage. • New products or approaches for controlling invasive species and other non-native pests.
Climate change and natural disasters • Climate records indicate that Edmonton is warming at a faster rate than the global average. • Scientists predict that Edmonton will be exposed to higher temperatures, drier summers, more extreme precipitation events, more variable extreme weather events, and an overall warmer and drier climate. • Without action, these impacts can exacerbate existing climate pressures on our economic, social, infrastructure, and environmental systems.	• The role of the urban forest in mitigating climate change impacts is an important service in making the city more resilient to climate change. • The risks of climate change to urban forest services and assets will be identified and assessed in the plan. • Strategies to mitigate high risks such as drought and invasive species will be developed and included in the financial forecasts where costs are available. • Mitigation strategies may include increasing the proportion of native species and/or diversity in the asset portfolio, applying new technologies for pest control, increasing soil volumes and improving soil health, and improving monitoring of asset performance.
Community and partnership approach • The City will need strong relationships and partnerships with community organizations and stakeholders. It will collaborate with these partners on shared objectives and negotiate priorities, available capacity and resources with them.	• The asset management plan should clearly define levels of service and the costs of providing different levels of service to inform negotiations and prioritization of urban forest investments. • There may be opportunities for the City to partner with the community for managing the urban forest such as monitoring the health of assets, controlling pests, or planting new vegetation.

Table 2.3 Critical issues and opportunities that may impact the Urban Forest Asset Management Plan

Roles & Responsibilities for Service Delivery

The City's Infrastructure Strategy outlines the current working practice for the governance of corporate Asset Management. It includes a draft set of responsibilities for a selection of roles (from Mayor and Council to all City employees, developed to support future refinements in the asset management system governance structure.

There are also several strategic asset management processes that are managed and coordinated by the Lifecycle Management unit to ensure consistency across the City. These include:

- Providing City-wide leadership and coordination of asset management practices and concepts, and strategy
- Stakeholder engagement
- Setting asset management objectives
- Infrastructure Management Policy and Infrastructure Strategy development and updating
- Developing and updating decision making and planning frameworks
- Preparing infrastructure status reports
- Developing a Levels of Service framework that can be consistently applied City-wide
- Forecasting and analyzing future user requirements and demands
- Coordinating internal and external asset management performance monitoring and reporting
- Facilitating skills development as it relates to asset management across the organization.

The Director of Infrastructure Operations is responsible for developing and updating the Urban Forest Asset Management Plan in collaboration with partners in Integrated Infrastructure Services (Open Space Planning and Design, Open Space Infrastructure Delivery) and Urban Planning and Economy. Section level supports include: Forestry Operations, Natural Areas Operations, and Operations Program Delivery and Partnerships.

Table 2.4 describes the responsibilities of others for the delivery of asset management services for the portfolio of Urban Forest assets. A full Responsibility Assignment Matrix (RACI – Responsible, Accountable, Consulted, Informed) is included in Appendix C along with a chart of the internal teams involved in delivering urban forest services.

City Team	Asset Management Role
City Executive Leadership Team	Accountable for: • Levels of Service
Integrated Infrastructure Services - Infrastructure Planning and Design - Lifecycle Management	Responsible for: • Asset management plan maintenance, planning of medium and long term investments • Infrastructure lifecycle management Accountable for: • The improvement plan, asset data management, infrastructure reporting, and renewal capital program planning
Integrated Infrastructure Services - Building Great Neighbourhoods	Responsible for: • Open space planning, design and delivery
Integrated Infrastructure Services- Infrastructure Planning and Design - Transportation Planning and Design / Facilities Planning and Design	Responsible for: • Transportation and facility planning and design including landscaping standards Accountable for: • Capital project delivery
Urban Planning and Economy - City Planning	Responsible for: • Planning of urban growth and open spaces • Policy development
City Operations - Parks and Roads Services	Responsible for: • Establishment and delivery of service levels. • Condition monitoring and assessment • Infrastructure operations including delivering programs, services and maintenance for trees and open area assets • Infrastructure maintenance including planning, data collection and monitoring • Right of way and parkland development • Business integration and strategic planning and process integration
Urban Planning and Economy-Planning and Environmental Services	Responsible for: • City environmental strategy and sustainable development reviews • Urban renewal
Financial and Corporate Services - Corporate Accounting	Accountable for: • Medium and long-term investment planning
Financial and Corporate Services - Business Integration	Responsible for: • Asset data management, tangible capital assets,

Table 2.4 Roles and responsibilities for service delivery

Limitations & Assumptions

This AMP has been prepared based on the best information available regarding adequate maintenance and renewal of assets using a 'whole of lifecycle' approach. Financial sustainability has been evaluated by comparing the investment needs of the life cycle strategies with current funding levels in the 20-year plan, assuming that this level of funding remains for the full planning horizon.

Being the first version of the AMP, several limitations are known to exist as described in Table 2.5. They will help inform the continuous improvement process for future versions of the Plan.

Limitation	Impact
Asset condition and age	Limited data were available on asset condition and age for this plan. As a result, the estimated remaining useful life and timing of renewals for existing assets will be less accurate than if the data was available. The City has started collecting more detailed data on asset condition which will be available for the next AMP.
Levels of service and performance tracking	Data was available for half of the performance measures. Key gaps included performance measures for assessing connectivity, biodiversity including native plants, and specific canopy coverage targets for city owned assets. Strategies for achieving the asset specific goals were not well defined as a result.
Growth and Future Demand	The City has several strategic objectives and goals related to the growth of the urban forest, however, its master plans for achieving this growth are outdated including the 1999 Naturalization Master Plan, the 2012 Urban Forest Management Plan and the 2014 City-wide Natural Area Management Plan. As a result, broad assumptions were made to estimate future quantities of the different types of urban assets that could be created to meet the City's growth targets. Updates to the master plans are recommended to better define options and forecasted cost estimates for meeting future demand.
Asset management strategies	In lieu of formalized/documented maintenance processes, the strategies within this plan have been based on workshops with the operations teams and information from the city's financial system. The strategies for achieving canopy coverage goals are based on several assumptions regarding canopy areas for maintained trees and areas with various types of vegetation cover. These assumptions should be validated with field data.

Table 2.5 Limitations of the AMP

3. State of Infrastructure

The State of the Infrastructure is an assessment of the City's current infrastructure assets against their maximum potential. It provides a benchmark evaluation of the assets and describes the age, condition profile, and current replacement value of the assets. By creating and tracking asset-related information, the City understands:

- What do we own? Edmonton owns and manages a variety of different assets. It is important to maintain an accurate count of these assets.
- What is it worth? If an asset failed today, what would it cost to replace it and the benefits it provides?
- What is the state and condition? Edmonton uses a standardized 5-point rating system on a scale of A to F (Very Good to Very Poor) to identify asset state and condition.

By understanding and tracking these requirements over time, the City can make sound decisions on its long term financial/investment plan to achieve the stated service level.

Asset Hierarchy

The City's diverse assets are broken down into six portfolios of different asset classes. To analyze the state and condition of the assets, the classes are further divided into categories, assets and sub-assets as shown in Figure 3.1.

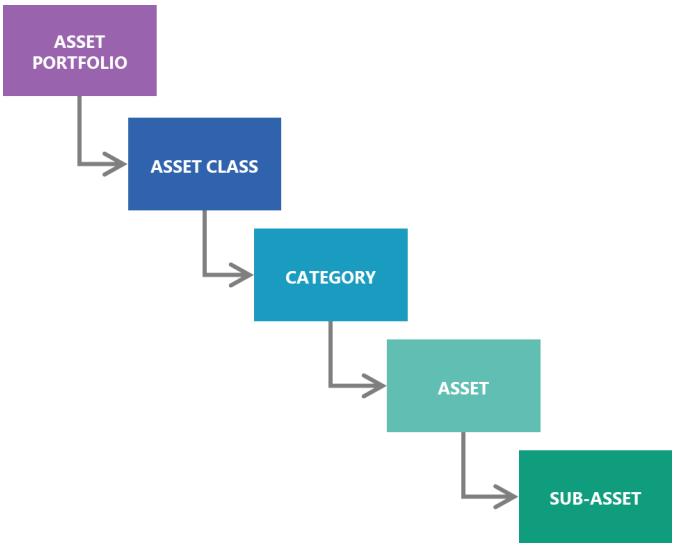


Figure 3.1 Asset hierarchy concept

Figure 3.2 shows how the asset hierarchy structure is applied to the City's green infrastructure. Note that the scope of this initial urban forest asset management plan includes maintained trees, all naturalization areas, and naturally wooded areas. Other natural assets such as wetlands, naturally non-wooded areas, and naturally non-vegetated areas are excluded from the plan.

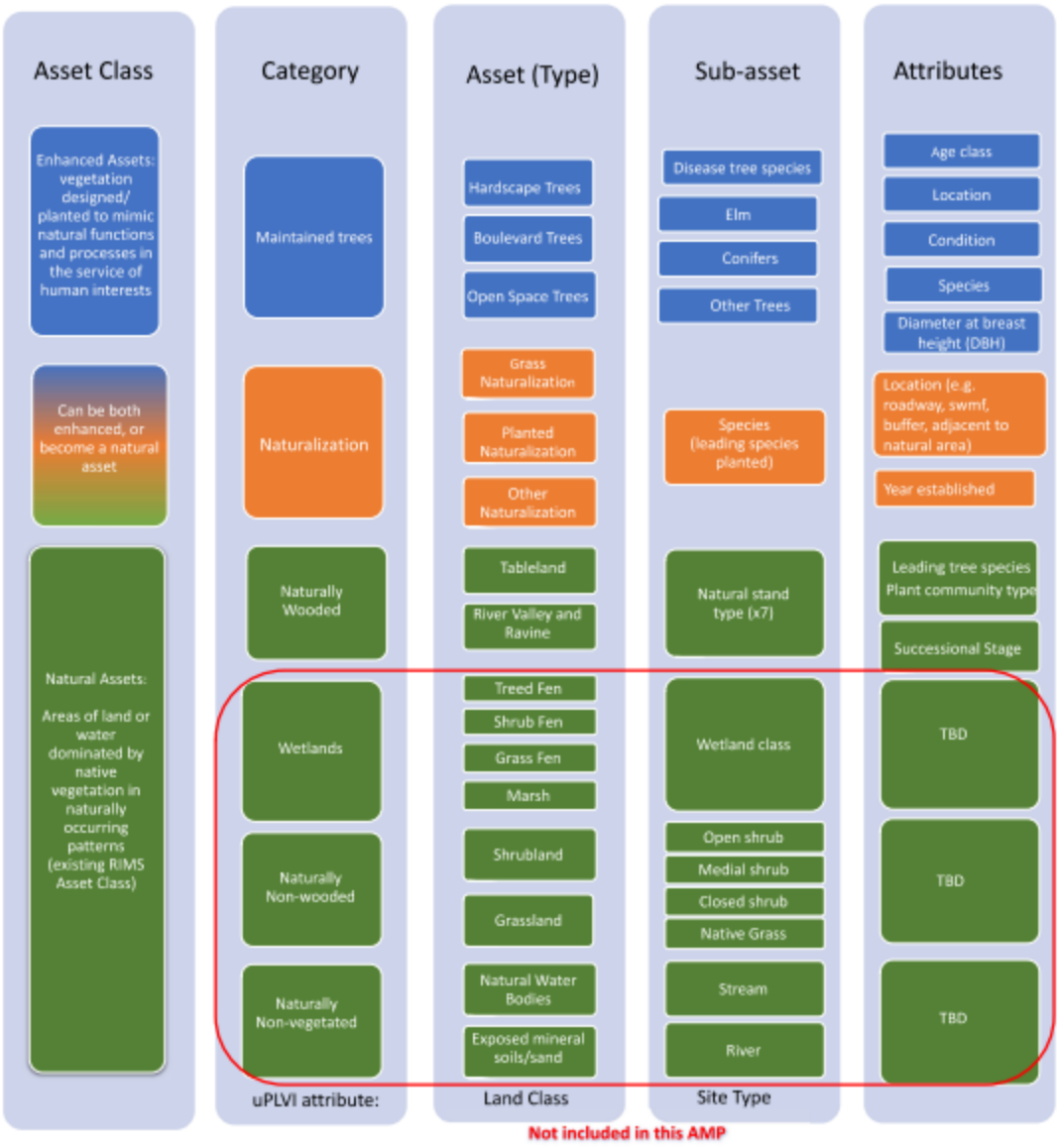


Figure 3.2 Hierarchy for the urban forest portfolio of assets

Definitions for each level in the asset hierarchy are included in Table 3.1.

Asset Hierarchy Level	Description	Example
Asset Portfolio	All city owned green infrastructure excluding engineered assets (e.g. green roofs, green walls, etc.)	• All woody vegetation in river valley and ravine areas • All trees along public roads

Asset Class	The portfolio is divided into enhanced assets (e.g. vegetation is designed or planted to mimic natural functions), natural assets, or naturalization areas that will either become enhanced or natural	• Enhanced assets are individual trees either planted or naturally occurring along roadways, in open spaces, and on city properties • Natural assets include naturally wooded areas in the river valley or ravines, and on the tablelands.
Category	Maintained trees, naturalization areas and natural areas	• Boulevard trees or open spaces trees on city properties • Natural areas that have never been landscaped such as areas along river valleys. • Naturalized areas that have been landscaped and managed to return to a natural state.
Asset Type	Trees are described in terms of their location, i.e. along a roadway or in an open space. Natural Areas are described in terms of the primary type of vegetation growing in the area. Naturalization area types are based on their development stage.	• Boulevard trees are located along roadways. • Open space trees are located in areas such as parks. • Vegetation types include tree stands, riparian zones, grass with trees or shrubs. Only the naturally wooded areas on the tablelands and in the river valley and ravines are covered by this plan. • The first stage of naturalization is grass which may or may not be planted with flowers, shrubs, or trees in subsequent stages.
Sub-Asset	The sub-asset is the species type	• Elm tree, mountain ash tree, It is the leading species for areas; for example, aspen-white spruce stand

Table 3.1 Asset hierarchy level descriptions

The state of the City's urban forest is presented at the levels of asset category and asset type in subsequent sections.

Asset Data

This section provides a summary of how data is collected and compiled, details on where the inventory data can be found, and assumptions applied to fill any data gaps. A comprehensive asset data inventory serves as the foundation for the City's asset management activities and asset planning and decision making. The asset data helps in making informed, strategic decisions about the City's infrastructure assets. By gathering and maintaining this information, the City can be proactive about managing any risks or costs associated with the renewal and replacement of assets.

Data Collection and Attributes

The City has leveraged many resources to quantify the inventory and determine its key attributes. Table 3.2 summarizes the sources of key attribute data.

Asset Type	Data attributes	Inventory Location (where data is found)	Data Collection Processes
Boulevard, Hardscape, and Open Space Trees	Quantity	GIS - Tree Layer (SLIM_M.PARK_TREES)	The Tree layer is maintained over time using information gained from initial inspections and tree removal processes. It has been historically kept in Geomedia (GIS) but is being transitioned to ArcGIS. A specialized operations software called Tree Keeper has recently been implemented which will integrate with the GIS data and can be used in the field.
	Unit		
	Age		
	Useful lives	Not available	Not applicable
	Asset Value	Calculated value using *Guidelines for the Evaluation of Trees*	Values are calculated based on tree attributes including diameter at breast height, condition, location, and species
	Condition	GIS Tree Assessment List for trees assessed prior to 2020.	Data for this AMP was available for less than 2% of the trees because prior to 2020, condition ratings were not tied to the location or Tree ID, only to a descriptive location on a street/block. The current, updated condition rating process is described in the Asset Condition section below.
Naturally Wooded Areas	Age	Not available*	Derived from the Urban Primary Land and Vegetative Inventory (uPLVI).
Naturalization Areas	Age	Naturalization stage was assumed based on the vegetation cover type	Not applicable

Asset Type	Data attributes	Inventory Location (where data is found)	Data Collection Processes
Naturalization Areas Naturally Wooded Areas	Quantity	GIS - Natural Areas (uPLVI and SLIM_M.PARK_NATURAL_VEGETATION_AREAS)	Derived from the Urban Primary Land and Vegetative Inventory (uPLVI). Naturalization areas are updated as they are converted. Canopy cover of deciduous, coniferous trees and shrubs measured using LiDAR.
	Unit	GIS - Natural Areas	
	Estimated Replacement Value	Not available	
	Condition	Not available	Not applicable
	Useful Life	Not applicable	Not applicable

*Future asset management plan to use the successional stage of naturally wooded areas derived from uPLVI and additional research.

Table 3.2 Data sources for the asset management plan

The age of naturalized areas is based on the year the naturalization process is started for an area. The City uses successive development stages to determine progress on transitioning naturalized areas to a more natural state. Table 3.3 describes the four development stages in the process. Data was not available for either age or development stage, so the stage was assumed based on the vegetation cover type as shown in Table 3.3.

Vegetation cover type	Assumed Stage	Description
Unmowed grass	Stage 1: Stop mowing	Regular grass mowing (turf maintenance) stops allowing the grass to grow naturally. Depending on the maintenance required for weed control this stage may last 1-5 years until the naturalized grass can stabilize and the healthy ecosystem will be better able to defend itself against weeds. Then, if the location is suitable to have trees and shrubs, the process will continue to stage 2: tree planting.
Grass with trees or shrubs	Stage 2: Tree Planting	Trees and shrubs that are native to Alberta will be planted to establish a healthy and diverse ecosystem. Groups of small trees will mature into a modified natural tree stand. Once the trees have matured the process continues to stage 3: biodiversity enhancement.
	Stage 3: Habitat Enhancement	To continue to promote a healthy ecosystem, smaller native trees, shrubs and wildflowers will be planted providing added benefits for beauty, biodiversity, and to provide resources for wildlife to flourish and re-establish..
Tree Stands Wildflower meadow	Stage 4: Established Modified Natural Area	These sites will also be considered a natural area if they were planted adjacent to or in an existing natural area and the boundary can be expanded. Otherwise, they will be considered a modified natural area.

Table 3.3 Assumptions for assigning naturalization stage

Table 3.4 lists the assumptions used to fill the data gaps for maintained trees.

Asset Class & Category	Attribute	Gap	Assumption
Maintained Trees	Age	Age for assets older than 20 years was less reliable; ages for assets older than 30 was unavailable.	Age was estimated using diameter at breast height (DBH). Linear regression analysis was used to develop DBH versus age functions. Additional detail is provided in Appendix D.
	Health / Condition	Data missing for 98% of the inventory	Current health/condition was based on remaining useful life calculated from the age and estimated useful life as described above.
	Hardscape Trees	Data indicating if grate is present	Trees were assumed to be hardscape if the data indicated "yes" for the grate field in the GIS Tree Layer, or if a tree is located in the downtown neighbourhood.
	Estimated Useful Life	No data	Most likely, pessimistic, and optimistic theoretical useful life values were developed for each tree species, based on professional opinion. The values for each tree species in the City's inventory are included in Appendix D. The most likely estimates were used for the maintained trees except for: - Elm trees - optimistic values were used for open space and boulevard trees based on the City's experience - Hardscape trees - the pessimistic lives were used for all hardscape except elm. The most likely useful lives were used for elms in hardscape based on the City's experience.

Table 3.4 Assumptions to fill data gaps for maintained trees

Data Review

This section assesses the reliability of the data used for the State of Infrastructure analysis of the Urban Forest asset class. Currency and accuracy of asset data are critical to effective asset management, accurate financial forecasts, and informed decision-making. However, it is also important to understand the reliability of the underlying data. Table 3.5 provides a description of the confidence grades used to assess the reliability of the data used for this plan.

Confidence Grade	Description
A - Highly reliable	Data based on sound records, procedures, investigations and analysis, documented properly and agreed as the best method of assessment. Dataset is complete and estimated to be accurate ± 2%
B - Reliable	Data based on sound records, procedures, investigations and analysis, documented properly but has minor shortcomings, for example some of the data is old, some documentation is missing and/or reliance is placed on unconfirmed reports or some extrapolation. Dataset is complete and estimated to be accurate ± 10%
C - Uncertain	Data based on sound records, procedures, investigations and analysis which is incomplete or unsupported, or extrapolated from a limited sample for which grade A or B data are available. Dataset is substantially complete but up to 50% is extrapolated data and accuracy estimated ± 25%
D - Very Uncertain	Data is based on unconfirmed verbal reports and/or cursory inspections and analysis. Dataset may not be fully complete, and most data is estimated or extrapolated. Accuracy ± 40%
E - Unknown	None or very little data held.

Table 3.5 Data confidence rating

The results of the reliability assessment of the key attribute data for the Urban Forest assets are presented in Table 3.6.

Asset Category	Asset	Confidence Grade				
		Inventory	Age & Estimated Useful Life	Estimated Value	Condition	Asset Average Grade
Maintained Trees	Individual trees in boulevards and open spaces	A	C	B	D	C+
Naturalized Areas	Areas selected for naturalization either through planting or natural growth	A	C	C	E	C
Naturally Wooded Areas	Forested stands in the River Valley and Ravine system and on the Tableland	A	E	C	E	C

Table 3.6 Urban forest asset data confidence

On average, the data for this plan and State of the Infrastructure assessment was assessed as uncertain or Grade C.

Asset Summary

This Section summarizes the current state of the assets covered in this plan including their age, remaining useful life and replacement value. This helps us to understand which asset categories have the highest value which is useful for prioritized decision making.

Asset Inventory

Table 3.7 lists the key urban forest assets owned by the City and covered under this AMP.

Asset Class and Category	Asset	Material	Quantity	Unit
Enhanced Assets - 374,671 Maintained Trees	Boulevard trees	Various tree species	162,095	trees
	Open Space Trees	Various tree species	208,462	trees
	Hardscape Trees	Various tree species	4,114	trees
744 ha Naturalized Areas	Grass naturalization	Areas where regular grass mowing (turf maintenance) has stopped, allowing the grass to grow naturally.	321	ha of unmowed grass
	Planted naturalization	Areas planted with trees and shrubs that are native to Alberta to establish a healthy and diverse ecosystem	287	ha of grass with trees or shrubs
			13	ha of tree stands
			0.07	ha of wildflower meadow
	Other naturalization	Bioswale, riparian, unknown	123	ha

Asset Class and Category	Asset	Material	Quantity	Unit
Natural Assets - 1,824 ha Naturally Wooded Stands	Forested stands on tableland	Forested stands that contain a high proportion of native vegetation providing good stepping stone habitat for native wildlife	274	ha
	Forested stands in the river valley and ravine system	Forested stands that contain a high proportion of native vegetation providing good habitat for native wildlife	1,550	ha

Table 3.7 Asset Inventory and Quantities

Maintained trees were categorized as boulevard or open space trees according to the location type recorded in the GIS tree inventory as shown in Table 3.8.

Asset Type	Location Type in GIS	
Open Space Trees	- Park - Buffer - School - Provincial Land - Unassigned - Private Property	- Edmonton Transit Service (ETS) - City Yard - Leased Land - Edmonton Rescue Services (ERD) - Library - Edmonton Police Service (EPS)
Boulevard Trees	- Boulevard - Centre Median	- Service Lane - Alley
Hardscape Trees	- All trees in the Downtown Neighbourhood	- All trees with a grate

Table 3.8 Maintained Trees Asset Type by Recorded Location in GIS

Asset Age and Remaining Useful Life

If data on the actual useful lives of assets is not available, the City works with either theoretical useful lives or estimated useful lives. The theoretical useful lives are approximations determined from the most accurate standards and guidelines. The estimated useful lives are based on experience and professional judgment. They represent the average age of a tree when it is no longer viable, or when about fifty percent of the population have died or been replaced.

As previously noted in Table 3.3, pessimistic, most likely, and optimistic values of useful lives were estimated for each species of tree in the City's inventory by an ISA Board Certified Master Arborist with expert knowledge of the Edmonton area. The values are presented in Appendix D and were used for the plan as follows:

- Pessimistic values were used for hardscape trees except for elms. The most likely value was used for elms in hardscape based on the city's experience.
- Optimistic values were used for elms not in hardscape.
- Most likely values were used for trees other than elms, not in hardscape.

Table 3.9 presents the average age, estimated useful life, and remaining useful life of the maintained trees. The actual tree age was used where it was available. Otherwise the estimated values were used as described above. The values in the table represent averages for each asset group.

Naturalization areas have an age based on when the decision was made to naturalize them. However, no data was available for this. Natural areas do not have an age. Neither naturalization nor natural areas have an estimated useful life because they are not currently operationally rehabilitated or replaced.

Asset Category	Asset	Average Age (yrs)	Average Estimated Useful Life (yrs)	Remaining Useful Life (yrs)
Maintained Trees	Boulevard Trees - Elm	30	100	70
	Boulevard Trees - Other Deciduous	14	52	38
	Boulevard Trees - Disease Prone Trees[1]	12	21	9
	Open Space Trees - Elm	23	98	75
	Open Space Trees - Other Deciduous	12	41	29
	Open Space Trees - Conifer	11[2]	51	40
	Open Space Trees - Disease Prone Trees	11	25	14
	All Hardscape Trees	14	27	13

1. Disease prone trees include any trees in the Genus Prunus and Sorbus
2. Conifer age is probably underestimated because the data on DBH used to estimate age is out of date.

Table 3.9 Age and remaining useful lives summary

Asset Valuation

This section reports the value of the urban forest assets using two approaches. The total replacement or restoration costs are:

- The cost to remove a maintained tree that has reached the end of its life and plant a new, usually smaller tree, including watering it for three years.
- The cost to replant naturalization areas or naturally wooded areas plus watering for three years until the plants are established. While these areas are primarily self-sustaining, they may occasionally require investment by the City for renewal due to poor condition or outside events causing damage.

The other valuation approach recognizes the services provided by a tree or tree stand as it grows and its canopy increases. The values of maintained trees were estimated according to methodologies within the *City of Edmonton's Guidelines for Evaluation of Trees - Boulevard and Open Space Trees, Open Space Operations*. Naturalization and naturally wooded areas were valued based on canopy cover according to methodology stated within the *City of Edmonton's Natural Stand Valuation Guidelines.* These guidelines are updated annually by the City. Table 3.10 provides an overview of the two valuation methodologies.

Asset Category	Valuation Methodology
Maintained Trees	The values of individual maintained trees were estimated using the trunk formula technique. In this technique, the value is estimated based on the cost to replace the cross-sectional area of the tree considering the diameter at breast height (DBH) 1.2m (4ft) above ground. In 2020, the City of Edmonton assigned a basic unit value of $11.81 per square cm ($76.19 per square inch) to all Open Space and Boulevard trees. This basic value is then adjusted by factors to account for: ● Different species of trees having different values; ● The tree's condition; and ● The tree's location. A more detailed description of the methodology is available at https://www.edmonton.ca/city_government/documents/PDF/Guidelines_Evaluation_Trees_August2020.pdf
Naturalization Areas and Naturally Wooded Areas	The values of natural stands including naturalization areas and naturally wooded areas represent the cost to replace the canopy of the wooded area with mature trees. It includes: ● The cost to plant the number of trees required to replace the canopy ● Costs to maintain the trees for 3 years which involves stake removal, watering and replacing 10% of trees assumed to not survive. ● A stand value factor that increases the value of larger areas of trees to account for their survivability or ability to endure disturbances. A more detailed description of the valuation guidelines for natural stands is available at https://www.edmonton.ca/residential_neighbourhoods/PDF/DRAFT_NaturalStandValuationGuidelines.pdf

Table 3.10 Asset Valuation Methodologies

Table 3.11 lists the estimated total costs to replace or restore the urban forest assets, and the asset values estimated using the methodologies described in Table 3.10. Comparing these values between asset groups allows the City to gain an understanding of which ones have the greatest equity to the City and the public.

<table>
<tr><th>Asset Category</th><th>Asset</th><th>Estimated Replacement and Restoration Costs</th><th>Estimated Value</th></tr>
<tr><td rowspan="3">Maintained Trees</td><td>Boulevard Trees</td><td>$312.7 million replacement cost*</td><td>$1,001.1 million</td></tr>
<tr><td>Open Space Trees</td><td>$402.1 million replacement cost</td><td>$577.9 million</td></tr>
<tr><td>Hardscape Trees</td><td>$7.9 million replacement cost</td><td>$11.4 million</td></tr>
<tr><td rowspan="3">Naturalization Areas</td><td>Grass Naturalization (unmowed grass)</td><td rowspan="5">These assets are typically self-sustaining and do not require replacement

Estimated restoration costs are:
• $49 million for planted naturalization areas
• $299 million for naturally wooded areas

Restoration costs include planting shrubs and trees, and 3 yrs of watering</td><td>$19.6 million**</td></tr>
<tr><td>Planted Naturalization (grass with trees or shrubs, tree stand, wildflower meadow)</td><td>$42.6 million</td></tr>
<tr><td>Other Naturalization (bioswale, riparian, unknown vegetation)</td><td>$12.1 million</td></tr>
<tr><td rowspan="2">Naturally Wooded Areas</td><td>Tableland</td><td>$151.0 million</td></tr>
<tr><td>River Valley and Ravine</td><td>$852.0 million</td></tr>
<tr><td colspan="2">TOTAL</td><td>$1,071 million</td><td>$2,668 million</td></tr>
</table>

* Replacement cost includes removing the old tree, planting a new one, and watering for 3 years.
** Unmowed grass areas have some trees that provide a canopy covering 11% of the areas on average

Table 3.11 Asset valuation summary ($2020)

Reviewing the table, the urban forest assets have an estimated service value of $2.7 billion. The most valuable assets are the maintained trees with a value of $1.6 billion closely followed by the naturally wooded areas with a value of $1.0 billion. The naturalization areas account for the difference with a value of $0.07 billion.

Asset Condition

Edmonton uses a standardized rating system to evaluate the state and physical condition of existing infrastructure assets. The system is a five point scale ranging from Grade A - very good to Grade F - very poor. Table 3.12 provides a summary of the condition grades used by the City for maintained trees.

AMP Grade	AMP Grade Description	Description of Condition and Ratings from City of Edmonton's Guidelines for Evaluation of Trees	Scoring Range
A	Very Good Fit for future	1. Perfect tree of specimen quality 2. Excellent tree 3. Very Good tree	85 - 100%
B	Good Adequate for now	4. Above Average tree 5. Good or Average tree	65 - 84%
C	Fair Requires attention	6. Below Average tree 7. Fair tree	35 - 64 %
D	Poor At risk	8. Poor tree	15 - 34%
F	Very poor Unfit for sustained service	9. Very poor tree	0 -14%

Table 3.12 Grades for evaluating tree condition

Condition data was available for 1.6% of the maintained trees. All other trees were assumed by the City to have a condition rating of 70% for the purposes of valuation. No condition data was available for naturalization or naturalized areas.

The City is currently updating its process for collecting condition data on maintained trees. From 2020 onwards, condition data will be updated through a drive-by inspection. The condition of each tree in the GIS inventory will be rated in increments of either: 0%, 15%, 35%, 65%, or 85%. Trees will be rated every second year. City trees located in the NE and SE quadrants of the City were assessed in 2020. The NW and SW assessment values will be updated into the GIS inventory in the 2021 assessment season. This data was not available for this AMP, but will be used to improve future AMPs.

Where recent condition assessment data is unavailable, it is typical to report on age as a proxy for condition. This was the approach used for maintained trees when condition data was not available. Table 3.13 provides a description of each condition grade.

Condition was not assessed using this approach for naturalization or natural areas because remaining useful life does not apply to these assets.

Grade	Grade Description	% of Remaining Useful Life (RUL)	Description of Age Based Condition
A	Very Good Fit for future	RUL ≥ 75%	The asset in the system or network has greater than or equal to 75% of its remaining useful life. It is generally in very good condition.
B	Good Adequate for now	75% > RUL ≥ 35%	The asset in the system or network has less than 75% (and greater than or equal to 35%) of its remaining service life. It is in good condition.
C	Fair Requires attention	35 > RUL ≥ 13%	The asset in the system or network has less than 35% (and greater than or equal to 13%) of its remaining service life. It is in fair condition.
D	Poor At risk	13% > RUL ≥ 3%	The asset in the system or network has less than 13% (and greater than or equal to 3%) of its remaining service life. It is in poor condition.
F	Very poor Unfit for sustained service	RUL < 3%	The asset in the system or network has less than 3% of its remaining service life. It is in very poor, unacceptable condition and should be replaced.

Table 3.13 Age based condition grades

Table 3.14 provides a summary of the percentage of the inventory by number of trees in each category. A Grade B, adequate for now, with a remaining useful life of between 35 and 75% was assumed for maintained trees if neither condition nor age data were available.

Asset Category	Asset	% of assets by # of trees				
		Grade A RUL ≥ 75%	Grade B 75% > RUL ≥ 35%	Grade C 35 > RUL ≥ 13%	Grade D 13% > RUL ≥ 3%	Grade F RUL < 3%
Maintained Trees	Boulevard Trees	7% 79,837	68% 69,449	22% 6,901	2% 670	2% 5,238
Maintained Trees	Open Space Trees	23% 120,141	61% 77,454	10% 3,944	2% 1,038	5% 5,885
Maintained Trees	Hardscape Trees	10% 1,324	13% 1,257	19% 695	9% 210	50% 628

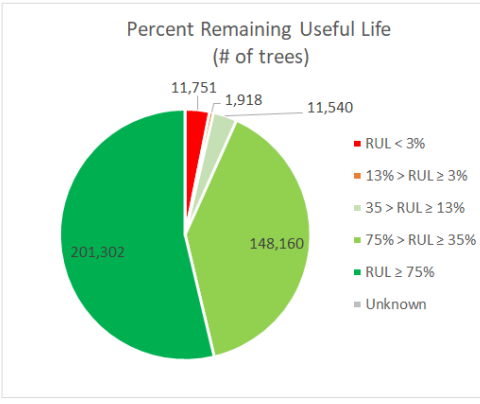
Table 3.14 Condition grade and remaining useful lives of maintained trees

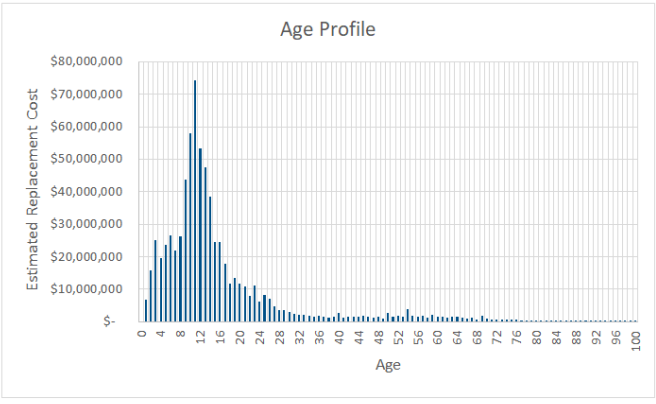
Of note are the 11,751 trees with less than three percent of remaining estimated useful life. It indicates that the City may soon be losing valuable urban forest assets as these trees die and are renewed. In future AMPs, inspection-based condition assessments of these older trees will provide a better indication of their actual remaining life.

Asset Dashboard

This Section provides a summary of the current state of infrastructure. It gives a snapshot in time of condition, age, asset replacement costs, and future renewal profile. Figure 3.3 provides a dashboard of results for the maintained trees. Areas were not included in the dashboard because age data were either not available or not applicable, condition data was not available, and expected useful lives are not applicable.

Asset Category	Asset	Total Quantity	Unit	Average Age	Average Estimated Useful Life	Total Estimated Replacement Cost
Maintained Trees	Boulevard Trees	162,095	Count	20	70	$ 312,681,255
Maintained Trees	Open Space Trees	208,462	Count	13	50	$ 402,123,198
Maintained Trees	Hardscape Trees	4,114	Count	14	27	$ 7,935,906
TOTAL		**374,671**		**16**	**59**	**$ 722,740,359**





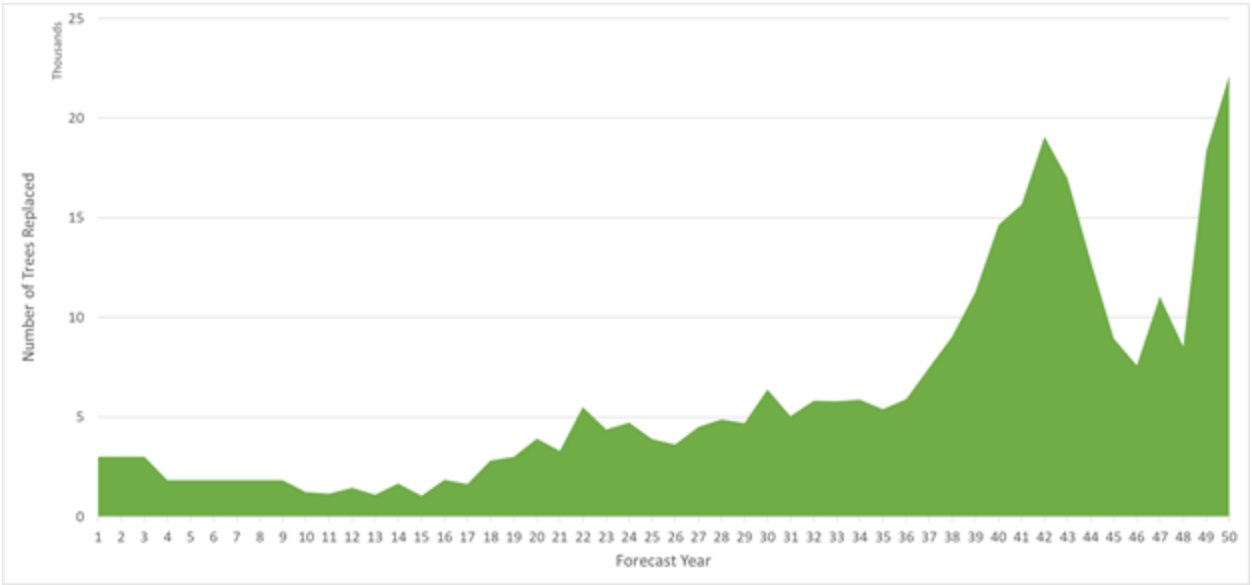


Figure 3.3 Asset dashboard

Dollar values shown in the dashboard are based on a replacement cost of $1,929 per tree (2020 dollars), i.e. $798 to remove the old tree, $801 to plant a new tree, and $330 to water the new tree for three years. The costs in the dashboard do not reflect the value that trees provide to society and their surroundings, but rather the cost to replant them.

Reviewing the dashboard:

- Maintained trees are relatively young with an average age of 16 years and an average expected useful life of 59 years. The inventory of maintained trees has 73% of its useful life remaining. Most are less than 20 years old. The ages of the trees accounting for the middle 50% of the inventory range from 9 to 17 years.

- Twenty-five percent (25%) of the inventory is older than 17 years, of which 80% are classified as American Elm or Green Ash. At the opposite end of the age profile, 25% of the inventory is younger than 9 years of age. There is a wider variety of species in this age cohort with 40% classified as American Elm, Bur Oak, or Green Ash.

- The replacement cost of the entire asset category is $723 million. Fifty-six percent or $402 million is attributed to open space trees; 43%, or $313 million is attributed to boulevard trees; and one percent or $8 million is attributed to hardscape trees.

- Reviewing the 50 year renewal forecast:

    - Between 1100 and 3000 existing trees will require replanting per year over the next 15 years for an average of 1,800 per year.

    - The rate of renewals begins rising steadily after year 15 as the number of existing trees reaching the ends of their lives increases.

    - Renewals peak at 19,000 trees 42 years in the future, and again at 22,000 trees at the end of the 50 year planning horizon. These peaks are the result of large numbers of existing trees reaching their expected lives. This reflects the relatively young age of the current inventory of trees which are expected to reach the ends of their useful lives in year 43 of the forecast on average.

It should be noted that for the purposes of the City's initial forecast model, each tree species was assumed to have an expected lifespan. All trees were assumed to die after they reached their assigned assumed age. This has an associated underlying assumption of a distribution of tree death for a given species that is symmetrical around the average of the assumed lifespan for a given tree species.

It was also assumed that 10% of trees died in the first three years of life, as this was an approved assumption associated with historically observed tree mortality. The resulting forecast of tree death and planting activities forecasted by the model over the next 20 years is illustrated in Figure 3.4 below. It should be noted that upon receiving updated field tree health assessment data (following the original assumptions made for this plan) that young tree death is higher than 10% currently.

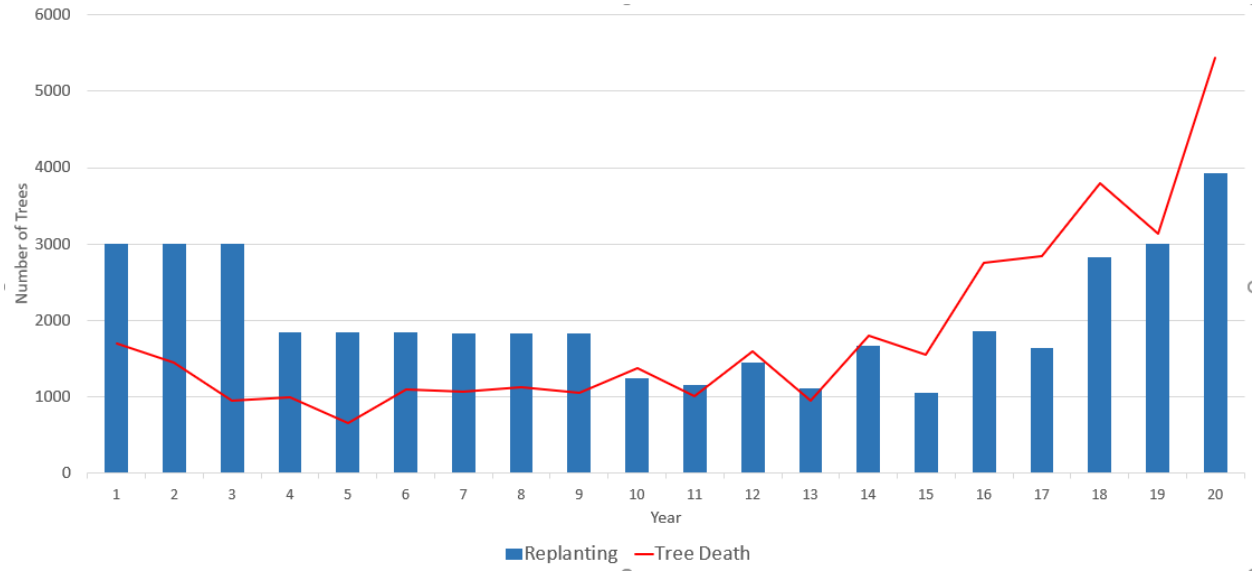


Figure 3.4 Forecasted number of tree deaths and trees replanted over a 20 year planning horizon

Tree replacements are higher than the forecasted number of deaths in the first 10 years to remove the current backlog of trees that have died but not yet been replaced. After year 14, there is a lag between the number of trees forecasted to die, and the number of trees replanted. This reflects the assumptions around tree mortality during the first 3 years of life.

Annual tree assessment results indicate that tree deaths are occurring even more frequently in early life than assumed for the forecast. Annual tree death has been observed to be between 3000-3200 trees, 70% higher than the forecast by the model over the next 15 years. Of all trees assessed to require removal over the last two years 24% were planted within the last six years.This would increase the requirement for replanting that was estimated in the initial model. Causes for early tree mortality are still being investigated to better understand potential causes for trees failure to reach maturity and how to improve young tree survivability. Figure 3.5 compares the probability of tree death assumed in the model to recent field observations currently under investigation.

Recent records of young tree mortality (2020, 2021) show tree deaths ranging from 3800 to 4900. Reasons for this higher mortality are being investigated, as the canopy increases so will the need to offset the increasing quantity of losses. Increasing mortality can be attributed to increases in the introduction of novel species into the urban forest. As climate change continues to accelerate, keeping ahead of losses will be a key component of the boulevard and open space trees.

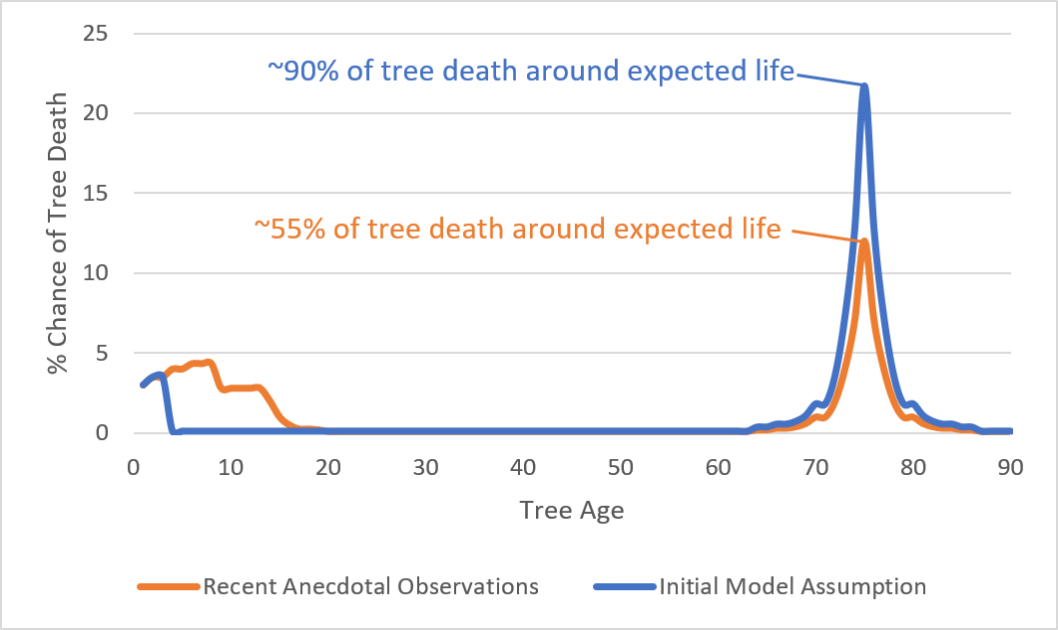


Figure 3.5: Forecasted number of tree deaths compared to recent field observations

The assumptions underlying the modelling for this initial Urban Forest Asset Management Plan underestimated tree death as a consequence of this difference. Other observations regarding these assumptions include:

1. The difference is potentially material and would substantially increase the investment required for replanting, particularly in the near team and likely over the entire analysis period. If early tree mortality issues remain unresolved, the average over the first 20 years could be 3000-3200 instead of 1800.
2. The City continues to investigate why trees are not living to full maturity and if a procedural / process change could improve lifespans / mortality.
3. The City also plans to make additional observations on tree mortality and aggregate this into a distribution by tree species over the next 3-5 years in preparation for use in the modelling for the next version of the City's Urban Forest Asset Management Plan
4. While collecting tree mortality data, average canopy by tree species / age, DBH at death, and other statistics can be gathered to better refine assumptions for the next plan.

While there remains some uncertainty associated with future tree resilience and mortality, the forecasts can certainly be assumed to be a lower boundary for required investment to achieve the City's goals and performance measures for the urban forest. As mortality data is collected, a revised model forecast may be merited to refine investment requirements to support future planning.

Recommendations to Improve State of Infrastructure in Future Plans

The following actions are recommended to improve asset data and state of the infrastructure assessments in future plans. They are summarized and prioritized in Section 9 along with recommended improvements from the other sections of the AMP.

1. Create an asset register based on the hierarchy presented in Figure 3.2 to serve as the single source of accurate, detailed, and current information on urban forest assets.

2. Develop a data management strategy and plan for the urban forest data describing:
    a) The attributes to be included for each asset including ownership for naturally wooded areas, naturalization stage for naturalization areas, location of maintained trees (i.e. open space, boulevard, hardscape, median, etc.), removal date for maintained trees,
    b) The database structure including integration with GIS.
    c) Database management to create a persistent database that can be updated over time and analyzed to identify and monitor trends in future AMPs.
    d) An administrative process that helps ensure there is a "single source of truth" for the inventory that represents the most reliable and up to date information available.

    Typically, these types of plans describe the current state of asset data and how it is being managed, the desired future state to improve asset management practices, the gaps between the two, and the plan for addressing the gaps.

3. Update data on the diameter at breast height and remaining useful life for conifers in the maintained tree asset class.

4. Research and develop age class attributes using successional stages for naturally wooded areas.

5. Develop growth functions for DBH versus age for tree species and sites. Trees are unique because they continue to grow over their lifetime, increasing in size and canopy cover. As a result, attributes such as DBH need to be updated periodically to more accurately assess the state of the assets.

6. When maintained trees are removed:

    a) Complete a stump survey for a sample of tree species to compare the measured DBH with the actual age of the tree to get a database for age vs. DBH for older trees.

    b) Collect the necessary data to analyze the reasons for losing young trees during the 10 year period after establishment (i.e. years 4 to 13).

7. Collect data on soil attributes for maintained trees that would affect tree health and help select the best species for renewal such as the quantity of grow space, other soil and drainage characteristics, and location relative to roadways and utilities.

8. Include other types of enhanced assets such as bioswales, rain gardens and other low impact development features in future plans. This would require an updated asset hierarchy and urban forest data plan.

9. Develop a condition assessment approach and collect data for natural and naturalized areas that aligns with the five point scale in the City's asset management template. The current assessment tool for monitoring the ecological health of natural stands may be a good starting point.

Asset Management Continuous Improvement Indicators

This section presents indicators for the continuous improvement of asset management practices related to understanding the current state of the asset infrastructure.

Data Confidence: Data confidence levels can influence the types of decisions the City makes to manage our assets. For example, high confidence condition data can trigger replacement projects. Continuous improvement performance trends for asset management can be tracked through the following indicators:

- Average confidence grades for critical assets (Table 3.6)
- Existing confidence grades and target confidence grades for priority asset categories (Table 3.6)

Asset Condition: Continuous improvement performance trends can be tracked through the following indicators:

- Average condition state of assets (Figure 3.3)
- Minimum condition state of assets (Table 3.14)
- Average Remaining Useful Life of assets (Figure 3.3)

4. Levels of Service and Performance Tracking

This Chapter documents the service levels currently being delivered and how performance is being tracked and measured,

Defining Levels of Service

Documented levels of service and the associated measures provide insights into the service the customers receive and the associated cost of maintaining the infrastructure assets to provide this service. Having these asset specific measures and linking them to goals and objectives in strategic documents supports alignment with the corporate vision, and guides investment decisions and day-to-day operational activities.

The monitoring of service performance enables the City to demonstrate transparency, equity and accountability in making decisions on service provision. With a common understanding of current levels of service and associated costs, the City will have better information to articulate the financial impacts of improving or reducing services, and to engage in "willingness to pay" discussions with customers.

Figure 4.1 shows the process that the City used to start formally documenting the City's levels of service objectives and performance. The outcomes of the process are summarized in the following sections.

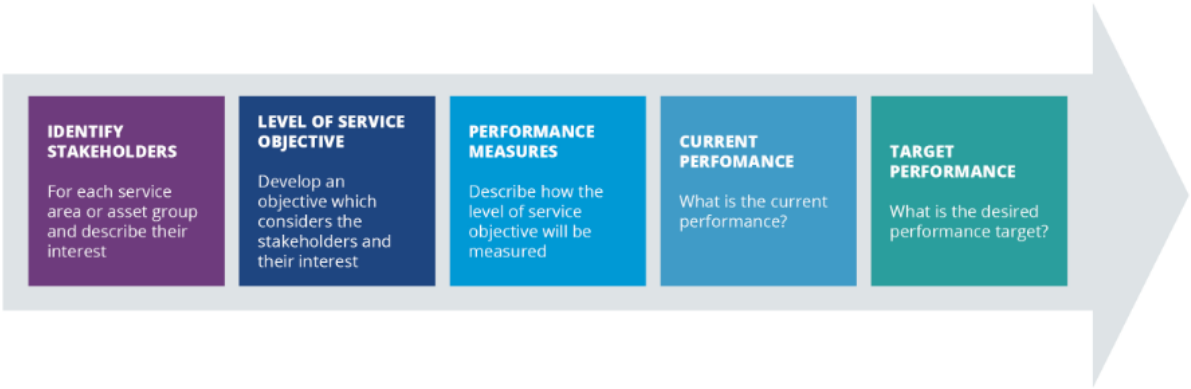


Figure 4.1 Levels of Service Development Process

Legislative Requirements

As a minimum, the services provided by City assets must meet legislative requirements at the municipal, provincial and federal levels. Key legislative requirements and the regulatory agency for the Enhanced and Natural Green Infrastructure assets are summarized in Table 4.1.

Regulatory Agency	Legislation	Requirement
City of Edmonton	City Policy C542A: Development Setbacks from River Valley/Ravine Crests	Provides for the separation of development from the river valley or ravine. This separation shall be created through establishment of a scientifically-derived Urban Development Line demarcating the boundary between developable upland area (urban development) and non- developable upland area or Environmental Reserve. This requirement protects natural areas and the stability of the river valley banks.
City of Edmonton	North Saskatchewan River Valley Area Redevelopment Plan (Bylaw 7188)	Protects the North Saskatchewan River Valley and Ravine System as part of Edmonton's valuable open space heritage for recreation and conservation purposes. Outlines a process for Environmental Assessment for any new development in the river valley.
City of Edmonton	Community Standards Bylaw (Bylaw 14600)	Regulates the removal, pruning and disposal of elm trees within the city. Also outlines weeds as identified by the City, in addition to provincially regulated noxious weeds.
City of Edmonton	Parkland Bylaw (Bylaw 2202)	Regulates the conduct and activities of people on parkland in order to promote the safe, enjoyable and reasonable use of such property and to protect and preserve natural ecosystems for the benefit of all citizens of the City.
City of Edmonton	Zoning Bylaw (Bylaw 12800)	Zoning pertinent to natural areas includes the following: • Natural Areas Protection Zone (NA): Allows for the conservation, preservation and restoration of identified natural areas, features and ecological processes. • Metropolitan Recreation Zone (A): Preserves natural areas and parkland along the river, creeks, ravines and other designated areas for active and passive recreational uses and environmental protection. • Public Parks Zone (AP): Provides an area of public land for active and passive recreational uses.
City of Edmonton	Corporate Tree Management Policy (C456C)	The purpose of this policy is to ensure growth, sustainability, acquisition, stewardship, tree maintenance, protection and preservation of the City of Edmonton Urban Forest (CoE Urban Forest) and to promote public education and engagement opportunities. It references the City of Edmonton's • *Tree Preservation Guidelines,* • *Natural Areas Systems Policy (C531)* • *Corporate Management and Tree Reserve Procedure* • *Natural Stand Valuation Guidelines* • *Guidelines for the Evaluation of Trees*
City of Edmonton	Open Space Policy (C594)	This policy Informs the planning, design and management of Edmonton's open space to achieve the outcomes and realize the vision of an integrated, sustainable, vibrant and multifunctional green network.

Regulatory Agency	Legislation	Requirement
City of Edmonton	Natural Area Systems Policy (C531)	This policy aims to conserve, protect, and restore Edmonton's natural uplands, wetlands, water bodies, and riparian areas, as an integrated and connected system of natural areas throughout the city. It also contains Guidelines for determining environmental reserve dedication for wetlands and other water bodies.
Alberta Ministry of Municipal Affairs	Alberta Municipal Government Act	Sets out roles, purpose, responsibilities and powers of local governments. This includes the requirement for Alberta municipalities to complete annual audited financial statements which must be submitted to Municipal Affairs by May 1 of each year. Also allows municipalities to identify concerns relevant to City residents for safe communities, including ability to develop environmental policy. During development, the Act allows municipalities to conserve lands through various mechanisms, including taking lands as Environmental and Municipal Reserve, or by creating Conservation Easements
Alberta Ministry of Agriculture and Forestry	Alberta Agricultural Pests Act	Outlines requirements for management of agricultural pests, including training and methods of management.
Alberta Ministry of Environment and Parks	Alberta Weed Control Act	Prohibited noxious weeds must be eradicated in accordance with the Provincial Weed Control Act (Natural and naturalization areas)
Alberta Ministry of Environment and Parks	Alberta Water Act	Comprehensive management of all surface and groundwater, addressing levels of use, impacts on water quality and loss of wetland habitat. Specifically, the Wetland Policy requires mitigation or compensation for wetland loss related to development.
Alberta Ministry of Environment and Parks	Alberta Wildlife Act	Manages species wildlife and plant species within the Province, including protection of nests, dens and hibernation habitat of managed wildlife species. Also identifies provincially protected wildlife species.
Alberta Energy Regulator	Alberta Responsible Energy Development Act (Alberta Energy Regulator)	Manages all environmental and landowner related concerns, including reclamation/ remediation for sites used for energy resource extraction, transportation and processing. Within urban areas, AER regulates 'site closure' of pipelines, wellsites and other energy infrastructure. Requires access be provided to utility rights-of-way.

Regulatory Agency	Legislation	Requirement
Alberta Ministry of Environment and Parks	Alberta Public Lands Act	Establishes the role of the Alberta government in managing public land. It sets out mechanisms by which rights in public land may be transferred by lease or sale. The Act and its regulations also control public land use through the establishment of public land use zones, recreation areas and trails. The Act provides for appropriate use and management of public land and for the classification of the public land base in Alberta.
Canadian Radio-television and Telecommunications Commission	Canadian Radio-television and Telecommunications Commission Act	Manages the development and siting of communication towers (e.g., wireless communication towers). Requires access be provided to utility rights-of-way.
Environment and Climate Change Canada	Government of Canada Migratory Birds Convention Act 1994	Affects when trees can be pruned and removed (must avoid spring breeding season).
Environment and Climate Change Canada	Government of Canada Wildlife Act	Allows for the creation, management and protection of wildlife areas for wildlife research activities, or for conservation or interpretation of wildlife. The purpose of wildlife areas is to preserve habitats that are critical to migratory birds and other wildlife species, particularly those that are at risk.
Fisheries and Oceans Canada	Government of Canada Fisheries Act	Trees growing in or next to fish bearing waters may require removal if they pose a hazard or have fallen into the stream.

Table 4.2 Legislation Requirements

Stakeholders and Their Needs

The City has identified key stakeholders for the services provided by the Enhanced and Natural Urban Forest assets to help define service requirements, document how best to deliver services, and how to measure the achievement of service levels that the community requires. The City's Infrastructure Strategy identifies the following stakeholder groupings:

- Service Recipients – Stakeholders that use the municipal services supported by assets (e.g. pedestrians shaded by boulevard trees).
- Rightsholders -stakeholders that have indigenous rights to the assets to practise traditional activities such as harvesting.
- Other Service Providers – Stakeholders that require the municipal service/assets to provide their own services (e.g. organizations offering recreational programs in natural areas).
- Regulatory Agencies – Stakeholders that set standards, compliance regulations or other legislation that govern service delivery (e.g. Ministry of Environment and Parks).
- The Wider Community – Stakeholders that wish to influence decision-making but may or may not be users of the service (e.g. taxpayers funding services they may not use, City staff)

- Neighbouring Municipalities – Other communities that are adjacent to Edmonton and are affected by or have an interest in City services (e.g. Leduc County).

The City has identified seven universal customer/stakeholder/citizen service values to consider when developing Customer Levels of Service measures. They help to group stakeholder interests to develop an overarching Levels of Service objective. The City's universal service values are:

- Accessibility: The ability for all possible customers of different abilities to access and use a service provided by the City, and in addition, to be able to access information about the service, and the assets that exist to provide that service.
- Reliability/Availability: The frequency the service is available for use by the customer. This is closely related to how reliable the service is. If a customer has access to a service between certain hours on a daily basis, this is the availability, if the service is often overrun or late/early, this would be the reliability.
- Quality: The level of excellence in service delivery provided by the City.
- Customer Service: The service provided for interacting with the customer regarding the services provided. This service allows customers to provide feedback on the services.
- Safety: A measure of service that considers the amount of harm that could be incurred to the customer, bystanders, wildlife/pets, and the environment.
- Sustainability: This translates into striving for community well-being, a sustainable environment, a prosperous economy, and smart growth and mobility choices. It is achieved by having a balanced financial capacity and creating a sustainable corporation that will drive toward this vision and provide the services citizens need today and in the future.
- Legislative: Service provided by the City that must meet standards set by legislative assemblies such as Provincial or Federal standards.

The reliability / availability measure does not apply to urban forest assets because the services they provide are not time dependent.

Table 4.1 provides a summary of high priority stakeholder interests and requirements for the urban forest assets included in this plan (Naturally Wooded and Naturalization Areas, and Maintained Trees). The interests and requirements have been categorized into one or more of the City's universal service values. The highlighted interests were identified in recent public consultations as highly valued services.

Stakeholders	Interests / Requirements	Service Value((s)
Service Recipients – park users, visitors, tourists	• Safe access to areas for gathering, enjoying nature, relaxation, and mental health	Accessibility Safety
Service Recipients - recreational users, visitors, tourists	• Safe access to areas for recreation	Accessibility Safety
Other Service Providers - other city departments (e.g. River Valley Parks & Facilities) and schools		

Stakeholders	Interests / Requirements	Service Value((s)
Service Recipients –Edmonton Native Plant Society (wildflower seed collection)	• Access to areas for gathering and harvesting	Accessibility Sustainability
Rightsholders - Indigenous peoples	• Access to areas for gathering, harvesting and ceremony • Potential opportunities for land-based learning in natural areas • Concerns where excavation of undisturbed natural areas may result in finding items of archaeological significance, and a desire to participate in ground disturbance monitoring in these cases • Connection to native species (spiritual, wellness, restorative) • Ecosystem goods and services including clean fresh air and water, stormwater capture to reduce flooding and erosion, shade to reduce ambient temperatures • Protected and connected natural areas system to promote human health and wellness	Accessibility Sustainability
Service Recipients – researchers and schools	• Safe access to areas for research	Accessibility Safety
Other Service Providers – utility companies including EPCOR (water, power, drainage), Telus, Shaw, and pipeline companies; other city departments, e.g. River Valley Parks & Facilities, transit; school boards	• Safe access to their infrastructure	Accessibility Safety
The Wider Community – Developers	• Regulations, standards, and guides for open space planning in new communities • Reduced 'red tape' around development adjacent to all urban forest assets • Increased property value	Accessibility Customer Service Quality

Stakeholders	Interests / Requirements	Service Value((s)
Service Recipients - residents	• Fast, informative and respectful customer service	Customer Service
Service Recipients – adjacent landowners **The Wider Community –** The Federation of Community Leagues / Homeowners Associations	• Integration of land use within envelope (fruit producing native species, beautification) • Privacy and sound barriers	Customer Service Quality
Service Recipients – residents, park users **The Wider Community** – Business improvement areas	• Attractive city for living and working in • Attractive green spaces for gathering and enjoying nature	Quality
Service Recipients – park users, transportation corridor users, recreational users	• Shelter from elements including sun and wind	Quality
Service Recipients – adjacent landowners **The Wider Community –** Developers, Building Great Neighbourhoods and Neighbourhood Renewal teams	• Preservation and responsible stewardship of assets to ensure retention of property values and a desirable neighbourhood • Landscape design and construction standards for green infrastructure	Quality
Service Recipients – residents, transportation corridor users (vehicular and active transportation) **Other Service Providers –** School Boards **The Wider Community** – Business improvement areas	• Safe and appealing corridors for vehicle travel and active transportation • Clear sightlines along roadways and at accesses	Quality Safety
Service Recipients - adjacent landowners **Other Service Providers –** utility companies including EPCOR (water, power, drainage), Telus, Shaw, and pipeline companies **Neighbouring municipalities** - Cities of Leduc, St. Albert, Fort Saskatchewan, Sherwood Park, Strathcona, Devon; and the North Saskatchewan Watershed Alliance	• Risks posed by the urban forest to people and infrastructure, e.g. fires, falling trees, damage by roots • Risks posed by pests and disease	Quality Safety

Stakeholders	Interests / Requirements	Service Value((s)
Other Service Providers – Fire and other emergency responders	• Safe access to areas for responding to emergencies	Safety
The Wider Community – The Federation of Community Leagues / Homeowners Associations	• Applying Crime Prevention Through Environmental Design Principles (CPTED) to make areas safer	Safety
Service Recipients – residents, visitors, tourists, transportation corridor users **The Wider Community** – Environmental Stewardship and Conservation Organizations[1]	• Ecosystem goods and services including clean fresh air and water, stormwater capture to reduce flooding and erosion, shade to reduce ambient temperatures • Protected and connected natural areas system to promote human health and wellness	Sustainability
The Wider Community – residents	• Ensuring Edmonton remains a competitive and successful environment for development and economic growth • Fiscally responsible management	Sustainability
Service Recipients – Fauna and wildlife **Other Service Providers –** utility companies including EPCOR (water, power, drainage), Telus, Shaw, and pipeline companies; Building Great Neighbourhoods and Neighbourhood Renewal teams **The Wider Community** – Environmental Stewardship and Conservation Organizations[1], Federation of Community Leagues, Urban Development Institute, IDEA and other home builder associations **Neighbouring municipalities** - Cities of Leduc, St. Albert, Fort Saskatchewan, Sherwood Park, Strathcona, Devon; and the North Saskatchewan Watershed Alliance	• High quality habitat that is biodiverse, connected, and sustainable • Restoring naturally wooded areas and trees disturbed by infrastructure projects to design and construction landscaping standards or above and beyond • Preservation of areas to help ensure a connected network for fauna and flora • Climate change adaptation	Sustainability

Stakeholders	Interests / Requirements	Service Value((s)
Other Service Providers – EPCOR	• Stormwater retention	Sustainability
1. These organizations include but are not limited to the Invasive Plant Council, Edmonton River Valley Conservation Coalition, CPAWS, Sierra Club, Cows and Fish, Mycological Society, Edmonton Native Plant Society, Edmonton and Area Land Trust, Edmonton Nature Club, Edmonton Native Plant Group, WILDNorth)		

Table 4.1 Levels of Service Stakeholder Interests and Requirements

Some of the stakeholder's interests in Table 4.1 will not be impacted by the levels of investment in asset lifecycle activities or asset performance. These include:

- Developing standards for designing and constructing naturalization areas or restoring natural areas,
- Policies and processes for reducing "red tape",
- Integrating land use within envelope,
- Strategies for engaging with stakeholders, and
- Responding to inquiries by Council and other City Departments

The City will address these interests through policies, master planning and other processes.

Level of service objectives were developed for the remaining interests along with measures for assessing performance against the objectives. Performance measures will be monitored over time to assess how stakeholders' primary requirements are being met given available resources and risk tolerances.

Levels of Service Objectives and Performance

Level of service objectives and performance measures have been developed based on the service values and stakeholder interests from the previous table. Performance measures have also been identified by their key driver - customer or technical. Measures below were taken from existing strategic and operational plans and work will be done in 2022 to narrow down measures based on operational feasibility and data availability.

- Customer performance measures are based on how the customer receives or experiences the service. Customer measures are generally those that would be used in public documents and are aimed at a layperson. They are typically measured by consulting with customers or other relevant stakeholders using tools such as surveys.

- Technical performance measures are based on what the City does to ensure delivery of the service. These measures support customer measures and tend to be used internally. Technical measures can also be further divided into longer term measures for asset management planning, and shorter-term operational measures for delivering asset life-cycle activities.

Table 4.2 presents level of service objectives and customer performance measures. Current and targeted values for performance measures are provided where data was available.

Service Value	Level of Service Objective	Relevant Asset Categories	Customer Performance Measures	Current Performance	Target Performance
Accessibility	We will provide volunteer opportunities for stewardship	Naturally Wooded Areas and Naturalization Areas	TBD	TBD	TBD
	We will provide attractive areas for gathering, enjoying nature, relaxing, recreation and mental health	Naturally Wooded Areas	Quantities of naturally wooded areas	1,824 ha	3,200 ha
		Naturalization Areas	Quantities of naturalized areas with trees or shrubs	300 ha	2,200 ha
		Maintained Trees	Quantity of maintained trees	374,700 trees	796,100 trees
Service Value	Level of Service Objective	Relevant Asset Categories	Customer Performance Measures	Current Performance	Target Performance
Quality	We will provide attractive areas for gathering, enjoying nature, relaxing, recreation and mental health	Open space trees Naturally Wooded Areas Naturalization Areas	% users satisfied with parks and green spaces	90 to 92% in 2014	80% (set in 2010)
Safety	We will provide safe access to areas for gathering, enjoying nature, relaxing, recreation and mental health We will provide safe roadside environments	Maintained Trees Naturalization Areas Naturally Wooded Areas	Percent claims at fault	TBD	0

Service Value	Level of Service Objective	Relevant Asset Categories	Customer Performance Measures	Current Performance	Target Performance
Customer Service	We will respond to customer service requests within 5 days	All	Percentage of customer service requests responded to within 5 days	TBD	100%
Sustainability	We will provide a forest with diverse species to improve resilience to climate change	Maintained Trees	% of one species	Ash - 22% Elm - 21% Spruce - just over 10%	No more than 10% of 1 species
		Naturally Wooded Areas and Naturalization Areas	Native species measure	TBD	TBD
	We will enhance the beauty of Edmonton and contribute to the wellbeing and quality of life of its current and future residents	All	Canopy cover percentage contributed by city assets	Overall tree canopy in 2019 was 13%	Overall tree canopy coverage of 20%
Service Value	Level of Service Objective	Relevant Asset Categories	Customer Performance Measures	Current Performance	Target Performance
Sustainability	We will protect and preserve the urban forest to promote the health and wellness of people, and native flora, and fauna	Naturally Wooded Areas	% of naturally wooded areas protected for biodiversity conservation	TBD	TBD
		Naturally Wooded Areas and Naturalization Areas	Connectivity measure TBD	TBD	TBD
Sustainability (Financial)	We will ensure cost effective service provision	All	TBD	TBD	TBD

Table 4.2 Level of Service Objectives and Customer Performance Measures

Table 4.3 presents level of service objectives and technical performance measures for operational activities. These measures will be tracked for making decisions on resources for operational and maintenance activities.

Service Value	Level of Service Objective	Relevant Asset Categories	Operational Performance Measures	Current Performance	Target Performance
Legislative	We will adhere to applicable bylaws and legislation	All	The number of non-compliances issued	0	0
Quality	We will provide attractive areas for gathering, enjoying nature, relaxing, recreation and mental health	Naturally Wooded Areas	All formalized viewpoints have been maintained within the required time frame	90% of viewpoints have no obstructing vegetation	Every 5 years
Quality	We will enhance the beauty of Edmonton and contribute to the wellbeing and quality of life of its current and future residents	Maintained Trees	% of trees planted surviving 5 years after planting	TBD	TBD
		Naturalization Sites - Planted	Survival and health of planted trees	78.6% survival	80% in the landscape standards
Service Value	Level of Service Objective	Relevant Asset Categories	Operational Performance Measures	Current Performance	Target Performance
Quality	We will provide attractive areas for gathering, enjoying nature, relaxing, recreation and mental health	Naturally Wooded Areas and Naturalization Areas	Frequency of inspections to identify service needs	4 per yr for Naturally Wooded Areas in Tablelands	12
Safety	We will provide safe access to areas for gathering, enjoying nature, relaxing, recreation and mental health	Naturally Wooded Areas and Naturalization Areas	% of trails (by length) pruned for vegetation clearance each year	TBD	TBD

Safety	We will protect and preserve the urban forest to promote the health and wellness of people, and native flora, and fauna	Naturally Wooded Areas and Naturalization Areas	% areas where fire risk has been reduced through vegetation management	10 areas in 2019	TBD
Service Value	Level of Service Objective	Relevant Asset Categories	Operational Performance Measures	Current Performance	Target Performance
Safety	We will provide safe access to areas for gathering, enjoying nature, relaxing, recreation and mental health We will provide safe roadside environments	Maintained Trees	% maintained trees removed within 2 years of being marked for removal	100%	100%
		Maintained Trees	% stumps removed within 12 months of tree removal	TBD	100%
		Maintained Trees Naturalization Areas Naturally Wooded Areas	Frequency of inspections to identify imminent safety hazards in publicly accessible areas	4 per year for Naturally Wooded Areas in Tablelands Every 2 years for maintained trees TBD-Naturalization	12 per yr for Naturally Wooded Areas in Tablelands Every 2 yrs for maintained trees TBD-Naturalization
		Maintained Trees Naturalization Areas Naturally Wooded Areas	Time to respond to hazards after a storm	TBD	24 hours for all calls unless it is a significant storm
Sustainability	We will protect and preserve the urban forest to promote the health and wellness of people, and native flora, and fauna	Naturally Wooded Areas and Naturalization Areas	% areas with invasive species	TBD	TBD

			% areas where legislated weeds are controlled or eradicated	TBD	TBD
Service Value	Level of Service Objective	Relevant Asset Categories	Operational Performance Measures	Current Performance	Target Performance
Sustainability	We will ensure cost effective service provision	Naturalization Areas	Area of turfgrass converted to naturalization areas per year	35 ha to 150 ha annually	TBD - upon completion of naturalization plan
		Naturally Wooded Areas and Maintained Trees	TBD	TBD	TBD

Table 4.3 Level of Service Objectives and Technical Performance Measures for Operations

Table 4.4 presents level of service objectives and technical performance measures for longer term asset renewal and replacement activities. These measures will be reviewed to develop asset strategies and financing planning in Sections 6 and 8 of this asset management plan. Several of the measures were also identified as customer performance measures in Table 4.2

Service Value	Level of Service Objective	Relevant Asset Categories	Planning Performance Measures	Current Performance	Target Performance
Accessibility	We will provide attractive areas for gathering, enjoying nature, relaxing, recreation and mental health	Maintained Trees	Quantity of maintained trees	374,700 trees	796,100 by 2071
Accessibility	We will provide attractive areas for gathering, enjoying nature, relaxing, recreation and mental health	Naturally Wooded Areas	Quantities of natural areas	1,824 ha of naturally wooded areas	3,200 ha of naturally wooded areas by 2071

Service Value	Level of Service Objective	Relevant Asset Categories	Planning Performance Measures	Current Performance	Target Performance
		Naturalization Areas	Areas of naturalization sites planted (i.e. moved to Stage 2)	300 ha	2,100ha
Safety	We will provide safe access to areas for gathering, enjoying nature, relaxing, recreation and mental health We will provide safe roadside environments	Maintained Trees	% trees pruned meeting the specified pruning cycles	55%	100%
	We will provide safe access to areas for gathering, enjoying nature, relaxing, recreation and mental health	Naturally Wooded Areas and Naturalization Areas	% of area mitigated for tree risk every 10 years	TBD	TBD
Service Value	**Level of Service Objective**	**Relevant Asset Categories**	**Planning Performance Measures**	**Current Performance**	**Target Performance**
Sustainability	We will provide a forest with diverse species to improve resilience to climate change	Maintained Trees	% of one species	Ash - 22% Elm - 21% Spruce - just over 10%	No more than 10% of 1 species
			% of elm or ash in replacement plantings	0% ash planted in 2019 or 2020 15% of elm planted in 2019 and 8% elm planted in 2020	15%

			Diversity of age class	60% young 20% semi mature 11% mature 4% old	40% young 30% semi mature 20% mature 10% old
		Naturally Wooded Areas	Diversity of seral stage	TBD	TBD
Service Value	Level of Service Objective	Relevant Asset Categories	Planning Performance Measures	Current Performance	Target Performance
Sustainability	We will enhance the beauty of Edmonton and contribute to the wellbeing and quality of life of its current and future residents	All	Canopy cover percentage contributed by city assets	Overall tree canopy on private and public property in 2019 was 13% (approximately 6 percent is city owned)	11% canopy contributed by city-owned urban forest assets
		Maintained Trees	Expected useful life	TBD	TBD
Sustainability	We will protect and preserve the urban forest to promote the health and wellness of people, and native flora, and fauna	Naturally Wooded Areas	% of natural areas protected for biodiversity conservation	TBD	TBD

Table 4.4 Level of Service Objectives and Technical Performance Measures for Replacing and Creating Assets

Recommendations to Improve Levels of Service Objectives and Performance in Future Plans

As the City improves its data collection and starts reporting annual performance using the measures identified in this chapter, it will reach a point where the costs of providing various levels of service will be better understood. Stakeholders can then be consulted regarding tradeoffs between levels of service and costs. The following actions are recommended to improve performance tracking and assessment in future AMPs. They are also summarized and prioritized in Section 9 along with recommended improvements from the other sections of the AMP.

1) Develop performance measures for ecological connectivity and diversity of native species in areas as these are key strategic service goals of the urban forest assets.

2) Collect the data to report on current performance for the measures identified in this chapter. If there are no plans to collect the required data, then review options for the performance measures that would be based on available data.

3) Improve collaboration between the urban forest operations team and the Environmental Strategies team to quantify the ecological benefits of the urban forest such as tonnes of pollution removed, carbon sequestered, and quantity of stormwater runoff retained.

4) Develop simple relationships using the results from the previous improvement item to estimate the ecological benefits of the urban forest on an annual basis as the urban forest inventory changes.

5) Review performance measures for new plans developed by the City such as the Breathe Implementation Plan and use the relevant ones for reporting the performance of urban forest assets. In other words, use readily available measures from strategic plans where possible. This will reduce the costs of measuring performance, and strengthen the links between urban forest levels of service and broader, more strategic goals.

6) Update performance measures targets identified as TBD after reviewing current performance.

7) Update the master plans for the urban forest assets and establish targets for quantities of each asset type required to achieve the key goal of 20% canopy cover.

Asset Management Continuous Improvement Indicators

This section presents indicators for the continuous improvement of asset management practices related to measuring and reporting on performance and levels of service.

Levels of Service: Establishing and tracking Levels of Service is critical to understanding service delivery. Continuous improvement performance trends can be tracked through the following indicators:

- Percentage of Levels of Service performance measures for which current performance is recorded (51% or 26 out of 51 performance measures).
- Percentage of Levels of Service performance measures for which current performance meets target performance (10% or 5 out of 51 performance measures).

5. Growth and Future Demand

A Demand Management Plan outlines:

- What the demand drivers are
- The future demand forecasts
- How these demands will impact our assets
- What we will do to manage them.

Having a Demand Management Plan is critical to making sure we have robust planning for future urban forest requirements.

Demand Drivers

The factors that affect the demand for urban forest services and the assets that support them must be understood to plan for a changing world. Shifts in demand tell us where increases or decreases in our Levels of Service should occur. This may include changes due to population, climate, industry / commercial development and technology. This section highlights future demands, existing and projected state, and their expected impact. If changes in demand are considered now, strategies can be put in place to adjust medium and long-range plans for anticipated changes in demand for services. Table 5.1 lists key drivers or the demand for urban forest assets and their anticipated impact on services.

Demand driver	Present state	Anticipated trend	Impact on services
Population	~1 million	Increase of 23,000 people per year reaching 1.5 million in 20 years Doubling to Official Plan target of 2 million in 50 years	• Less land available for natural areas • More maintained trees to beautify new roads and parks • With new neighborhoods built there will be more open space areas and trees • Higher demand for natural areas and related maintenance services (e.g. litter pickup, monitoring for prohibited activities) • More customer calls and longer travel times for crews to access sites. Additional yards may be required for operational staff and equipment as the city continues to grow.
Legislative changes	Alberta currently has 6 regulations / legislation for carbon and GHG emissions[3]	Province plans to implement new methane standards	• As greenhouse gas reduction targets and regulations continue to increase and there is a desire to meet Federal targets, demand for green infrastructure and planting targets will increase

Demand driver	Present state	Anticipated trend	Impact on services
Legislative changes	Not available	Occupational health and safety standards will become more stringent	• Utility corridors will need to be larger to ensure there is adequate space for both utilities and green infrastructure. If the space is inadequate, then existing trees cannot be replaced as they reach the end of their lives, and new trees cannot be created.
Climate	Average daily temperatures range from -11.7 °C in January to 17.5 °C in July Yearly precipitation values range from 466 mm to 536 mm Growing season of 178 days	Average temperatures 5 to 7 degrees warmer by the 2080s More rain, less snow, drier summers Increased summer climatic moisture deficits Potential changes in frequency and intensity of extreme weather events Growing season increase to 243 days by 2080	• Demand for increased canopy coverage as temperatures increase • Increased demand for natural and naturalized areas to abate stormwater and prevent erosion • Increase in the number of hazards due to storm damage • Seasonal changes may change or impact the levels of service, extend planting season, require a shift in the types of species planted, and more maintenance including watering and inspections for insects and disease
Public awareness of the urban forest benefits	82% of a sample of residents ranked the urban forest benefits as 4 or 5 where 1 is not at all important and 5 is extremely important	Public awareness of urban forest benefits is increasing due to educational programs	• Higher demand for the services and benefits of forested, treed areas • Higher demand for volunteer and stewardship opportunities • Increased potential for user group conflicts particularly in heavily wooded areas where some want development and others want conservation.
Citizen's quality of life	Ranked 71 in the world by Numbeo[2]	Busy schedules and limited leisure time have resulted in an increasing preference for more flexible, individualized fitness and wellness experiences	• Increase in ecological impacts from human use to naturally wooded areas requiring more restoration • Demand for more trails and recreational activities in naturally wooded areas • Citizens want to have open spaces within walking distance of homes, driving maintenance and stewardship of treed areas up

Demand driver	Present state	Anticipated trend	Impact on services
City economy	City of Edmonton's fall 2020 forecast predicts an economic contraction of 6.4 per cent for Edmonton for the whole of 2020	From 2021 onward, growth is expected to be positive, though a full recovery to 2019 output levels is not expected until 2022 for Edmonton. Between 2021 and 2024, the city's economy is expected to grow by about 3.1percent annually[1].	• The rate of new development, demand for new trees, and land donations for areas will vary with the economy.
Technology	Not available	Increasing opportunities for citizens to use technology to learn more about the urban forest	• Increase in demand and stakeholder involvement as technology is used to educate more citizens about the benefits of the urban forest. • Technology also drives continual improvement and creates efficiencies in planning and operations • Increase in people working from home may create an increased demand for access to urban forest assets and more trees, natural areas, and naturalized areas closer to homes.

1. City of Edmonton Fall 2020 Forecast Update (Office of the Chief Economist)
2. Numbeo website, https://www.numbeo.com/quality-of-life/rankings.jsp, accessed Feb 2021
3. Osler Canadian Legislation and Regulations on Carbon and GHG (https://www.osler.com/en/resources/regulations/2015/carbon-ghg/carbon-and-greenhouse-gas-legislation-in-alberta), accessed Feb 2021

Table 5.1 Demand drivers, projections, and impact on services

Forecasting Demand

Information reflecting the identified demand drivers above needs to be collected in the long term to develop trends and understand or predict future changes.

The City has various master plans and strategic plans that provide background information that supports demand forecasting for urban forest assets. A summary of key outcomes from these plans is included in Table 5.2.

Plan	Description	Key outcomes impacting urban forest assets
The Urban Forest Management Plan, 2012	A 10 year strategy for sustainably managing and enhancing Edmonton's urban forest	• 20% target for canopy cover coverage through partnerships, preservation, residential action, naturalization, and additional landscape tree plantings • Contains both asset and non-asset related strategies and actions for achieving canopy coverage goal
City-wide Natural Area Management Plan (2014)	Sets out objectives and strategies for managing and restoring the Natural Areas owned by the City	• Identifies stewardship strategies and actions for meeting management goals. Does not address future growth and demand. • Describes community stewardship strategy for non-asset related programs
Naturalization Master Plan, 1999	Master plan developed in 1994 to identify criteria and candidate areas for naturalization	• Goal to naturalize 312 ha of roadway boulevards and 43 ha of parks for a total area of 355 ha. Current inventory has 745 ha, so target has been met • Contains criteria for identifying and prioritizing candidate sites for naturalization
Natural Connections Strategic Plan (2007)	Sets out the City's conservation vision, goals and system outcomes – the strategic direction – that will guide conservation planning over the next ten years.	• Contains potential system indicators such as quantity of stepping stone / linkages, nearest neighbour index and structural / functional connectivity. However the plan does not provide current or target values of the measures.
Breathe Strategic Plan 2017	Sets direction for the sustainable care and expansion of the city's open spaces.	• Applies to publicly accessible areas • Includes a geospatial database containing an inventory of all the open spaces in the city, and accompanying functional and connectivity analysis results. • Provides a summary of open space metrics for various development areas in 2017 but no future estimates or targets • The next steps include the BREATHE Implementation Plan to establish quantifiable indicators, targets and timelines to measure the performance of the green network over time.

Plan	Description	Key outcomes impacting urban forest assets
Climate Resilient Edmonton, Adaptation Strategy and Action Plan (2018)	The plan identifies actions to make Edmonton more resilient to the effects of climate change	• Actions include reducing the impacts of the urban heat island effect, a drought management program, developing a river and ravine flooding program, adapting pest management programs, developing and implementing an ecosystem services based program.
Connect Edmonton, 2019	Edmonton's strategic plan is the city's guide to what it aims to achieve and it directs where change is needed today.	• Edmonton's highest level plan and it's about making transformational change. • Identifies indicators that will be tracked including several that drive the demand for urban forest services such as growth in population, housing, transportation; access to amenities that improve quality of life; and climate resilience measures.
Edmonton Metropolitan Regional Growth Plan	The plan is the culmination of ongoing research, trend monitoring, and consultations. It guides the daily work of the Edmonton Metropolitan Region Board, ensuring decisions and programs are integrated to support the long term economic prosperity and quality of life for all citizens of the Region.	• Population is expected to grow by 23,000 people per year over the next several decades • Increase of 460,000 by the end of year 20
City Plan	Articulates the choices we will make to become a healthy, urban and climate resilient city of 2 million people that supports a prosperous region.	• 2 million "net new trees" will be planted "throughout our nodes and corridors, parks, private and public realm" by the time the city reaches a population of 2 million • Direction 1.4.2.3 to expand and enhance a healthy and sustainable urban forest • 2.4.1.2 Conserve, restore and reconnect natural areas and ecological networks within the built environment for human and ecosystem health. • 5.1.1.3 Expand and enhance Urban Greenways as part of the Green and Blue Network to improve the built and natural environments. • 5.1.1.6 Acquire lands within the North Saskatchewan River Valley and Ravine System for natural areas protection, open space connectivity and use. • 5.1.2.2 Expand and diversify Edmonton's urban tree canopy and native vegetation. • Map 4 shows the planned Green and Blue Network for a population of 2 million • Map 8 shows future roadways including arterials

Plan	Description	Key outcomes impacting urban forest assets

Urban Parks Management Plan, 2006	Policy document and guide to the future acquisition, design, construction, maintenance and animation (use) of City parks, river valley and natural areas.	• Describes the process for developing parks including the requirement for developers to provide a portion of their land holdings for school and recreational purposes (10% plus density bonuses). Over the past 25 years the City has been unable to meet program needs with the 9.5% of space it has been accepting from developers. Approximately 11- 12% would be required.
		• Plan guidance includes
		  ○ A minimum target of 2.0 hectares of parkland/1000 people is required for new neighbourhoods. It does not apply to existing neighbourhoods.
		  ○ Protecting and expanding the urban forest within parks. A target of 70 trees per ha was identified for areas within the River Valley and Ravine Parks, City Level parks, and pocket parks. Minimum targets of 45 trees per ha and 55 trees per ha were identified for District Activity Parks, and School and Community Parks, respectively. A target of 65 trees/ha was selected for Urban Village Parks.
		• Operating guidelines for natural areas including method of assembly and buffer requirements.
		• Operating guidelines for greenways including tree planting standards of 240 trees/ha assuming 10m width and 2 trees every 8 to 10 m.
		• Acquiring area in the River Valley System primarily through environmental reserve dedications

Ribbon of Green (1990, 1992, and 2020 SW and NE Plan)	Provides strategic direction to guide the protection and responsible use of the southwest (SW) and northeast (NE) portion of Edmonton's River Valley and Ravine System over the next 20 years.	• The Plan provides direction to the acquisition, management, programming, and development of publicly owned land within the Plan's two study areas. • Acquisitions occur primarily through opportunity purchasing and environmental reserve dedication. Currently much of the River Valley and Ravine System is privately-owned. The City will work to acquire land to expand this public resource. • Contains maps showing future parks and potential restoration areas

Table 5.2 Strategy and Development Plans

Forecasts of future demand for urban forest assets based on current trends in asset growth and their drivers are described in the following sections by asset category.

Maintained Trees

An additional 7,500 maintained trees are forecasted to be added to the City's inventory per year due to development and project activity. This will increase the current inventory by 375,000 maintained trees over the next 50 years. The forecast was based on the following trends:

- An average of 8,667 trees being added to the inventory per year through Urban Planning and Economy, and Developer services;
- An average of 1,100 trees per year being lost from project work and from land sold for development, resulting in a net increase of approximately 7,500 trees per year.

An additional 46,500 maintained trees were also assumed to be added to the inventory over the next 50 years from infill planting of existing developed areas. A total of 6,000 trees are planned for the next 2 years and an additional 1,500 trees per year from year 3 onwards until year 50.

Natural Areas

Future quantities of natural areas were based on the city realizing its Preferred Scenario goal in the City Plan of owning 6,400 ha (8% of the City) of natural areas including 3,200 ha of naturally wooded areas. The city currently owns approximately 1,800 ha of naturally wooded areas. It was assumed for this plan that:

- The city would acquire 28 ha of naturally wooded area per year to reach its goal of 3,200 ha of naturally wooded areas over 50 years.
- None of the natural areas currently owned by the city would be lost to development.

Naturalized Areas

The quantity of naturalized areas is expected to increase from 745 ha to 3,100 ha based on the following historical trends:

- The inventory of unmowed grass naturalization areas will grow by 100 ha in 2021 and then by 35 ha/yr on average for the remaining 49 years in the planning horizon for a total of 1815 ha.
- The 3-yr trend of planting 7.5 ha of naturalization areas each year will continue over 50 years to create 375 ha of tree stands.
    - 30% of grass areas with trees or shrubs (approximately 100 ha) will be planted and assumed to mature into tree stands in 50 years. The remaining 70% will stay as grass with trees or shrubs.
    - Unmowed grass areas will be planted at a rate of 5.5 ha per year with the assumption that it will take 15 years after planting to transition from grass with trees or shrubs to a tree stand.
- An assumption that new development will create an additional 10 ha per year split between the various types of naturalized areas as follows:
    - 40% grass
    - 40 % grass with trees and shrubs
    - 20% other (riparian, bioswale)

It was also assumed that the quantity of naturalization areas would not decrease due to development, i.e. any loss would be offset by creating an area in another location.

Table 5.3 shows forecasted increase in naturalization assets by year 50 compared to the current inventory.

Asset Type	Current Quantity (ha)	Quantity in 50 years (ha)
All Naturalized Areas	745	3,100
• tree stands	13	300
• grass with trees or shrubs	287	500
• Unmowed grass	321	2,300
• Other (bioswale, riparian, wildflower meadow)	124	

Table 5.3 Forecasted increase in naturalization assets

Forecasted Key Performance Measures for Planned Growth

The outcomes of the planned growth scenario described in the previous sections were assessed against the following key performance measures from Section 4 on Levels of Service and Performance:

- Plant 2 million trees by 2050;
- Achieve the Preferred City Plan scenario of conserving 8.2% of the city's total area, or 6,400 ha, as natural areas. This amount includes 3,200 ha of naturally wooded sites;
- Provide a tree canopy covering 20% of the city's total area of 78,300 ha, or 15,660 ha of canopy cover.

Table 5.4 presents the forecasted performance measures for the planned growth scenario.

Asset Category and Type	Forecasted Quantity in 50 yrs	Forecasted Canopy Area in 50 yrs (ha)	Number of trees planted by 2050	% city preserved as Natural Areas in 50 yrs
Maintained trees	796,100 trees	3,200	273,000	not applicable
Naturalized areas with trees or shrubs	800 ha	350	2,250,000	not applicable
Other naturalized areas	2,300 ha	350	0	not applicable
Natural areas - naturally wooded included in the AMP	3,200 ha	2,900	0	6,400 / 78,300 = 8.2%
Natural areas not included in the AMP (wetlands, non-wooded areas, non-vegetated areas, non-city owned)	3,200 ha	750	0	
Canopy area on non-city owned properties (excluding natural areas which are included in the row above)	4,150 ha	4,150	Not estimated	not applicable
Total	not applicable	11,350 **14.5% of the city area**	2,523,000	8.3%
Performance Measure Targets	**not applicable**	**20%**	**2,000,000**	**8.2%**

Table 5.4 Forecasted performance measures for the planned growth scenario

The results in Table 5.4 are based on the following assumptions:

- Maintained trees have an average canopy of 40 m^2
- Non-city owned properties have a current canopy of 4,150 ha. Appendix E provides additional details on the analysis to estimate this quantity.;
- The average percent canopy coverage for the different types of areas will not change over time from the existing values listed below:
    - 90% for naturally wooded natural areas, and 22% for other types of natural areas;
    - 78% for naturalized tree stands;
    - 25% for naturalized grass areas with trees and shrubs;
    - 15% for other types of naturalized areas.

As shown in the table, **the forecasted growth in assets will meet two of the performance measures, but not achieve the 20 percent canopy target.** The next section on Demand Management Planning presents a combination of asset based and non-asset based solutions for closing the canopy cover gap.

Demand Management Planning

Demand can be managed through:

- Asset based solutions: Maintenance of existing assets, upgrading of existing assets and providing new assets to meet future demand; and
- Non-asset based solutions

Figure 5.1 presents an overview of the asset-based and non-asset based solutions we plan to use for managing and planning for future demand and levels of service.

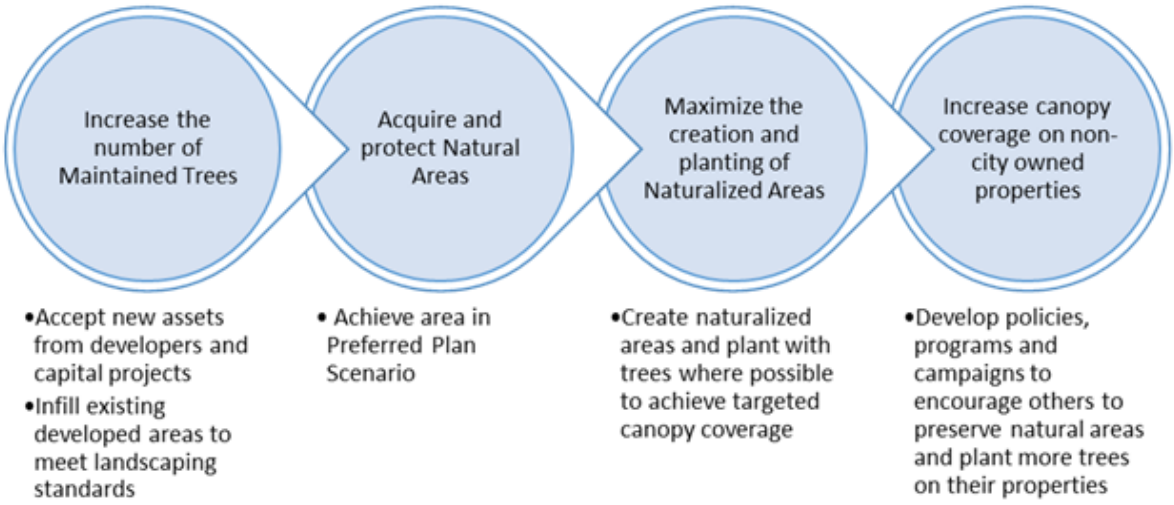


Figure 5.1 - Demand Management Plan

Following the plan in Figure 5.1, the city will need to take the following steps over the next 50 years to achieve a 20% canopy coverage:

- Develop new policies to protect and preserve existing City trees.
- Increase the quantity of maintained trees as described in the planned growth scenario, i.e. by accepting new assets created by developers and from capital projects, and by planting new trees to meet landscaping standards where possible to infill existing developed areas.
- Acquire and protect natural areas as described in the planned growth scenario to achieve the total area identified in the Preferred City Plan scenario.
- Invest in policies, programs and campaigns to create an additional 2,900 ha of canopy on non-city owned property. This represents a 70% increase in canopy cover on non-city owned areas.
- Naturalize another 700 ha of area in addition to the forecasted areas presented in the planned growth scenario; and

- Plant another 1,400 ha of naturalized areas in addition to the areas to be planted in the planned growth scenario.

Table 5.5 lists the quantities of new assets required under this strategy to meet future demand and the key performance targets.

Asset Category and Type	Current Quantity	New Assets	Key Drivers	Technical Performance Measures
Maintained trees	375,000	421,500	• Population • New roadway length • Area of new development • Urban greenway upgrades • Public awareness of urban forest benefits	• Canopy growth • 2 million trees planted • Quantity of trees per capita • % areas and roadways meeting landscaping standards • Diversity of species and age class
Naturalized areas with trees or shrubs	300 ha	1,900 ha	• Population • New habitat greenway • Length of arterial roadway ROW not naturalized • Climate change • Public awareness of urban forest benefits	• Canopy growth • 2 million trees planted • Quantities of natural areas and naturalized areas (ha, or ha/resident)
Natural areas - city owned naturally wooded areas included in the AMP	1,800 ha	1,400 ha	• Population • Quantity of natural areas available • Area of new parks and new development • Quality of life • Public awareness of urban forest benefits	• Canopy growth • Quantities of natural areas and naturalized areas (ha, or ha/resident) • % of naturally wooded areas protected for biodiversity conservation
Natural areas not included in the AMP	6,100 ha	-2,800 ha[1]		
Canopy on non-city owned properties	4,150 ha	2,900 ha	• Climate change • Public awareness of urban forest benefits • Quality of life	• Canopy growth

1. The quantity of natural areas not included in the AMP is forecasted to decrease because a portion will be acquired by the city, and a portion will be developed.

Table 5.5 - Quantity of assets planned to meet future demand and performance targets

Reviewing the table, significant growth in assets is planned including doubling the quantity of maintained trees, increasing the area of naturalized trees stand by a factor of six, increasing the amount of protected naturally wooded areas by 75%, and implementing programs to increase the quantity of canopy cover on non-city owned properties by 70 percent. Table 5.6 presents the forecasted key performance measures for the level of growth described in Table 5.5.

Asset Category and Type	Forecasted quantity in 50 yrs	Forecasted canopy area in 50 yrs (ha)	Number of trees planted by 2050	% city preserved as Natural Areas in 50 yrs
Maintained trees	796,100 trees	3,200	273,000	not applicable
Naturalized areas with trees or shrubs	2,200 ha	1,500	10,650,000	not applicable
Other naturalized areas	1,600 ha	250	0	not applicable
Natural areas - naturally wooded included in the AMP	3,200 ha	2,900	0	6,500 / 78,300 = 8.3%
Natural areas not included in the AMP	3,300 ha	750	0	
Canopy area on non-city owned properties	4,150 ha	7,050	not estimated	not applicable
Total	not applicable	15,650 **20% of the city area**	10,600,000	8.3%
Performance Measure Targets	**not applicable**	**20%**	**2,000,000**	**8.2%**

Table 5.6 - Forecasted key performance measures for the AMP

Table 5.7 presents other approaches for managing future demand in addition to increasing the quantities of assets. It includes programs to encourage canopy growth on non-city owned properties which will be a key component of the strategy for achieving the canopy target.

Demand component	Description	Methodology	Example of Specific Application
Operation	Alternative delivery option for planting new trees	Programs involving volunteers in providing and planting trees on public land	• Roots for Trees • Commemorative Tree Program • Tree Donation program • Arbor Day • Request to Plant program
Operation	Increase the lifespan of maintained trees to maximize the canopy and other ecological benefits per tree	Research, identify, and pursue new methods of supplying adequate soil volume, quality, and water for normal tree growth	• Research programs and partnerships • Planting trials at OMC Nursery
Regulation	Continue to develop design and construction standards to create healthy trees that meet lifespan targets	Collaborate with stakeholders to incorporate best management practices and emerging industry standards in future updates of City of Edmonton Design and Construction Standards	• The City participates in regular meetings with the Urban Development Institute and industry representatives
Incentive	Create ownership and appreciation of urban natural areas	Provide opportunities for hands-on planting and/or stewardship of natural areas	• Have Shovel Will Travel, • Roots for Trees, • Partners in Parks
Incentive	More opportunities for naturalization areas and maintained trees	Develop a model and review process for encouraging development of low-impact neighbourhoods that use the urban forest	• Not available
Education	Increase communication about tree pest issues, such as Dutch Elm Disease and invasive native and exotic insect pests on private and public lands	Provide accurate, and updated information on the website, and in the media	• The Forestry Unit is an active member of the Society to Prevent Dutch Elm Disease
Education	Develop local and regional information sharing networks	Distribute urban forestry information through new and existing networks	• Accurate and current information on arboricultural best practices, tree facts and urban forest issues is available on the City website, through workshops, public meetings, conferences, newsletters, and brochures

Demand component	Description	Methodology	Example of Specific Application
Education	Communicate the ecological and health benefits of trees	Partner with like-minded conservation programs	• Master Composter / Recycler • Alberta Biodiversity Monitoring Institute • Edmonton Horticultural Society • Edmonton Native Plant Society • Edmonton River Valley Conservation Coalition
Education	Encourage research and development of urban forest knowledge	Enhance partnerships with post-secondary educational institutions to develop collaborative research programs	• Sustainability Scholars Program
Education	Recognition program that celebrates civic pride, local beauty, and environmental responsibility	All owners within the city are evaluated and awards are provided	• Communities in Bloom • Edmonton in Bloom
Demand Substitution	Encourage canopy growth on non-city owned properties	Develop a model and review process for encouraging development of low-impact neighbourhoods that use the urban forest Plant giveaways and other incentive programs for private property owners to plant trees.	• Plant giveaway program through Root for Trees

Table 5.7 Non-asset based demand solutions

The next section of the plan describes the lifecycle strategies for managing both existing and new assets including details for creating new assets.

Recommendations to Improve Planning for Growth and Future Demand

The demand forecasts for the plan can be characterized as a basic level of maturity according to the following description from the 2015 International Infrastructure Management Manual:

"Forecasts based on experienced staff predictions with consideration of known past demand trends and likely future growth patterns".

The next steps to improve forecasts would be to base them on a *"robust projection of a primary demand factor and extrapolation of historic trends".* The following actions are recommended to improve future forecasts:

1) Identify primary demand factors for forecasting future quantities of maintained trees, naturalization areas, and natural areas. Ideally, the primary factors would be available from other more strategic plans such as the City Plan, the Breathe Implementation Plan (in progress), Ribbon of Green plans (e.g. SW and NE, and 2022 completion), and Connect Edmonton. Potential factors include estimated quantities of:
    - Areas to be developed;
    - Quantities of park space, greenways, or transportation corridors to be created;
    - Non-city owned natural areas that could be secured.
    - Naturalization areas being created by developers.

2) Work with utility companies and developers to find new ways to create and share green space to allow existing trees to be replaced and new trees to be created.

3) Determine historical performance where possible for key performance indicators identified in Section 3, and track ongoing performance. These can then be used over time to extrapolate trends and develop relationships based on key factors.

4) Further analysis to confirm the assumptions underlying demand forecasts in this plan including:
    - Research to develop canopy estimates for the different types of maintained trees by level of maturity (young, semi-mature, mature and old), species, and the different types of areas.
    - Analysis to confirm the current canopy on non-city owned properties
    - Confirming and tracking canopy coverage provided by both city and non-city owned assets. The growth in canopy coverage on non-city owned properties will be a key factor in determining the quantity of assets the city will need to provide to meet its performance target of 20% canopy coverage.

5) Update the plans for urban forest assets including the:
    - 1994 Naturalization Master Plan. These assets will have a major role in achieving the canopy coverage goals. Potential sites identified in the Preferred City Plan Scenario should be assessed using the naturalization criteria from the 1994 plan to confirm the quantity of areas that could be naturalized.
    - 2012 Urban Forest Management Plan to reassess the 20% target, current performance, and updated strategies for achieving the canopy goal such as:
        - Targets for city owned and non-city owned properties,
        - Policies to preserve and protect existing public and private canopy cover, and
        - Programs to encourage canopy growth on non-city owned properties. The results of the jurisdictional review may provide options.
    - 2014 Natural Area Management Plan to include future growth and demand for natural areas.

6) Coordinate growth planning work and assessment with Climate Action Plan Goals of accelerating nature based solutions to achieve the City's climate resilience goals.

6. Asset Management Strategies

A life cycle strategy sets out the planned actions and intended methods of managing an asset throughout its life. This section describes the current strategies used by City staff to manage its urban forest assets. The purpose of life cycle strategies is to maintain the assets in an appropriate way that will deliver the required Level of Service for the least overall cost, while keeping risk within agreed boundaries.

Asset Life Cycle Planning

Life cycle planning is about understanding the life cycle behavior of the various types of assets and using this understanding to develop robust forecasts of the investment funding required for appropriate interventions (operations, maintenance or renewal activities) that, when taken, allow assets to continue delivering the required levels of service. Figure 6.1 illustrates the phases an asset experiences throughout its life.

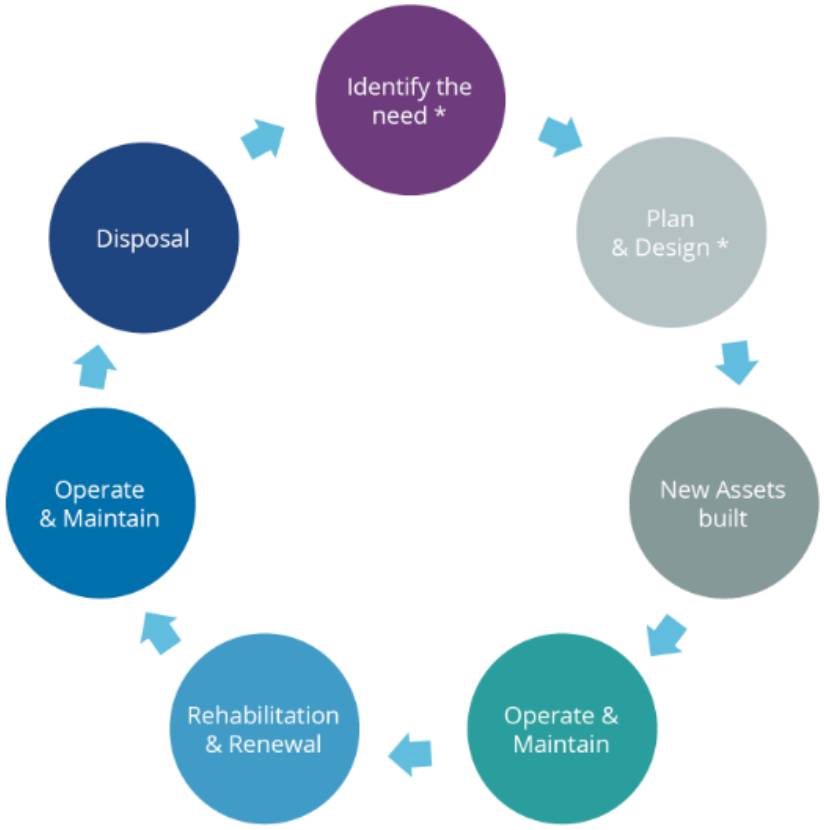


Figure 6.1 Asset Life Cycle

The asset management strategies included in this chapter focus on the phases from "new assets built" to "disposal". Once the existing life cycle behavior is understood then it may be possible to

develop alternative life cycle strategies to improve overall life cycle performance in terms of both cost and service.

Operations and Maintenance Strategies

Operations and maintenance are critical parts of the asset life cycle. They ensure that assets run effectively on a day-to-day basis to provide a chosen standard of service. The City has asset maintenance plans for specific programs that provide a more detailed approach to planning and delivery of operations and maintenance. This AMP provides a summary of operations and maintenance strategies at an asset class level.

The overarching process for the City's operations and maintenance is shown in Figure 6.2. Each step in the process is covered in more detail in the subsequent sections.

Figure 6.2 Operations & Maintenance Process

Situational Awareness

This section summarizes the key factors that can impact the delivery of maintenance activities from a technical and customer perspective.

Customer factors that influence the delivery of maintenance activities include:

- Higher levels of service are expected for high profile sites such as business improvement areas. For example, seasonal tree lighting is maintained year round in business improvement areas, and tree assessments and replacements are done yearly.
- Tree risk assessments are completed more frequently in areas close to human activity such as picnic tables, playgrounds, and along transportation corridors and pathways.
- The volume of customer requests requiring resources to be diverted from planned maintenance work to respond.

Other factors that impact the delivery of operational and maintenance activities are listed below:

- The availability of human resources due to delays in seasonal hiring and in contracts.
- The timely repair of equipment and availability of fleet can affect delivery of maintenance activities.

- The frequency of storms requiring resources to be diverted from normal operations and maintenance activities.
- Timely information from tree health assessments is needed for planning operations and maintenance activities.
- Legislation and regulations such as the Migratory Birds Convention Act and Alberta Wildlife Act, and the elm pruning regulations in the Community Standards ByLaw affect the times of year and seasons when maintenance activities can occur.
- Optimal pruning cycles can vary by species.
- Identification of an invasive species can require an urgent response to limit its spread
- Operations and maintenance activities by other service providers can impact operational and maintenance activities for the urban forest.
- Periods of drought put stresses particularly on young, recently planted trees, and require higher inspection frequencies to monitor tree health and increased watering for impacted trees where appropriate.

The functional teams responsible for operating and maintaining the urban forest assets prepare annual work plans outlining the activities planned for the year including key performance indicators for monitoring and controlling its execution considering the key factors listed above. Plans are prepared by the planting, pruning, naturalization and natural area operations teams.

Strategies

The current operations and maintenance management strategies have been identified under the following work categories:

- Inspections – there are different types of inspections that can occur throughout the life cycle of an asset. Some simply check that the asset is operating as planned and can provide early warning of conditions that may warrant treatment or further inspection. Other inspections are for measuring or observing the condition of the assets, or for measuring performance. These provide information for planning renewals and determining if performance targets will be met. Inspections may also be required by legislation, departmental policy, or completed based on an industry standard or manufacturers recommendations.
- Operations – these are routine activities necessary for operating the assets to help the asset function as intended. They generally provide public health, safety and amenity, e.g. watering new trees for the first three years until they are established, and mowing along curbs, trails and property lines. Operations activities will consume resources including manpower, energy and materials, but do not extend the overall life of the asset.
- Preventive Maintenance – these are regularly scheduled activities, completed while the asset is still in an “operational” condition. The purpose of Preventive Maintenance is to intervene preemptively before there is a functional deficiency in the asset, to reduce the risk of performance failures, deterioration, or other types of potential deficiencies that may arise as the asset ages. Getting preventive maintenance right will both reduce total overall cost and improve service performance to customers.
- Corrective Maintenance – these activities are physical repairs to an asset that is not functioning as required. The repair reinstates the asset to its normal “operating” condition,

but does not significantly extend the overall life of the asset (i.e. it is a repair not a full replacement or an upgrade or major rehabilitation). Corrective maintenance repairs are expected to increase as assets age, but can be considerably more expensive than planned preventative maintenance and often, because it is reactive, corrective maintenance activities will have a direct impact on service to customers until they restore service functionality.

Table 6.1 outlines our operations and maintenance strategies for the maintained trees, naturalization areas, and naturally wooded areas. Appendix F contains detailed tables from workshops with staff describing the lifecycle activities by asset type, when in the asset lifecycle they are completed, their priority and cost, and how they are delivered.

Asset Category & Type	Regular Inspections	Operations	Preventive Maintenance	Corrective Maintenance
Maintained trees in hardscape, boulevards, and open spaces - deciduous tree species including elms	• Condition assessments and inventory update every 2 years • Annual inspections of trees with cabling and bracing • Inspections for pest management as needed (by other department)	• Annual update of inventory to add new trees • Watering new trees for 3 yrs	• De-staking trees after 3 yrs & protecting from rodents where required • Systematic pruning every 3 to 7 yrs depending on species type	• Responding to customer requests including inspections, ad-hoc pruning, & maintaining cabling and bracing • Storm response including inspections and removing hazardous trees and branches • Treatment for specific diseases & pests as required
Maintained trees in hardscape, boulevards, and open spaces - conifer tree species	• Condition assessments and inventory update every 2 years • Annual inspections for pest management as needed (by other department)	• Annual update of inventory to add new trees • Watering new trees for 3 yrs	• De-staking trees after 3 yrs & protecting from rodents where required	• Responding to customer requests including inspections, ad-hoc pruning, & maintaining cabling and bracing • Storm response including inspections & removing hazardous trees and branches • Treatment for specific diseases & pests as required

Asset Category & Type	Regular Inspections	Operations	Preventive Maintenance	Corrective Maintenance
Naturalization areas - grass naturalization	• Inspections in years 2 to 5 as part of asset creation to decide on naturalization state (grassland or planted)	• Mowing along curbs, trails, and property lines	• Noxious weed control 2 yrs after naturalizing site	• Unscheduled inspections and actions in response to customer service requests including removing unauthorized bike trails, litter, and safety hazards
Naturalization Areas - Planted Naturalization Areas	• Site inspection after planting	• Asset information is added to inventory and inspection data is checked for quality assurance • Watering new trees for 3 yrs • Clearance pruning along formal trail edges	• Annual noxious weed control starting 2 yrs after planting	• Unscheduled inspections and actions in response to customer service requests including removing bike trails litter, and safety hazards • Storm response including inspections and removing hazardous trees and branches • Restoration of disturbed stands
Natural Areas - Naturally Wooded Stands	• Inspect stands acquired from developers to confirm if area will be accepted into the city's inventory • Annual inspections for prohibited / noxious weeds & unauthorized activities • Insect monitoring (done by another unit)	• Clearance pruning along maintained trail edges • Hazardous tree removal • Noxious and prohibited noxious weed control	• Viewpoint vista pruning every 5 yrs including clearing and disposal of vegetation • Fuel load reduction by applying recommended treatment and removing and disposing of material	• Unscheduled inspections and actions in response to customer service requests including removing bike trails, litter, and safety hazards • Storm response including inspections and removing hazardous trees and branches • Restoration of disturbed stands

Asset Category & Type	Regular Inspections	Operations	Preventive Maintenance	Corrective Maintenance
Natural Areas - Naturally Wooded Stands (continued)	• Tree Risk Assessment along maintained trail network annually for stationary targets like picnic tables & playgrounds; every 10 years for other areas • Fire risk mitigation - Inspections every 1 to 10 yrs to identify and assess fuel load levels • Viewpoint inspections every 5 years for vista pruning • Ecological health monitoring		• Tree Risk Mitigation along maintained trail network annually for stationary targets like picnic tables & playgrounds, every 10 years for other areas	

Table 6.1 Operations and maintenance strategies

Critical Assets

Understanding asset criticality is essential, as assets support the core services provided by the City, but not all assets have the same impact on service provision, should they fail. Asset criticality reflects the relative importance of an asset to service delivery. The consequence arising from the sudden and total loss of an asset (or asset component) is directly linked to criticality, and the two are often proxied within risk analysis and other management systems.

For the City, critical assets are assets identified where their safety, financial, economic development, environmental, or other service level consequences of failure are sufficiently severe to justify proactive life cycle strategies. If critical assets fail, they cause significant impacts to the operations of the City. By identifying critical assets and critical failure modes, we can target and refine our inspections, maintenance plans and capital expenditure plans at the appropriate time.

The urban forest assets overall have been assessed at a medium level of importance in the City's Risks Based Infrastructure Management System (RIMS) framework. Identified critical assets within the urban forest asset class have been included in Table 6.2.

Asset Category	Critical Asset	Why asset is critical	Specific Operations & Maintenance strategies
Maintained Trees	All trees	Damaged trees or branches can injure people or property, or prevent access to other critical infrastructure such as transportation and other utility corridors	• Inspections for hazards and follow-up treatment • Storm response plans • Maintaining buffers along trails and property lines. • Ongoing planned maintenance, preventative pruning to remove deadwood, diseased or weak branches
Planted Naturalized Areas, Naturally Wooded Areas	Trees along pathways, at borders with neighbouring properties, and within utility corridors		
Maintained trees	Hardscape	Highest cost to replace and located in downtown area and in Business Improvement Areas with highest visibility and population density	• Tree assessments and replacements are done yearly • Regular pruning cycles

Table 6.2 Critical assets operations and maintenance strategies

Prioritization of Maintenance

This section of the plan describes how the City prioritizes maintenance activities on its urban forest assets. Understanding priorities is important for making decisions on where to allocate scarce resources including staff and budgets. Table 6.3 lists the operations and maintenance activities by priority. The tree planting, tree pruning, and natural area operations units prepare annual work plans based on the information in Table 6.3 and use key performance indicators to monitor and control how they are delivered.

There is no work plan for the naturalized areas because City staff do not currently visit naturalized areas on a rotating schedule. Visits are promoted mostly through 311 inquiries, interest in planting trees, monitoring new conversion sites or other community interests.

Asset Category & Type	Urgent Work	Essential Work	Less Essential or Desirable Work
All assets	• Storm response including inspections & removing hazardous trees and branches. • Hazardous tree removal • All notifications and calls are responded to within 24 hrs depending on the size of the storm and volume of calls.	• Inspections and actions in response to customer requests concerning safety hazards and sightline concerns. Customer requests are responded to within 5 days.	• Inspections and actions in response to customer requests concerning non-safety issues. Customer requests are responded to within 5 days. Work may not necessarily be scheduled or completed within 5 days.
Maintained Trees	• Tree removal & stumping within 2 yrs of being marked for removal • Tree Replacement	• Annual update of inventory to add new trees • Watering new trees for 3 yrs • De-staking trees after 3 yrs • Removing rodent protection • Systematic pruning every 3 to 7 yrs depending on species type • including ad-hoc pruning, and maintaining cabling and bracing • Annual inspections of trees with cabling and bracing • Inspections as needed for pest management (by other department) • Treatment for specific diseases & pests as required (by other department) • Condition assessments and inventory update every 2 years	• None identified

Asset Category & Type	Urgent Work	Essential Work	Less Essential or Desirable Work
Naturalization Areas	• None in addition to storm response and hazardous tree removal	• Noxious weed control 2 yrs after naturalizing site • Inspections in years 2 to 5 as part of asset creation to decide on naturalization state (grassland or planted)	• Site inspection after planting • Watering new trees for 3 yrs • Asset information is added to inventory and inspection data is checked for quality assurance • Noxious weed control 2 yrs after planting • Mowing along curbs, trails, and property lines • Clearance pruning along formal trail edges • Restoration of disturbed areas
Naturally Wooded Areas	• None in addition to storm response and hazardous tree removal	• Annual inspections for prohibited / noxious weeds & unauthorized activities • Mechanical control of prohibited/noxious weeds • Insect monitoring (by other department) • Tree Risk Assessments and Mitigation along trail network • Clearance pruning along formal trail edges • Fire risk mitigation - (e.g., fuel load reduction by applying recommended treatment and removing and disposing of material)	• Inspect stands acquired from developers to confirm if area will be accepted into the city's inventory • Viewpoint maintenance every 5 yrs including vista clearing and disposal of vegetation • Restoration of disturbed stands • Ecological Health Monitoring

Table 6.3 Priority of operations and maintenance activities

Delivery of Operations & Maintenance Activities

This section describes how physical work gets done including all inspections, operations and maintenance works. Separate descriptions are provided for maintained trees, naturalization areas, and natural areas.

Maintained Trees

Forestry Operations is responsible for delivering the operations and maintenance activities for open space and boulevard trees.. It is one of six units within Open Space Operations. Open Space Operations (OSO) is part of Infrastructure Operations under City Operations at the City of Edmonton. The primary purpose of OSO is to maintain the existing Open Space assets for the City.

Forestry Operations is made up of four functional teams; Pruning Operations, Planting Operations (which includes Tree Inventory and Assessment), Project Forestry and Community Forestry . These teams are supported by the Pest Management Team for inspections and treatments for pests (plants, disease, insects). Forestry Operations also currently has a number of contracts in place or in process to procure services and materials to support operations and maintenance of the maintained trees. Table 6.4 lists the status of current contracts as of April 2020.

Contract Title	Type of Contract	Contract Dates	Contract Status
Hydro Vac 934498	service	3yr term commenced September 15, 2020. Up to 7 opt yrs available	Contract Executed
44 inch tree spade D929175	service	Contract was executed on Feb.1, 2021 and expires January 31, 2022	Scope was incorporated into the new Transplanting, Planting, Tree Spading and Related Services contract - 934770. Contract was executed on Feb.1, 2021 and expires January 31, 2022 - currently being re-tendered in 2021 due to lack of funds
Caliper Trees 933797	Materials Competitive	Expiry April 10, 2022 w/ 5 Opt yrs remaining	Contract Executed
Bare Root Tree Liners 934299	Materials Competitive	Expiry October 31, 2021 w/ 3 Opt yrs remaining	Contract Executed
Com Page Communications	service	Expired	Not currently on the procurement list
Single Axle and Tandem Axle Water Trucks 939018	service	Currently in last option year	New 2021 contract is currently in execution stage
Purchase of shrubs	Materials	Not applicable	No existing contract
Transplanting, Planting, Tree Spading and Related Services 934770	service	Contract was executed on Feb.1, 2021 and expires January 31, 2022	Contract was executed on Feb.1, 2021 and expires January 31, 2022 - currently being re-tendered in 2021 due to lack of funds
Tree stakes (T-Post) Supply and Delivery	Materials	Contract expired in 2019.	On procurement list for 2021 - planned 2022 contract start date is Jan 15, 2022
Decorative Tree Lights 934651	Material Supply	Expiry August 15, 2021 w/ 4 option years remaining	Contract Executed

Contract Title	Type of Contract	Contract Dates	Contract Status
Tree Pruning and Maintenance Services 934512	Service competitive	Expiry October 14, 2023 w/ 5 option years remaining	Contract Executed
Dump Sites, Northlands 930965	service	Expiry December 31, 2021 w/ 7 option years remaining	Contract Executed

Table 6.4 Outsourced Operations & Maintenance Activities for Maintained Trees

As of May 2021, the City plans to issue a new contract for Nesting and Migratory Bird Survey Services currently using low value purchase orders (LPOS).

Naturalization Areas

The Operations Program Delivery and Partnerships, Planning and Monitoring Team within the Open Space Operations Group is responsible for operating and maintaining the Naturalization Areas. They manage delivery of the following activities by others:

- Weeds are monitored and controlled through the Integrated Pest Management team.
- Contractor is used for watering
- Volunteers and contract tree planters are used for both initial planting of areas (Stage 2) and understory and infill planting to fill in gaps and create diversity.

Naturally Wooded Areas

Natural Area Operations is one of six functional teams within the Open Space Operations Group of Infrastructure Operations. The Natural Area Operations Unit is responsible for:

- Ensuring the existing trails within the River Valley and other Natural Areas are safe and accessible for all users.
- Working with internal and external partners to remove debris left from people experiencing homelessness that set up temporary abodes on parkland and have since vacated.
- Managing the hazards within the Natural Areas (including trees) that can impact parks users or residents. Having a dedicated ISA (International Society of Arboriculture) certified Forester looking at and mitigating any hazards, while working to preserve overall forest health.
- Collaborating on a Fire Risk model and applying the model to the Natural areas across the City of Edmonton, while working to reduce the risk of fire in high risk areas.
- Providing dedicated focus on the removal of invasive species and provincially regulated weeds from Edmonton's Natural Areas including the River Valley.

- Working with internal stakeholders to preserve and/or improve the ecological value of the network of preserved Natural areas across Edmonton

Natural Area Operations objective is to have staff or internal resources wherever possible trained to complete most operations and maintenance activities. A task and work description is available for assessing and managing tree risks (Natural Areas Forest Management) along with a more specific Standard Operating Procedure for tree risk assessments.

In cases where specialized training or safety requirements are prohibitive, procurement will be sought for such services. All procurement is aligned with the Parks and Roads Services Procurement processes. Table 6.5 lists the current and planned contracts for services.

Contract Title / Description	Selection Process	Contract Dates	Comments on Procurement Strategy
Purchase of LiDAR dataset	Competitive	1 time purchase on July 1, 2019	May be managed by Business Integration (TBD) - multiple business areas interested in data, building stakeholder group. Want to own dataset. Exploring opportunity to procure annually or biannually (may need to re-tender each type though due to technology changes etc).
Analysis of natural area fire risk and city-wide canopy cover (& sports fields condition)	MOU or non-competitive procurement with U of A	1 time purchase on March 1, 2019	PARS has an existing agreement with U of A; this would build on that agreement.
Natural Area Tree Services contract	Competitive	Currently evaluating bids	This contract will be used for risk mitigation work in place of the Forestry Tree Pruning contract.

Table 6.5 Outsourced Operations & Maintenance Activities for Natural Areas

Standards & Specifications

Work to implement existing life cycle strategies are carried out in accordance with the Standards and Specifications in Table 6.6.

Asset Category	Assets	Regulatory Requirement or Standard
Maintained Trees, Naturalization Areas, Naturally Wooded Areas	All trees	• *Migratory Birds Convention Act* and *Alberta Wildlife Act* - affects pruning and removal of trees. • Corporate Tree Management Policy (C456C) provides details on how and why trees are maintained. • Integrated Pest Management Policy (C501A) - provides operational guidance on how to effectively control weeds. • *Alberta Dangerous Goods Transportation and Handling Regulations*, and *Canada Transportation of Dangerous Goods Regulations* - limits the volume of hazardous material that can be transported and by whom. • Truck route map & slow moving vehicle, structure clearances, high load corridors, bridge maximum weights - Trucks over 8001kg registered weight must follow truck routes.

Asset Category	Assets	Regulatory Requirement or Standard
Maintained Trees, Naturalization Areas, Naturally Wooded Areas	All trees	• Alberta One Call & City of Edmonton OHS Ground Disturbance Standard - process for all ground disturbances, i.e. planting, stump grinding. • Construction Standards - Landscape and design volume 5 (https://www.edmonton.ca/documents/Design_and_Construction_Landscaping.pdf). • ANSI standards.
Maintained Trees	Boulevard and Open Space Elm trees	• *Community Standards Bylaw* - affects the time of year/ season that Elms can be pruned. • Alberta Agriculture Pests Act- municipality has responsibility to prevent and control DED under the APA (pruning to remove deadwood, removal of dead trees and proper disposal of elm wood.
Naturally Wooded and Naturalization Areas	Planted Naturalization Areas, And Naturally Wooded Areas	• *Alberta Wildlife Act.* • North Saskatchewan River Valley Area Redevelopment Plan (7188). • Operational bylaws (parkland and community standards). • Servicing Standards Manual, Ch 8 - details the landscape. design specifications for road and utility rights-of-way including a section on naturalization. • Bylaw 6046, Weed Control Bylaw for regulating the control of noxious weeds.

Table 6.6 Standards and Specifications

Renewal & Rehabilitation Strategies

This section includes details of renewal and rehabilitation strategies. These are activities that fully replace an asset with an equivalent new asset, or apply a treatment that reinstates the asset (or a component of the asset) to new or near new condition.

Intervention Strategies

Intervention strategies include:

- Early Life Interventions – these are treatment options that may be considered when an asset is in the first quarter of its lifespan. Typically, they are rare for most asset types, but some assets do require replacement of component parts at frequent intervals throughout the overall lifespan of the asset.
- Mid-Life Rehabilitation – these are treatment options that may be considered when an asset is in the second or third quarter of its lifespan. Most common forms of mid-life rehabilitation are the replacement or refurbishment of component parts that have a shorter lifespan than the overall asset.
- Later Life Rehabilitation - these are treatment options considered to be still viable even when an asset is in the fourth quarter of its lifespan. They can include replacement or refurbishment of component parts the same as might be considered for Mid-Life Rehabilitation, except that for Later Life Rehabilitation there is a condition that the treatment

option should only be undertaken if it is cost-effective given the potentially short remaining life of the overall asset.

- End of Life Renewal - these are treatment options considered when an asset is approaching or at the end of its lifespan. Typical options include replacement (renewal) of the asset with an equivalent new asset, major rehabilitation that returns the asset to new or near new status.

Table 6.7 summarizes the renewal and rehabilitation interventions for each asset category. No early, mid-life, or later life rehabilitation options were identified for the urban forest assets in this initial AMP

Asset Category	Asset	Rehabilitation Options	End of Life Renewal Options
Maintained Trees	Boulevard and Open Space Trees	• Stakes and wire removal on trees planted by the City. • Watering and Fertilization • Pest Management	• Tree removal and stumping within 12 months of being identified for removal • The species that is replanted may not be the same as the type removed to meet biodiversity targets and operational needs. • Tree replacement is to take place within 12 months of the tree removal and stump grinding
Naturalization Areas	Grass naturalization sites	• Renewal of areas by planting smaller native trees, shrubs and wildflowers to create a healthy ecosystem providing added benefits for beauty, biodiversity, and to provide resources for wildlife to flourish and re-establish.* • Restoring damaged areas*	• Grass naturalization sites are assessed for planting 1 to 2 years after mowing has stopped. • Other areas are not renewed because there is no end of life for these assets. Examples include bioswale, riparian, and grassed areas.
Naturalization Areas and Naturally Wooded Areas	Planted naturalization and Naturally Wooded Areas		• Areas are not renewed because there is no end of life for these assets.

* These options were not included in cost forecasts for this AMP because insufficient data were available to determine the frequency of their occurrence and unit costs

Table 6.7 Renewal, and Rehabilitation Interventions and Costs

Disposal of Assets Strategies

Disposal includes any activity associated with the disposal of a decommissioned asset including sale, demolition or relocation. No urban forest assets are expected to be disposed of or decommissioned. However, city-owned trees, and natural and naturalization areas, are lost due to other initiatives such as capital projects and development activities. The City has adopted a Corporate Tree Management Policy (C456C) to "*ensure growth, sustainability, acquisition, tree maintenance, protection and preservation of City of Edmonton urban forest*". The policy provides for:

- The recovery of equitable compensation for the loss and/or damages to City Trees in accordance with the *City of Edmonton Natural Stand Valuation Guidelines* and/or the *City of Edmonton Guidelines for the Evaluation of Trees.*
- A tree reserve account that enables the recovery and distribution of funds received from City Tree losses and/or damages, in accordance with the *City of Edmonton Corporate Management and Tree Reserve Procedure*, to ensure sustainability, protection and preservation of the City's Urban Forest.

The tree reserve account is a key source of funding for new trees that is described in more detail in the Financial Plan in Section 8.

The first step in creating a naturalization area is to stop mowing a landscaped area, which can be considered the "disposal" of the landscaped area. The future annual savings from not having to mow these areas have been considered in the forecasted costs as described in the following section.

Forecasting Future Asset Lifecycle Costs

A model was developed using the Remsoft software to forecast the costs to operate, maintain, and renew the existing urban forest assets over a 50 year planning horizon. There are five (5) major sections that define the dynamics of a Remsoft Model:

1. Landscape – This is the urban forest inventory.
2. Actions and Transitions – These are the interventions, or strategies, and their consequences
3. Yields – These are the time based relationships such as growth and deterioration
4. Lifespan – this defines the limits of the assets' useful life.
5. Outputs – These define what the model can predict and how it is represented.

The inventory was described in Section 3 on the State of the Infrastructure. Appendix D contains additional information on the other sections of the model.

Models are always a simplification of reality, with the goal being to reduce the amount of uncertainty that comes with making forecasts and plans. Not every detail is known or can be predicted. The following assumptions were made to aggregate some details into broad relationships that allow the model to behave correctly and provide useful forecasts:

- The lifespans of maintained trees other than hardscape trees were assumed to be the most likely for a typical street tree or roadside shelterbelt or other mass planting. A table is provided in Appendix D listing these "most likely" lifespans for each of the 149 species in the city's current inventory.

- All the trees in the downtown area were assumed to be hardscape trees with a pessimistic lifespan, with the exception of Elm trees which were assumed to have a most likely lifespan. A pessimistic lifespan reflects challenging sites with low resources. Elm perform better in hardscape than other species

- Maintained trees may not be replaced with the same species at the end of their useful lives. The species of replacement trees were distributed among the current top 10 percent (excluding Ash).

- All vacant spots are available for planting.

- All Maintained Trees have an average canopy of 40 m^2.

- 10% of Maintained Tree plantings fail and need to be replanted.
- Naturally Wooded Areas are maintained but not changed.
- The expenditures associated with naturally wooded areas are accounted for as an annual budget and pro-rated by area, if natural areas are added to the City's portfolio. Acquisition costs of the land itself is not included.
- Four states for Naturalized Areas were modeled:
    - Unmowed – A new naturalized area
    - Grass – After 3 years the unmowed areas are available to be planted or left as grass
    - Planted Trees – planted with trees and shrubs
    - Treated as natural – after 20 years the areas will be managed similar to naturally wooded areas.

Figure 6.3 shows the forecasted total costs per year to operate, maintain, dispose and renew the existing urban forest assets over a 50 year planning horizon. The variance in the costs is due to disposing and replacing the maintained trees as they reach the end of their lives. The low costs at the beginning of the 50 year period reflects the relatively young age of the portfolio of Maintained Trees. The costs peak when these trees reach the end of their lives in 43 years on average.

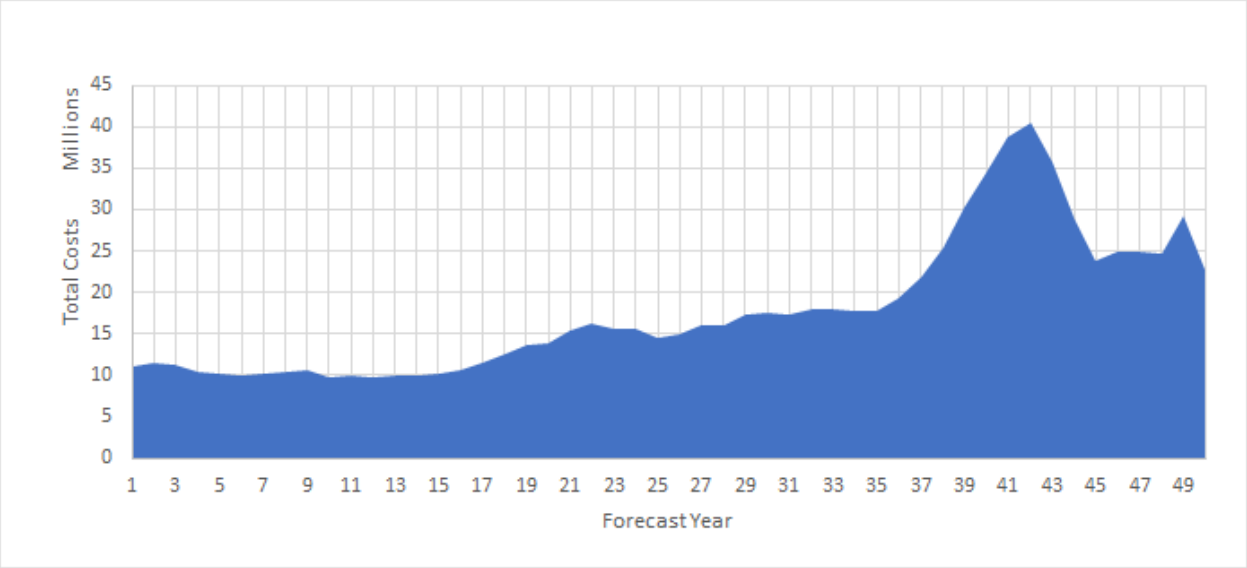


Figure 6.3 Forecasted Total Costs to Operate, Maintain, Dispose of and Replace the Existing Urban Forest Assets ($2020)

New Assets Strategies

This section describes the City's strategies for creating new assets. As discussed in Section 5, the quantities of maintained trees and naturalization areas are forecasted to increase over the 50 year planning horizon due to development activity. Additional assets will need to be created by the City as well to reach the key performance measure targets of 20% canopy coverage and conserving 8.2% of the city as natural areas by 2070. Table 6.8 summarizes the assumed quantities of new assets by category for the purposes of this plan.

Asset Category	Current Quantity	New Assets to Meet Performance Measure Targets
Maintained Trees	374,671 trees	421,500 trees
Naturalization Areas - planted naturalization areas	300 ha	2,200 ha
Naturally Wooded Areas	1,824	3,200 ha

Table 6.8 New assets needed to meet performance targets

The following sections describe the current strategies for identifying new maintained trees, naturalization areas, and natural areas and incorporating them into the City's inventory.

Maintained Trees

The City acquires new boulevard and open space trees from the following activities:

- Accepting trees created by developers;
- Accepting new trees created as part of capital projects completed by other City departments; and
- Planting new trees to infill currently developed areas.

Developers and capital project owners are required to meet the City's landscaping standards when creating new open spaces, transportation corridors, and other utility corridors. The process for accepting these trees is to:

- A Final Acceptance Certificate (FAC) is completed byCity UPE or PARS through an inspection process.. If the site meets the FAC inspection criteria and UPE or PARS receives the required documentation, the UPE or PARS representative will approve the FAC on behalf of CIty Operations. City Operations will be notified that a site has been approved and the Enterprise Geospatial Information team will add the new tree assets into the tree inventory.
- For maintained trees, Forestry Operations will verify the trees entered into the inventory match the FAC details and any newly planted trees will be added to the watering program until they are established and continue maintaining them over their lifecycle including pruning and renewing.

The City's process for planting new trees to infill currently developed areas is described below:

- Urban Planning and Economy has hired an external consultant to find City owned sites that are deficient in trees, based on the current Landscape Standards. The planting of trees in infill areas is currently coordinated through the City's Canopy Expansion project. This project currently has a two year scope (2021-2022) as follows:
    - Urban Planning and Economy engages Forestry Operations to review design drawings
    - 3,000 plantings are assigned to Forestry Operations to plant (the funding for this work will come from the Tree Reserve); 1,500 trees are to be planted in 2021 and

1,500 in 2022. After the trees are planted and inspected, the trees will be put into the tree inventory and maintained by Forestry Operations.

    - 1,500 plantings are assigned to Urban Planning and Economy to plant (these trees will go through a formal FAC process similar to Capital projects and are funded through profiles setup. All 1,500 are to be planted in 2021.

- The process for planting new trees to infill currently developed areas is not defined beyond 2022.

Naturalization Areas

The City acquires new naturalization areas from:

- Accepting areas created by developers following the same process described above for maintained trees; and
- Reverting city owned sections of open space to a more natural state following a staged process.

A Naturalization Master Plan was developed in 1994 including criteria for selecting and prioritizing potential sites for naturalization. The four categories of criteria are biophysical suitability, aesthetics, land use, and accessibility for future maintenance activities. Appendix 1 of the Master Plan provides additional details on how the criteria are rated. Table 6.9 summarizes the process used to naturalize sites after they have been identified following the criteria. A process map for naturalizing areas is provided in Appendix G.

Budget Category	Treatment Description	Asset Age/ Condition	Delivery Type
Capital	Site identification, public engagement, and planning	Before creating area	City - Naturalization Program
Operations	Broadcast spraying for noxious weeds prior to stop mowing, continued mowing expenses.	0 yrs	City
Operations	Stop mowing	1 yrs	City
Capital	Inspect to decide on naturalization state (i.e. grassland or planted)	2 yrs	City
Capital	If the decision is to plant, then site assessment of soil condition, development of planting plan, planting prep, staff coordination, circulation, one calls, etc.	In year 2 - 5	City
Capital	Stakeholder engagement on planting decision	In year 2 - 5	City
Capital (tree reserve fund)	Trees planted by City - watered for 3 years (includes labour, water and plant material costs) Some areas may also be planted with forbs or wildflowers	In year 3 - 5	City & volunteers for planting Contractor for watering
Capital	Site Inspection	In year 3 - 5	City

Budget Category	Treatment Description	Asset Age/ Condition	Delivery Type
Operations	Asset information is added to inventory and inspection data is checked for quality assurance	1+ after planting	City
Operations	Smaller natives trees, shrubs and wildflowers are planted as required to enhance habitats and promote a healthy ecosystem. At the conclusion of this stage, maintenance activities cease at the site, and the area is considered to have transitioned into a modified natural area.	As required	City

Table 6.9 Process for Creating New Naturalization Sites

Natural Areas

The city acquires natural areas through its physical planning and development process. Areas are accepted from developers after completing an inspection similar to other urban assets. The City has also purchased natural areas though the Natural Area Reserve Fund (NARF) which was set up by Council for the purpose of acquiring key natural areas located on the tableland that are not able to be acquired through the dedication of Municipal or Environmental Reserve. Currently this funding source is allocated and additional funds would be required to continue this program. Some naturalization areas may also be moved to the natural areas inventory depending on certain factors.

City Policy C531 on Natural Areas Systems (June 2007) provides further details on the process and information requirements regarding the identification and protection of natural areas for development projects.

Forecasting the Lifecycle Costs of New Assets

The lifecycle costs of new assets were forecasted using the Remsoft model for the following three growth scenarios:

- *Planned Growth* based on current trends (see Table 5.4);
- *Targeted growth to achieve 20% canopy coverage in 50 years* assuming *70% increase in canopy on non-city owned property* (See Table 5.5 and Table 6.8);
- *Accelerated growth to achieve canopy coverage in 30 years* assuming *no increase in canopy on non-city owned property.* This scenario requires an additional 4500 ha of planted naturalization areas in addition to the quantities in Table 6.8 due to the assumption of no increase in canopy on non-city owned properties.

The estimated annual costs and performance outcomes for each scenario are compared to the results for the existing inventory of assets in Table 6.10.

Costing Scenario	Average Annual Cost over 50 yrs ($2020)	% Canopy Coverage	Number of new trees planted by 2050	Quantity of Natural Areas as % City area
1. Current inventory assuming trees are replaced as required	$17.8 million	13%	0	3%
2. Planned growth no additional risk management	$25.8 million	15% by 2070	2.4 million	8.2% by 2070
3. Targeted growth to meet KPI targets in 50 years with additional canopy provided on non-city owned properties	$30.6 million	20% by 2070	10.6 million	8.2% by 2070
4. Accelerated growth to meet KPI targets in 30 years with no additional canopy provided on non-city owned properties	$48.7 million	20% by 2050	59 million	8.2% by 2030

Table 6.10 Forecasted Average Annual Lifecycle Costs of Current Assets and Growth Scenarios

Reviewing the table, the costs of adding new assets to the current inventory are:

- An additional $7.9 million per year if growth continues at current rates;
- An additional $12.8 million per year to achieve 20% canopy coverage over 50 years assuming canopy also increases by 70% on non-city owned properties; and
- An additional $30.9 million per year to achieve 20% canopy coverage over 30 years assuming no increase in canopy on non-city owned properties.

The costs do not include the costs to purchase new areas for conservation as natural areas or for naturalization.

Recommendations for Improving Asset Strategies in Future Asset Management Plans

As noted at the beginning of this chapter, life cycle planning is about understanding the life cycle behavior of the various types of assets and using this understanding to develop robust forecasts of the investment funding required for assets to continue delivering the required levels of service. Much of the information needed to do this was available from the City's financial system and operational plans. Additional recommendations to improve lifecycle planning in future asset management plans are provided below:

1) Complete and keep team level work plans current, and develop a work plan for naturalization areas. The sections on the annual program, resource allocation, and procurement plan have important information for longer term, tactical level planning.

2) Improve the estimates of unit costs for naturalization maintenance activities, infill planting, and restoration of disturbed lands by tracking costs and quantities of work delivered.

3) Update the asset lifecycle strategies to include planning and design activities and track these costs separately from the asset operations, maintenance, and renewal activities, e.g. updating specific Natural Area Management Plans.

4) Develop standards for ecological health and assess areas to identify the need for restoring and renewing them by planting smaller native trees, shrubs and wildflowers to create a healthy ecosystem. The renewed or restored areas will provide added ecosystem goods and services. Track the timing and costs of these activities to improve forecasts in future AMPs.

5) Plan for and improve the Emergency Response Plan. Ensure that the team is ready for emergency work and manage the shift between emergency work and planned work.

6) Consider options to the existing strategies to identify the least cost approach for providing the levels of service described in Section 4 including:

    a) Pruning cycles for trees by neighbourhood, species and possibly by age class structure.

    b) Lower planting densities for naturalization areas; and

    c) Service level thresholds for interventions.

7. Risk Based Decision Making

The City is exposed to a variety of internal and external factors that add uncertainty to the successful delivery of service. These uncertainties are termed "risks" and, unchecked, have the potential to adversely affect an organization's ability to deliver services in an effective and efficient manner. This chapter describes our processes for managing risk, identifies high priority risks and our approach for mitigating them, and how we use risk to prioritize our decision-making.

Risk Management Processes

Risk is often defined by the following basic equation: Risk = Likelihood × Consequence

This section outlines how risk is assessed, managed, monitored, and reported. It identifies mitigation actions and their costs, and describes how risk results are used in decision-making. It is important to understand these to achieve our goal of building an effective, transparent, data-driven asset management system that connects asset investment with progress towards strategic goals and service level outcomes. The next sections of the plan describe:

- The city's current Risk-based Infrastructure Management System (RIMS);
- The future process for evaluating risk as the City's asset management processes improve;
- High priority risks identified to date;
- Current and future actions to mitigate risks; and
- How risk is and will be considered in prioritizing asset investment decisions.

Current Risk-based Infrastructure Management System (RIMS)

The Risk-based Infrastructure Management System (RIMS) is a tool that assists the city in ranking rehabilitation needs and allocating renewal funds across the various infrastructure assets to ensure long-term value. Five categories of consequences are assessed in the City's methodology:

- Safety and health
- Growth and economic development
- Environment
- Financial capability to react to infrastructure failure
- Service to people

Table 7.1 presents the City's current assessment within RIMS of the consequences of urban forest assets failing. The detailed assessment scales are included in Appendix H. The higher the consequence of failure rating, the more critical the asset.

Consequence of Asset Failure	Open Space Trees	Boulevard Trees (not hardscape)	Trees in Hardscape	Naturally Wooded Areas	Naturalization Areas
Safety and Public Health	Moderate	Moderate	Moderate	Moderate	Negligible
Growth	Marginal	Marginal	Marginal	Marginal	Marginal
Environment	Moderate	Moderate	Marginal	Severe	Substantial
Financial	Negligible	Negligible	Negligible	Negligible	Negligible
Service to People	Negligible	Negligible	Negligible	Moderate	Marginal

Table 7.1 2021 Assessment of consequences of urban forest assets failing

Reviewing the table:

- Naturally wooded areas have a higher consequence of failure and are therefore assessed as being more critical than maintained trees.
- Failure of the urban forest assets would have the greatest impact on the environment followed by public health and safety.

The likelihood of failure in RIMS is based on the asset's age or condition. The closer an asset is to the end of its useful life, the higher the likelihood of failure. Risk is determined as the product of consequence and likelihood of failure. The risk rating is then used to prioritize asset renewals and replacements.

Future Risk Management Process

As the City advances in its asset management practices, it plans to implement the following five-step process to manage risks:

1) **Risk Identification** and recording of potential events that could affect the City's service planning and delivery.
2) **Risk Assessment** to estimate the likelihood of the event occurring and its consequences on the city. The risk of each event is assessed as the product of its likelihood of occurrence and consequence of its impacts. The events are prioritized based on their risk ratings.
3) **Risk Response** involves planning and implementing actions and plans to mitigate or avoid unacceptable risks. It also identifies a response plan if the risk can't be avoided.
4) **Residual Risk Assessment** involves assessing the risk after a response has been implemented. It recognizes that not all risks can be avoided.
5) **Risk Control** involves implementing risk response plans, keeping track of identified risks, monitoring residual risks and identifying, analyzing, and planning risk responses for newly arising risks.

The objective of risk management is to assess which risks pose unacceptable threats to the organization and advance plans to address them. A risk-based approach to assessment and mitigation enables the City to make more informed, defensible decisions regarding the allocation of

resources and planning future works, thereby enhancing the ability to deliver efficient and effective service.

The City uses RIMS for making decisions on asset replacements and renewals, and has a framework for assessing risks to specific capital projects. It does not, however, have a framework for assessing risks to service delivery and other negative impacts related to its infrastructure assets. As a result, the identification of high priority risks to delivering urban forest services in step 2 was based on the expert opinion of the city's urban forest management team. The results of the assessment are described in the following section.

Risk Identification and Assessment

Identifying and assessing events that have the potential to adversely affect the city's ability to deliver urban forest services in an effective and efficient manner are the first steps in managing risks. The city's urban forest management team identified events and assessed their risk to urban forest services in several workshops over the past year including:

- A workshop on 22 October 2020 to identify climate change risks following the Public Infrastructure Engineering Vulnerability Committee (PIEVC) protocol. Summary sheets of the results for the urban forest assets within the scope of this plan are included as Appendix I. Key findings from the PIEVC assessment include:
    - Climate change risks are expected to increase over the study period as the frequencies or likelihoods of climate change events are forecasted to increase with time;
    - Drought and invasive plants, insects and disease from changing temperatures were the two climate change impacts assessed as being high risks to all types of urban forest assets except for grassed naturalized sites.
    - Hardscape trees were assessed as being most at risk to climate change followed by naturally wooded areas, other types of maintained trees, planted naturalized sites, and grassed naturalized sites.
- Workshops in December 2020 to identify more detailed impacts or consequences of climate change events, as well as other types of risks and their impacts. Summary tables of the results from the workshop are presented in Appendix J-1 and J-2 for each asset group.

Table 7.2 lists the risks to maintained trees identified and assessed as high in these workshops. All of the risks listed in the table will increase tree mortality, damage and stress leading to:

- A reduction in tree canopy area and its related services;
- An increase in the frequency of damaged limbs and fallen trees creating safety hazards to urban forest users and surrounding properties;
- An increase in operating costs to assess and respond to damages.

Additional impacts are noted in the risk descriptions.

Risk ID	Maintained Tree Type Providing Service	Risk Category	Risk Description	Risk Score
1	All maintained trees	Climate change - insects and disease	Insects and diseases arrive and populations are established and spread.	High in 2080 (PIEVC protocol)
2	All maintained trees	Climate change - freezing rain / unseasonal snow	Ice and snow build up on tree branches. The extra weight on limbs results in broken branches, cracked, compromised limbs, fallen trees, hazardous branches	High in 2080 (PIEVC protocol)
3	All maintained trees	Climate change - Drought	Drought stresses trees reducing their lifespans and increasing mortality rates. increased susceptibility to pests, disease, and the establishment of invasive plants.	High in 2080 (PIEVC protocol)
4	All maintained trees	Climate change - lightning	Lightning strikes on individual trees can cause broken branches, mortality, damaged roots, and damage to surrounding properties.	High in 2080 (PIEVC protocol)
5	All maintained trees	Climate change - heavy winds or tornados	Tree damage and loss due to heavy winds or tornados can create safety hazards due to falling limbs or damaged power lines, and increase the risk of insects and disease. Severe events such as a tornado may also increase the likelihood of people removing large trees on non-city properties.	High in 2080 (PIEVC protocol)
6	Hardscape trees	Climate change - warmer temperatures	Hotter and drier summers and shorter winters will cause heat stress and scorch on trees increasing mortality and frequency of disease and insect infestations.	High in 2080 (PIEVC protocol)
7	Open space trees and boulevard trees (not hardscape)	Climate change - flooding	Soils become saturated for long periods of time leading to more tree failures under high winds and increased stress in trees causing blights and other potential diseases.	High in 2080 (PIEVC protocol)
8	Hardscape trees	Climate change - higher annual total precipitation	Higher annual total precipitation can create drainage issues increasing disease pressures on susceptible trees. It could also result in fewer days available to plant trees in the summer months.	High in 2080 (PIEVC protocol)
9	All maintained trees	Human - construction and maintenance activities	Activities by other city departments or external contractors / individuals mechanically damage the trees or compact the soils leading to increased stress and susceptibility to insects and disease, and tree loss or shortened lifespans.	High

Risk ID	Maintained Tree Type Providing Service	Risk Category	Risk Description	Risk Score
10	All maintained trees	Economic - Inadequate funding	Inadequate funding for operations, maintenance and renewals leading to customer complaints, reputational damage, and lower levels of service including reduced aesthetics and canopy coverage from delays in tree replacements, and increased safety risks from delays in identifying and reacting to hazards such as broken limbs, human use, and invasive species.	High

Table 7.2 High priority risks to maintained trees

Tables 7.3 lists and describes the risks to naturalization areas and naturally wooded areas identified and assessed as high. As with the maintained trees, any of the risks listed in the table that will increase tree mortality, damage, and stress will result in:

- A reduction in tree canopy area and its related services;
- An increase in the frequency of damaged limbs and fallen trees creating safety hazards to urban forest users and surrounding properties;
- An increase in operating costs to assess and respond to damages.

Risk ID	Asset Providing Service	Risk Category	Risk Description	Risk Score
11	All naturalized areas and naturally wooded areas	Economic- Inadequate funding	Inadequate funding for operations, maintenance and renewals leading to customer complaints, reputational damage, and lower levels of service including reduced aesthetics and canopy coverage from delays in tree planting, and increased safety risks from delays in identifying and reacting to hazards such as broken limbs, human use, and invasive species.	High
12	Planted naturalization areas and naturally wooded areas	Climate change - insects, invasive plants and disease	Insects, invasive plants and diseases arrive and populations are established and spread leading to a loss of native habitat and species biodiversity, damage or loss to trees and a reduced canopy cover, and potential safety hazards to people.	High in 2080 (PIEVC protocol)
13	Naturally wooded areas	Climate change - heavy winds or tornados	Tree damage and loss due to heavy winds or tornados can create safety hazards due to falling limbs and loss of habitat. Impacts include canopy loss and less area for recreation and gathering.	High in 2080 (PIEVC protocol)

Risk ID	Asset Providing Service	Risk Category	Risk Description	Risk Score
14	Planted naturalization areas and naturally wooded areas	Climate change - wildfire	Impacts of wildfires include tree damage, loss of canopy and habitat, safety risk to humans and animals, loss of area for recreation and gathering, poor aesthetics, and negative impacts on watersheds and sensitive soils. Negative impacts will be partially offset by benefits such as increased regeneration of species and increased diversity of arthropods.	High in 2080 (PIEVC protocol)
15	Planted naturalization areas and naturally wooded areas	Climate change - drought	The impacts of drought include loss of trees, canopy and species biodiversity; establishment failure for new plants; increased susceptibility to pest and disease; increased fire risk, and increased watering costs.	High in 2080 (PIEVC protocol)
16	Naturally wooded areas	Climate change - flooding	Soils become saturated for long periods of time leading to soil erosion and slope instability, tree loss and damage, increased stress in trees causing blights and other potential diseases, and less area for recreational use.	High in 2080 (PIEVC protocol)
17	Planted naturalization areas and naturally wooded areas	Climate change - lightning	Lightning strikes on individual trees can cause broken branches, mortality, damaged roots, ground scorching, increased risk of igniting a wildfire, and damage to surrounding properties.	High in 2080 (PIEVC protocol)
18	Planted naturalized areas	Climate change - hail/ freezing rain / unseasonal snow	Ice and snow build up on tree branches and high mortality of seedlings. The extra weight on limbs results in broken branches, cracked, compromised limbs, fallen trees, hazardous branches.	High in 2080 (PIEVC protocol)
19	Planted naturalized areas	Climate change - warmer temperatures	Hotter, drier summers and shorter winters will increase the mortality of seedlings, increase fire risk, and may reduce species diversity as current species may not be able to tolerate the warmer temperatures. Warmer temperatures will also increase the risk of more frequent disease and insect infestations.	High in 2080 (PIEVC protocol)
20	Unplanted and planted naturalized areas	Human activity - Lack of public support from citizens	Lack of public support for naturalizing or planting an area leading to citizen dissatisfaction and frustration, more complaints, increased political pressure to stop naturalization.	High

Risk ID	Asset Providing Service	Risk Category	Risk Description	Risk Score
21	All naturalized and naturally wooded areas	Human activity - City Development & Land Use Changes	Loss of canopy & available area to naturalize leading to a reduced canopy area & loss of associated benefits, habitat & native species loss, less space for gathering and recreational activities, fragmentation of areas, increase in hard surfaces and stormwater runoff, and fire suppression.	HIgh
22	Naturally wooded areas and all naturalized areas	Human activity - Illegal trail building	Soil compaction and erosion, and damage to trees reducing canopy coverage, fragmenting areas, and increase in weeds (edge effects).	High
23	Naturally wooded areas and planted naturalized areas	Human activity -Illegal encampments & waste dumping	Asset damage and loss including newly planted trees, understory shrubs, sensitive species, soil contamination. Resulting impacts would be increased pests and safety risks including fire and waste such as syringes.	High
24	Naturally wooded areas and all naturalized areas	Human activity- construction and maintenance activities	Activities by other city departments or external contractors / individuals mechanically damaging the trees or compacting the soils leading to increased stress and susceptibility to insects and disease, and tree loss or shortened lifespans.	High
25	Planted naturalization areas and naturally wooded areas	Human activity - fewer volunteers	Fewer volunteers for planting naturalization sites and serving as stewards for naturally wooded areas leading to higher costs for city staff to complete these activities.	High
26	Naturally Wooded Areas and Naturalization Areas	Landslides / Slumping / Unstable Soils on slopes greater than 3:1	Soil movement can damage trees leading to canopy loss and property damage.	High
27	Planted naturalization areas and naturally wooded areas	Dead or damaged trees	Fallen trees or branches can be a safety hazard to trail users, cause damage to neighbouring properties and other city infrastructure, and increase wildfire risk by increasing fuel loading.	High

Table 7.3 High priority risks to natural and naturalization sites

Risk Mitigation

Table 7.4 summarizes the current and future responses to the high priority risks. The responses lower risks by reducing their likelihood of occurrence or their impacts. A risk framework is not available to quantify the remaining residual risks after the actions are taken (see Step 4 of the Future Risk Management Process). However, the tables describing risks in Appendix J.1 and J.2 contain details on responses for each individual risk that will help with the assessment once the framework has been established. As an interim step in the risk assessment process, this plan summarizes current and future responses by risk category.

Risks	Current Responses	Future Responses
Climate Change risks to **Maintained Trees:** 1. Insects and disease 2. Hail / Freezing Rain / Unseasonal Snow 3. Drought 4. Lightning Strikes 5. High winds / tornado 6. Warmer Annual Temperatures 7. Flooding 8. Higher annual total precipitation	• Visual inspections from the ground every two years • Removing dead, hazardous, and diseased infested trees (through inspections) and compliance with elm bylaw requirements • Identification, monitoring, surveillance and management of pests (insects and disease) following Integrated Pest Management plans • Phytosanitary inspections of nursery stock • Training COE staff to recognize pest threats and general public education and awareness • Modelling to estimate costs of managing EAB and DED. • Increasing biodiversity of tree species when planting • Systematic pruning cycles of trees including disease prone trees. • Implementing plant health care strategies to improve pest resistance and reduce secondary pest problems • Investigating and utilizing natural control agents • Proactive and reactive cabling and bracing identified through pruning and inspections • Responding to storms 24/7 including storm damage / rigging training for Arborists • Watering established trees identified as stressed or declining during droughts by water truck technicians • Low impact development	• Increasing routine structural pruning cycles on young trees to improve their resilience to storms, lightning strikes and heavy winds • Increasing frequency of inspections and risk assessments • Removing insect or disease infested trees that are high risk to the forest & injecting nearby & feature trees with insecticide or fungicide • Identifying inventoried / volunteer elm and ash trees on City properties (back alleys) and maintaining and removing as necessary • Improve soil and drainage conditions during planning and building stages to increase resilience to droughts • Construct soil cells for hardscape trees and medians to grow healthier more fit trees that will be less susceptible to drought • Improve drainage designs to increase resilience to flooding • Improving /increasing tree species diversity to improve resilience and sustainability of the Urban Forest

Risks	Current Responses	Future Responses
Human Activity risks to **Maintained Trees:** 9. Construction and maintenance activities	• General public education and awareness • Dedicated landscape technicians completing regular inspections • Air excavations for compaction • Increased watering • Building relationships with the building, design and construction industries to continually improve regulations and industry requirements for working around trees • Building of Public Tree Bylaw	• Increased inspections and risk assessment • Implement proposed Public tree Bylaw • Education and workshops • Investigate possibilities of a private tree bylaw or other incentives to sustain overall canopy
Economic risks to **Maintained Trees, Naturalization Areas, and Natural Areas:** 10 & 11. Inadequate funding	• Operations and maintenance activities are prioritized to ensure critical assets are managed to minimize the risk of harm to people, property, and the environment • Preparing this AMP to understand the relationship between costs and levels of service	• Improved asset management maturity to better understand the impacts of inadequate funding and the costs of service delivery options
Climate Change risks to **Naturalization Areas** and **Naturally Wooded Areas:** 12. Insects, invasives and disease 13. High winds / tornado 14. Wildfire 15. Drought 16. Flooding 17. Lightning Strike 18. Hail / Freezing Rain / Unseasonal Snow 19. Warmer Annual Temperatures	• Reactive inspections and actions to identify, assess and manage risks including fuel load levels to reduce fire risks, access to unsafe areas, watering established trees during droughts, and the establishment and spread of pests. • Increasing the frequency of watering newly planted trees during a drought • Removing trees and debris that present fire and other safety risks • Increasing the species diversity of seedlings • Applying herbicides and mechanical removal to manage regulated invasive plants proactively when naturalizing sites and reactively for planted and natural areas. • Replanting disturbed naturalization areas • Ensuring mowed borders along private property in naturalized areas (where operationally possible) to create small fire breaks.	• Response planning for tornado impacts including tree risk mitigation, ongoing inspections, and replanting • Using the fire risk model to prepare a City-wide fire strategy (FireSmart Plan) • Selecting site-specific species when planting to plan for long-term adaptation. • Updating the species list to include more drought tolerant species in planting plans; this may include species that are expanding their range • More proactive/thorough removal and control of regulated invasive plants (model spread of invasive) through mechanical, herbicide and biocontrol means, including restoration of these areas

Risks	Current Responses	Future Responses
Climate Change risks to **Naturalization Areas** and **Naturally Wooded Areas** (continued from previous page)	• Following design and construction standards for tree planting setbacks from property lines • Naturalizing areas, supplemental plantings, and constructing slope stability projects to mitigate flooding impacts • Treating some species against non-regulated insects and disease such as trunk injections of black & Manchurian ash for cottony psyllid; American elm for European elm scale	• Identifying areas for high flood risk and promote mitigation (e.g., through infrastructure or vegetation/spp change) • Developing a strategy to restore areas with high non-regulated invasive species count to native species • Recording elms and ash occurring in Natural Areas for removal, mitigation, or protection against Dutch Elm Disease and Emerald Ash Borer • Removing or treating trees infested with non-regulated insects and disease.
From **Human Activities** to **Naturalization Areas** and **Naturally Wooded Areas**: 20. Lack of public support from citizens for naturalization 21. City development & land use changes 22. Illegal trail building 23. Illegal encampments & waste dumping 24. Construction and maintenance activities 25. Fewer volunteers	• Public Education of the benefits of naturalization • Public engagement and planning before decisions to stop mowing and start planting including the Parkland Care communications strategy • Educating and informing the public on actions to reduce risks including fire regulations and safety, and preventing the establishment and spread of regulated insects and diseases. • Planting buffers around isolated tree stands • Updating the Ribbon of Green and NSRV ARP (Bylaw 7188) through the Modernization project (2020-2022) • Installing signs at new trail entrances to deter the public from building illegal ones • Regular inspections of areas to identify illegal trail building, fires, and other damaging human activities • Replanting areas where feasible	• Increased focus on quality and availability of education / awareness materials outlining the benefits of Naturalized Areas, the management goals of the City, impacts of illegal dumping, and opportunities for volunteering in programs such as Root for Trees. • Implementing planned naturalization sites 1 year in advance to allow for more public engagement • Developing policy and supporting documents that provide clearer direction and preserve more canopy and area for naturalization • Working with the Planning Department to help avoid any loss/changes. • Implementing the proposed Public tree Bylaw

Risks	Current Responses	Future Responses
From **Human Activities** to **Naturalization Areas** and **Naturally Wooded Areas**: (continued from previous page)	• Dedicated Urban Foresters completing regular inspections including monitoring, surveillance and management of pests following Integrated Pest Management plans • Sharing development related risks during the circulation process and building relationships with the industry to continually improve regulations and requirements for working around trees such as air excavations for compaction and increased tree watering in construction areas • Developing the Public Tree Bylaw	• Replanting/reseeding of naturalized areas and restoration of naturally wooded areas. • Increased frequency of inspections and risk assessments.
From **Other Risks** to **Naturalization Areas and Naturally Wooded Areas:** 26. Landslides / Slumping / Unstable Soils 27. Dead / Damaged Trees	• Bank stabilization construction projects and naturalization planting on slopes greater than 3:1 • Tree risk mitigation strategy (see city-wide NAMP for NAW areas) • Understory tree planting (to assist with succession and regeneration of tree stand)	• Naturalization of slopes (contracted naturalization) • Develop tree risk mitigation strategy further • Improve and increase understory planting strategy

Table 7.4 Summary of high priority risk responses

The costs of current risk responses were presented in the previous section on asset management strategies and costs (see Table 6.10). Several initiatives to further reduce asset risk are also underway in the city including developing a public tree bylaw, preparing a city-wide fire strategy, and further developing a tree risk mitigation strategy.

Prioritizing Decisions Using Risk

The City uses the risk outcomes from the section above to plan and prioritize investment needs. These are incorporated into the overall plan and assessment of asset renewal requirements for the class as shown in Figure 7.1.

Figure 7.1 Planning for asset class renewal needs

Operations and Maintenance Prioritization

The City has prioritized its operations and maintenance activities as shown in Table 6.3 of the previous chapter. Activities related to health and safety such as storm response, hazardous tree removal, and responding to customers have the highest priority followed by essential work activities:

- Such as watering and systematic pruning to ensure newly planted trees achieve their expected useful lives and the City gains the benefits of a mature tree canopy;
- To control pests and disease including inspections, noxious weed control, and insect monitoring;
- To mitigate fire risks including inspections and fuel load reductions.

Assessing Risk and Reviewing Performance Outcomes

An objective prioritization of the risks identified in this chapter was not possible because the City does not have a risk framework for this purpose. However, a key finding from the PIEVC assessment was that drought, and invasive plants, insects and disease posed a high risk to all types of urban forest assets except for grassed naturalized sites. Therefore, it was decided for this AMP to use the Remsoft model described in the previous chapter to forecast the financial impacts of the following risk scenarios:

- A drought occurring every six years and lasting for one year;
- A Dutch Elm Disease infestation starting in 10 years; and
- An Emerald Ash Borer Infestation starting in 5 years.

A memo is provided in Appendix E describing the assumptions and parameters of each forecasting scenario. Table 7.5 provides an overview of the scenarios and their average annual lifecycle costs over the 50 year planning period. The results are compared to the lifecycle costs of managing the current inventory, and for managing the planned growth in assets.

Costing Scenario	Average Annual Cost over 50 yrs
1. Current inventory assuming trees are replaced as required. This scenario includes the asset strategies identified in Chapter 6 and the current risk mitigation actions described in Table 7.2.	$17.8 million
2. Planned growth - Current inventory of trees is replaced as required plus new assets are created at the current rate of growth. This scenario includes the asset strategies identified in Chapter 6 and the current risk mitigation actions described in Table 7.2.	$25.8 million
2a. Planned growth scenario plus infestations of Emerald Ash Borer and Dutch Elm Disease: • Risk is accepted and no additional actions are taken to mitigate the impacts • 100% of the trees are lost over a 7 year period and replaced with another species • Unit costs for removing ash trees were assumed to be 20% higher than the costs in Scenarios 1 and 2. This is to account for appropriate tree disposal and any specialized equipment required for removal activities.	$25.8 million per year PLUS an additional $49.4 million per year over the 7 years the infestations occur
2b. Planned growth scenario plus additional activities to mitigate the impacts of a drought occurring every 6 years: • Watering: Watering costs increase 50% in drought years • Assume 20% loss of naturalized plantations and maintained trees that are under three (3) years old. These trees will be assumed to have died in the drought year and replanted the following year • Assume double the expected death from non-drought natural causes of maintained trees over 3 years old • Assume a 10% increase in maintenance costs of natural areas	$25.8 million per year PLUS an additional $2.1 million per year over 50 years to mitigate drought.

Table 7.5 Forecasted costs and impacts of drought, Emerald Ash Borer, and Dutch Elm Disease

The forecasted timing and magnitude of these financial risks are illustrated in Figures 7.2 and 7.3. For the Emerald Ash Borer and Dutch Elm Disease scenario, dual infestations were assumed to occur within a 20 year period, with each lasting seven years before all trees died. The timing of each is unknown, so these impacts may occur at any time, though as the climate warms, the likelihood of their arrival increases. This is also true with droughts, which will likely increase in likelihood over time.

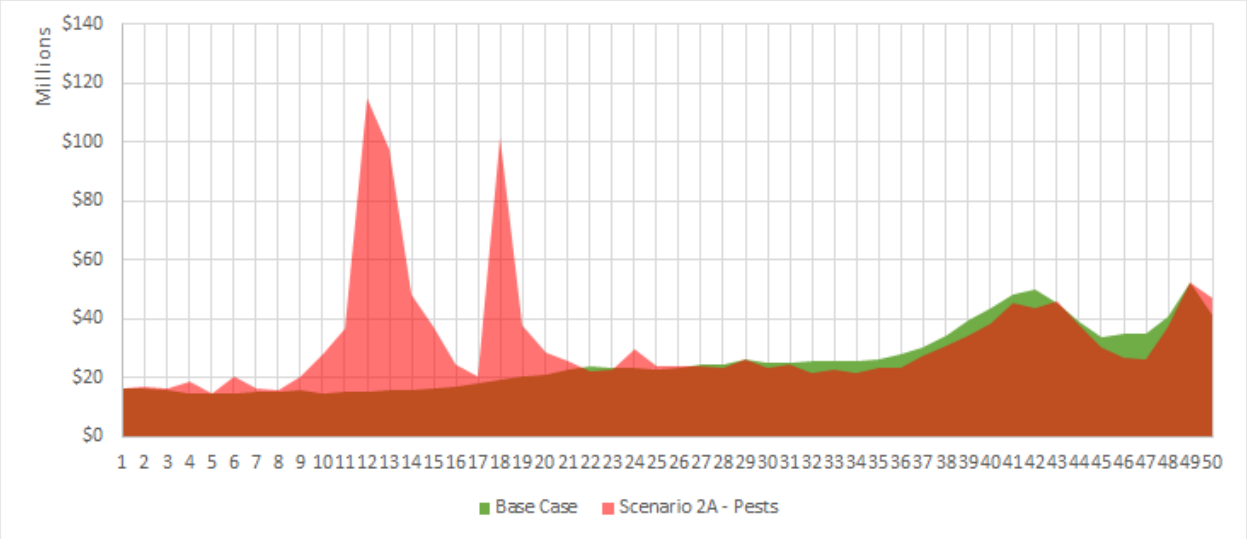


Figure 7.2 Forecasted estimate of financial impact of Emerald Ash Borer and Dutch Elm Disease

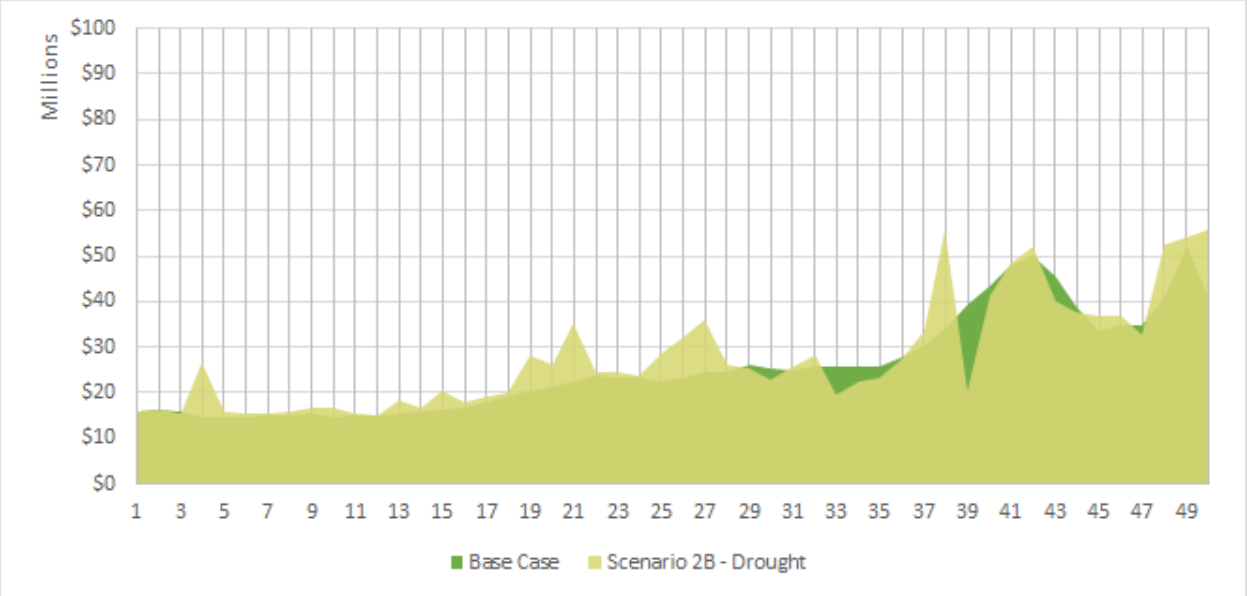


Figure 7.3 Forecasted estimate of financial impact of drought

Recommendations to Improve Risk Management in Future Plans

The City is actively managing risks to the urban forest as shown by the list of current risk responses in Table 7.2 Recommendations to improve risk management are provided below:

1) Prepare a risk framework for assessing and identifying unacceptable risks to infrastructure assets. The framework should align with the RIMS methodology.

2) Apply the framework to assess the risks identified in Appendix J.1 and J.2 and populate the risk register for the next version of the AMP.

3) Develop and estimate the costs of strategies to manage risks assessed as unacceptable using the framework, i.e. mitigate, accept, transfer, avoid.

4) Use the information from this AMP and other plans and reports to assess the benefits and costs of the future mitigation options listed in Table 7.4 and decide which ones to implement. Other plans and reports that would be useful for preparing the risk management plan include:

    a) Management plans for specific Natural Areas;

    b) Urban Street Trees Investment Strategy prepared by EHan Engineering, May 2017;

    c) A literature review to better understand the impacts of drought on natural areas;

    d) Response planning for tornado impacts including tree risk mitigation, ongoing inspections, and replanting;

    e) A City-wide fire strategy (FireSmart Plan) based on the fire risk model;

    f) Identifying areas for high flood risk and promoting mitigation (e.g., through infrastructure or vegetation change).

5) Document the selected risk mitigation actions in the risk register and use it as a tool to regularly monitor and report on risks.

6) Include the selected mitigation actions and their costs in future AMPs.

Asset Management Continuous Improvement Indicators

This section presents indicators for the continuous improvement of asset management practices related to understanding the current state of the asset infrastructure.

Continuous Improvement Indicator for the Asset Management System

Risk Management: The number of risks mitigated reduces the impact and likelihood of a potential threat. Continuous improvement performance trends can be tracked through the following indicators:

- The count of risk by rating
- Total mitigation cost by risk rating

8. Financial Plan

A financial plan provides a long term financial forecast and funding plan for implementing the asset management strategies adopted by the City to provide its target Levels of Service. The following sections present the City's financial forecasts of cost and revenue for a 20-year period. The cost forecasts are based on an analysis that included several alternative scenarios developed to evaluate the program requirements for the Urban Forest portfolio. These scenarios included:

1. A "No Growth" scenario - that assumes the City only replaces trees that die and adds no new trees, natural areas, or naturalization areas to the portfolio. This scenario does not achieve key performance targets for tree planting, canopy or natural area acquisition by the City.

2. A "Planned Growth" scenario - that continues at a pace of growth that is consistent with past rates of growth. This scenario does not achieve the canopy key performance target.

3. A "Targeted Growth" scenario - that increases growth of planting in naturalization areas and includes incentives that encourage additional planting in non-city owned lands. This scenario achieves all KPIs, including the 20% canopy target by 2070.

4. An "Accelerated Growth" scenario - that greatly increases the rate of acquiring and planting of naturalization areas, and assumes canopy contribution by non-city owned lands does not increase. This scenario achieves all KPIs, including the 20% canopy target by 2050.

Additional details on the planned and targeted growth scenarios were provided in Chapter 5 on Growth and Future Demand. Chapter 6 on Asset Management Strategies describes the Remsoft model used to forecast future costs, and presents a summary of future costs for the scenarios. Appendix D contains a more detailed description of the modelling approach and assumptions.

Two additional scenarios were also completed to evaluate the potential impact of drought, pests and disease such as the Emerald Ash Borer and Dutch Elm disease. The impacts of these risks were quantified over a multiple year impact period and are described in more detail in Chapter 7 on Risk Based Decision Making. A summary of the assumptions and parameters associated with all six scenarios can be found in Appendix E.

Financial Forecasts

The City selected the "Targeted Growth" option as the preferred management scenario for the purposes of the financial plan. There were several reasons for its selection:

1. It achieves all performance measures, including planting 2 million trees, acquiring 8% of the city in natural areas, and reaching a canopy equivalent to 20% of the city's area. A summary of the outcomes and the year they are achieved under this scenario are provided in Table 8.1.

KPI	Performance Target	Activity
Planted Trees	2 million trees by 2050	Scenario Outcome: Achieved Year 2M Achieved: Year 6 Total Planted by 2050 11.2M
Canopy Coverage	20% of city land area by 2070	Scenario Outcome: Achieved, 20% Year Achieved: 2070
Natural Area Protected	8% of city land area by 2070	Scenario Outcome: Achieved, 6,400 ha, 8.2% Year Achieved: 2070

Table 8.1 Summary of the management scenario outcomes

2. It is incrementally achievable based on current resources and practices.
3. It relies not only on the City planting additional trees to contribute to future canopy, but also assumes policy incentives will be developed for private landowners to plant trees and increase canopy towards the City's target over the next 50 years.
4. It strikes a balance between costs and increasing canopy through alternatives such as naturalization plantings, natural areas preservation, and third party contributions.

Key assumptions associated with the preferred management scenario were presented in Chapter 5 on Growth and Future Demand (Tables 5.5 and 5.6). They are summarized in Table 8.2.

Asset Category	Assumption	Quantities Associated with the assumption
Existing City Assets	Existing assets are renewed and replaced as they reach the end of their lives	• The model shows between 1100 and 3000 existing trees will require replanting per year over the next 15 years for an average of 1,800 per year. It must be noted that the tree health assessments are finding that between 3000 and 3200 trees will require replanting annually as trees are failing earlier than the model predicts. • This rate of renewal begins rising steadily after Year 15 as the number of existing trees reach the ends of their lives. • Renewals peak at 19,000 trees 42 years in the future, and again at 22,000 trees at the end of the 50 year planning horizon.

Maintained Tree Growth	The quantity of maintained trees will increase due to new development plus infilling of existing developed areas	• A net increase of 7,500 maintained trees will be added to the City's inventory per year due to development
		• An additional 46,500 maintained trees will be added to the inventory based on the following
		  ○ 6,000 trees (next 2 years) and
		  ○ 1,500 trees (yr 3 to 29) in existing "developed areas" – infill planting

Asset Category	**Assumption**	**Quantities Associated with the Assumption**
Naturalization Area Growth	• Converting existing city-owned areas to naturalization areas • Acquiring new naturalization areas from developers. • City will plant existing naturalization areas to convert them to treed stands over the long term.	• Unmowed grass areas will grow to 2515 ha over the planning period. • A total of 1900 to 3000 ha is available for naturalization and restoration activities and is assumed to be owned by the city and will not decrease. • 35.5 ha of naturalization planting each year will continue over 50 years to create 375 ha of tree stands. • Inventory of naturalized areas will grow by 10 ha/yr from developers
Natural Areas	• City will acquire and protect current natural areas to meet its Preferred Scenario goal in the city plan of 6,400 ha naturally wooded areas. • Natural Areas not owned by the City will decrease as it is developed.	• City will acquire 3,900 ha of Natural Areas • 1400 ha of acquired Natural Areas will be naturally wooded to meet the target of 3200 ha • Remaining Natural Areas will decrease from 1500 ha to 100 ha over the next 50 years
Non-City Contribution to Canopy	Existing Canopy estimated at 4150 ha	• Assume policy incentives add an additional 2900 ha of canopy (70% increase) on property owned by third parties.

Table 8.2 Summary of the selected management scenario assumptions

Figure 8.1 illustrates the contribution of each asset category towards achieving the City's canopy target of 20% under this scenario.

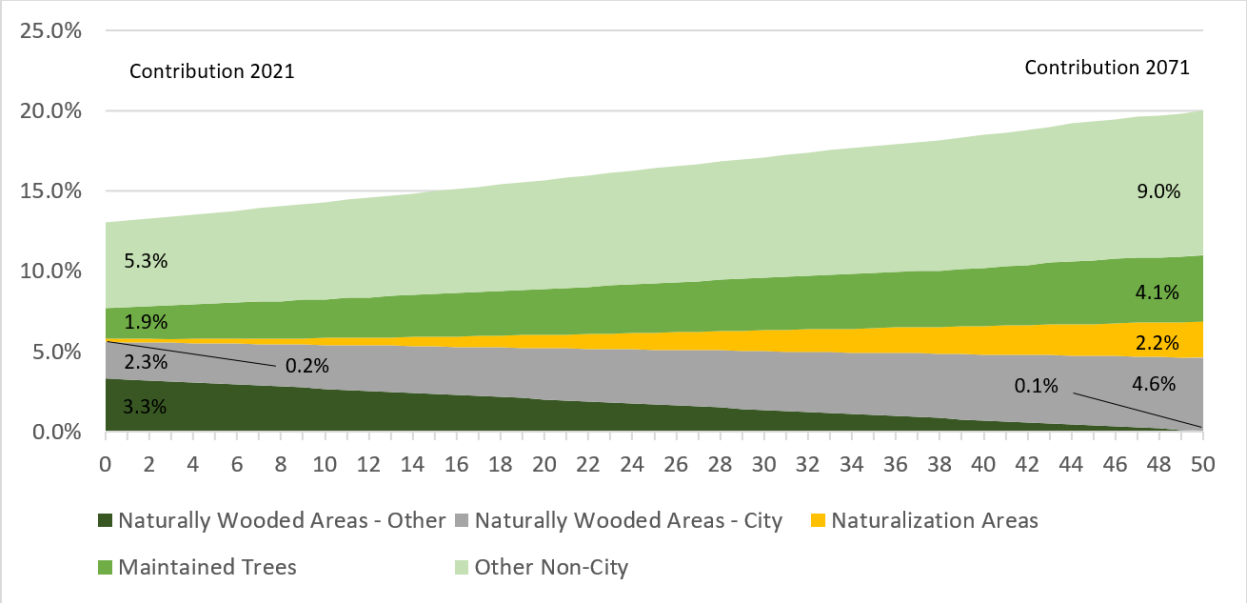


Figure 8.1 Canopy Contributions by type, under the proposed management scenario

Several key points should be considered from this result:

- The largest contributor to canopy within the city, now and in 2071, is from trees that are located on third party lands. This is assumed to increase by 70% over the 50 year analysis period. This requires successful incentive programs to encourage the planting and maintenance of trees on private lands within the city. This component has the added advantage of requiring little or no cost to the city for tree maintenance and renewal. Policies, including incentives and penalties, may require adjustment to achieve this assumed contribution.
- Natural Areas contribute approximately 4.7% to canopy by 2071. This represents a reduction in overall Natural Areas within the city, due to development activity reducing its overall contribution to canopy over the next 50 years by 0.9%. While overall canopy contribution is reduced, the City's ownership of Natural Areas doubles from 3200 ha to 6400 ha over the next 50 years. A portion of these areas contribute to canopy.
- Naturalization areas represent the largest proportional increase in canopy contribution, growing from only 0.2%, to contributing 2.2% within 50 years.
- The maintained tree contribution increases over time, with the number of maintained trees increasing from 374,600 to over 796,100 trees within the portfolio.

Table 8.3 lists the lifecycle activities included in the costs forecasted for the management scenario.

Program Area	Funding Source	Activity
Maintained Tree Portfolio	Operations	• Inspections / inventory assessments • Hazard assessments and mitigation • Tree maintenance • Pruning • Stressed tree watering • Establishment period watering of FACd trees • Tree removal and grinding • Stake removal for trees planted by developers • Rodent protection
	Capital - Renewal	• Tree planting (replacement) • Tree establishment watering (replacement) • Tree removal and grinding • Stake removal • Rodent protection removal
	Capital - Growth	• Tree planting (infilling) • Tree establishment watering (growth) • Stake removal • Rodent protection removal
Naturally Wooded Areas	Operations	• Inspections (weeds, tree/fire risk, ecological monitoring) • Maintenance (clearance, risk mitigation, view, service)
	Capital - Renewal	• None
	Capital - Growth	• Acquisition inspections
Program Area	**Funding Source**	**Activity**
Naturalization Areas	Operations	• Inspections and maintenance • Hazard assessments and mitigation
	Capital - Renewal	• None
	Capital - Growth	• Site identification • Naturalization preparation • Plan for planting • Initial planting • Infill planting • Weed control • Watering

Table 8.3 Summary of the activities forecasted in the management scenario

Land acquisition costs for Natural Areas were not modelled as part of the plan, and naturalization areas were also assumed to be city owned. The City acquires lands through a variety of mechanisms, and as such, the predictability of these costs is difficult. As a consequence, the plan focussed on operational and capital costing for the urban forest assets only, excluding land cost.

The following sections provide more detailed summaries of the forecasted estimates associated with the management scenario.

Operations & Maintenance Forecast

Table 8.4 outlines the financial forecast for the next 20-years based on the operations and maintenance strategies for all three program areas. Several of the operations and maintenance activities for Naturally Wooded Areas and Naturalization Areas are interlinked and were not quantified as separate items.

Activities for Naturally Wooded Area activities include:

- Inspections for weed control, tree risk, fire risk, and ecological monitoring;
- Maintenance activities such as tree/fire risk mitigation, clearance pruning, viewpoint maintenance, restoration of disturbed lands; and
- Responding to service requests.

Naturalization Area activities include:

- Inspections and maintenance activities associated with assessing added inventory, as well as addressing service requests and restoration of disturbed lands.
- All other Naturalization Area activities were assumed to be related to Growth Capital.

Operations & Maintenance Activities/Programs	Average Past Budget	Forecast Annual Cost ($000)						
		2021	2022	2023	2024	2025	2026-2030	2031-2040
Maintained Trees	**$5,801**	**$7,465**	**$7,102**	**$7,293**	**$7,382**	**$7,349**	**$37,957**	**$88,443**
Pruning	$3,085	$4,392	$4,600	$4,825	$4,994	$5,039	$26,523	$63,203
Watering - Renewal	$1,190	$1,597	$982	$907	$790	$673	$2,707	$5,289
Tree Maintenance	$1,306	$1,263	$1,301	$1,336	$1,368	$1,401	$7,769	$17,075
Inspections and Inventory	$220	$213	$219	$225	$230	$236	$1,258	$2,876
Naturally Wooded Areas	**$1,033**	**$1,047**	**$1,063**	**$1,079**	**$1,094**	**$1,110**	**$5,789**	**$12,765**
Naturalization Areas	**$175**	**$203**	**$216**	**$230**	**$244**	**$258**	**$1,495**	**$4,023**
Total	**$7,009**	**$8,715**	**$8,381**	**$8,602**	**$8,720**	**$8,717**	**$45,241**	**$105,231**

Table 8.4 Operations and maintenance 20 year financial forecast ($2020)

Several key points are worth noting about the forecasted figures:

- The forecast is higher than historical budgets, reflecting a higher level of management activity as the City increases efforts to achieve its performance targets.
- This forecast is based on modelling over 50 years into the future, and the results shown are a truncated 20 year window of that longer term forecast.
- Operational costs tend to increase, particularly as the Maintained Tree portfolio increases in size over time.
- Adhoc watering for stressed established and for trees that planted as replacements has been included as an operational item, as consistent with historical practice.
- The level of investment associated with this management scenario achieves the City's performance measures. However, all goals are not fully met until 30 to 50 years in the future. The City's tree planting target (2 million trees planted by 2030) is achieved in Year 6, or 2026.
- As mentioned earlier the overall operational budget increases consistently over the next 50 years, as the City's urban forest grows. This pattern is illustrated in the table, with an average annual increase of 1.6%. By 2040, it has increased to approximately $10.8M. Tree pruning costs are a large contributor to these increases, particularly aerial pruning, as trees mature and can no longer be managed through ground pruning. These costs double within the first 20 years, and triple by the end of the 50 year analysis period.
- All figures are in constant 2020 dollars and do not account for inflation.
- The forecasted operational costs for Naturally Wooded Areas and Naturalization Areas are small in comparison to Maintained Trees, but escalate over the planning period. Naturalization budgets are predominantly funded through Growth Capital funding, as new areas are planted.

The next section summarizes the forecasted investment requirements for capital renewal in the Maintained Tree portfolio.

Asset Disposal and Capital Renewal Forecast

Table 8.2 outlines the asset disposal and capital renewal forecast for the next 20 years based on the management scenario. Capital renewal activities are only provided for the Maintained Tree portfolio. Naturalization Areas were assumed to be self sustaining after they were planted, similar to Naturally Wooded Areas.

Renewal & Replacement Activities/Programs	Average Past Budget	Forecast Annual Cost ($000)						
		2021	2022	2023	2024	2025	2026-2030	2031-2040
Maintained Trees	**$2,459**	**$2,400**	**$3,053**	**$3,467**	**$2,308**	**$2,375**	**$11,357**	**$31,927**
Tree Replanting	$1,673	$2,400	$2,400	$2,400	$1,472	$1,472	$6,840	$15,737
Tree Removals	$786	$0	$653	$1,067	$836	$903	$4,517	$16,190
Naturally Wooded Areas	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Naturalization Areas	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total	**$2,459**	**$2,400**	**$3,053**	**$3,467**	**$2,308**	**$2,375**	**$11,357**	**$31,927**

Table 8.5 Asset disposal and capital renewal 20 year forecast ($2020)

There are several observations that can be made from the table.

- Renewal investment is relatively stable over the initial 20 years, ranging between $3-4M in the initial 16-17 years and then escalating thereafter to be approximately $6.5M in 2040. This forecast does not consider current tree health assessment data of losses of over 3000 trees annually.
- Tree removals, disposal and grinding are included within the renewal forecast. This is contrary to historical practice, where often these were partially or fully funded through an operational budget. To be more consistent with asset management practices associated with other asset types owned by the city, for the purposes of the plan these are linked as a capital cost to the capital investment of the replacement tree. This assumption is valid as long as there is a new tree being planted to replace the one being removed. This assumption was made in the initial model as well as associated watering the new tree for three years. In current practice, some trees are not replaced due to utility conflicts or other site condition issues. For simplicity, the model assumed all dead trees are replaced. Future plans may build on future data collection to refine this assumption.
- The early forecast matches well with recent existing budgets.
- The capital renewal forecast escalates substantially beyond the 20 year horizon summarized in Table 8.2. This is illustrated in Figure 8.6 below.

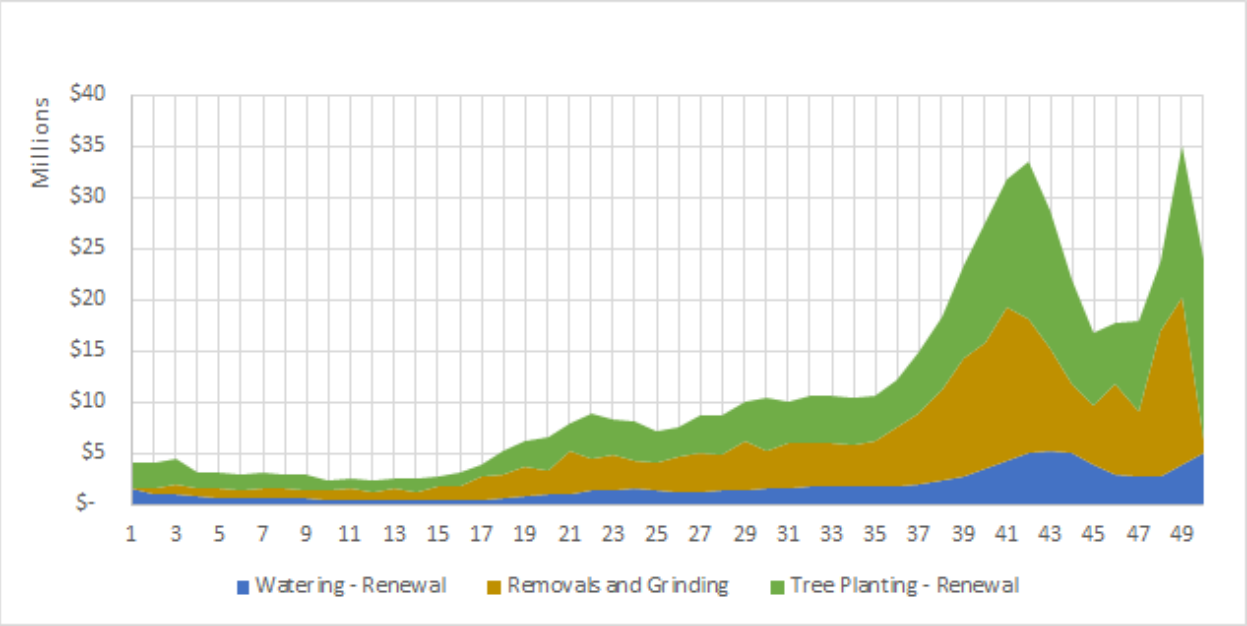


Figure 8.2 Asset disposal and capital renewal forecast for 50 years, by activity ($2020)

There is a large increase in renewal investment, particularly after 20 years. From year 20 to year 35 (2040-2055), renewal costs are 2 to 3 times higher than the initial 15 years of the forecast. After year 35 (2055), renewal costs escalate further to 8 to 10 times the levels in the early period. This latter period corresponds to large cohorts of trees in the City reaching the end of life, requiring removal, and replacement with new saplings. It is important for the City to plan for this period financially, either through a reserve fund, or by ensuring there is available contingency funding during this period.

Resourcing is also an important consideration given the forecast reflected in Figure 8.6. While existing City resources can likely accommodate forecasted levels of renewal planting over the next 15 years, and perhaps also up to 2030, there will certainly be resource challenges in the latter years. With significant lead time, strategies to manage this future challenge can be explored.

New Capital Forecast for New Assets

Table 8.6 outlines the financial forecast for new capital funding required for the next 20 years based on the new asset strategies. New assets were considered to be new trees planted in areas that previously were vacant or had alternative vegetation. Under the management scenario, these costs consisted of:

- Maintained Trees: Infilling, where trees were planted in locations that previously had no tree, as well as the watering for 3 years
- Naturally Wooded Areas: Assessment and inspection activities conducted for new Naturalization Areas to integrate these lands into the City's portfolio. **The cost of land purchase or acquisition was not considered as part of this forecast.**

- Naturalization Areas: Assessing and establishing new areas for naturalization, planning and undertaking planting, infill planting and watering and weed control to encourage the sites to establish and canopy cover to expand as trees are established.

New Assets & Disposal Activities/Programs	Average Past Budget	Forecast Annual Cost ($000)						
		2021	2022	2023	2024	2025	2026-2030	2031-2040
Maintained Trees	**$86**	**$2,742**	**$3,078**	**$2,043**	**$1,875**	**$1,707**	**$8,535**	**$17,070**
Tree Planting - Infilling	$86	$2,406	$2,406	$1,203	$1,203	$1,203	$6,015	$12,030
Watering - New Trees	0	$336	$672	$840	$672	$504	$2,520	$5,040
Natural Areas	**$0**	**$0**	**$3**	**$3**	**$3**	**$3**	**$15**	**$30**
Naturalization Areas	**$1,467**	**$5,642**	**$5,885**	**$6,570**	**$6,578**	**$6,587**	**$33,385**	**$67,231**
Assessing New Areas	$327	$141	$69	$69	$69	$69	$346	$692
Establishing New Sites	$0	$844	$414	$414	$414	$414	$2,068	$4,136
Planting Planning	$218	$304	$304	$3,433	$3,433	$3,433	$17,165	$34,331
Planting New Trees	$288	$3,433	$3,433	$3,433	$3,433	$3,433	$17,165	$34,331
Infill Planting	$61	$0	$0	$0	$0	$0	$328	$487
Weed Control	$296	$123	$132	$140	$148	$157	$909	$2,447
Watering New Trees	$277	$797	$1,533	$2,210	$2,210	$2,210	$11,051	$22,103
Total	**$1,553**	**$8,387**	**$8,966**	**$8,616**	**$8,456**	**$8,297**	**$41,935**	**$84,331**

Table 8.6 New assets and disposal financial forecast

Key observations regarding the forecast include:

- The forecast represents a substantial increase in budget for growth capital activity. This corresponds to the escalated level of planting required to achieve the City's performance targets, particularly for tree canopy, over the long term.
- It should be noted that stake removal and rodent protection removal have not been forecast within the model, and these associated costs would be in addition to current model estimates.
- Infilling the Maintained Tree portfolio was assumed to continue at a consistent rate for the first 29 years of the analysis period. After this period, it was assumed that the City's urban forest was completely "filled out", and no further infill planting would be required. All new additions would only come from developers thereafter.
- Naturalization planting was assumed to occur at a consistent rate over the 50 year analysis period, and stop once the 20 % canopy target was achieved in 2070.
- Current naturalization planting procedures require planting a tree every square metre, equivalent to 10,000 trees per ha. This is a relatively dense planting strategy, with mature tree distributions likely to range between 1500-2000 trees per ha. This dense planting

strategy may be supported to offset high failure to thrive rates, or to encourage early canopy closure to reduce the need for weed control. This strategy obviously has an impact on the required Growth Capital funding requirements. Reductions in density planting might be one strategy to close funding gaps, should it be demonstrated that tree establishment rates are sufficient to support alternative strategies.

Financial Forecast Summary

Table 8.7 outlines the financial forecast summary for the next 20 years based on the forecasted costs of operations and maintenance, asset disposals and renewals, and new assets as described in the management scenario in the preceding sections. Figure 8.3 provides a graphical representation of the financial forecast for the next 20 years. A more detailed summary of financial results of the management scenario can be found in Appendix K

Lifecycle Activities	Average Past Budget	Forecast Annual Cost ($000)						
		2021	2022	2023	2024	2025	2026-2030	2031-2040
Total Operations & Maintenance	**$7,009**	**$8,715**	**$8,381**	**$8,602**	**$8,720**	**$8,717**	**$45,241**	**$105,231**
Capital renewal & rehabilitation forecast	$2,459	$2,400	$3,053	$3,467	$2,308	$2,375	$11,357	$31,927
Capital new assets & disposal forecast	$1,553	$8,387	$8,966	$8,616	$8,456	$8,297	$41,935	$84,331
Total Capital	**$4,012**	**$10,787**	**$12,019**	**$12,083**	**$10,764**	**$10,672**	**$53,292**	**$116,258**
Total	**$11,021**	**$19,502**	**$20,400**	**$20,685**	**$19,484**	**$19,389**	**$98,533**	**$221,489**

Table 8.7 Financial forecast summary

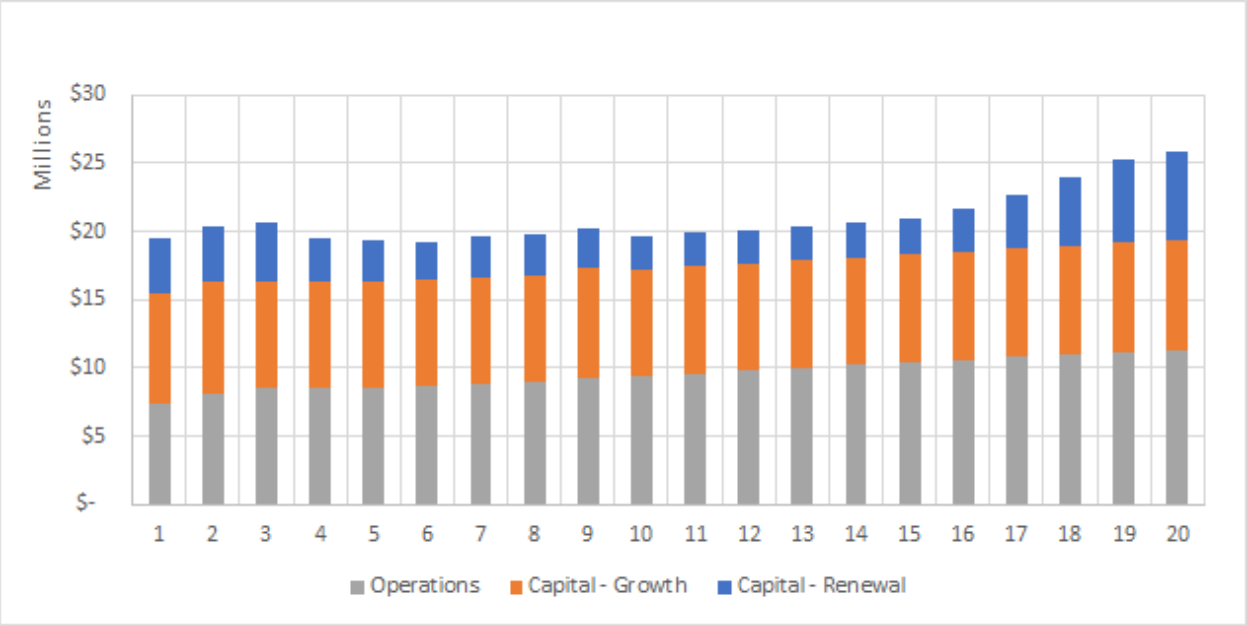


Figure 8.3 Financial forecast annual cost for the next 20 years, by investment category

The forecasted costs represent a large increase relative to average past budgets for these programs. This large increase is predominantly associated with increases in planting to achieve long term canopy goals. There are also increased operational activities, particularly for pruning, increased planting in early years to clear a backlog of replacements and a higher level of management for the Maintained Tree portfolio.

As mentioned earlier, it is important to recognise that while the next 20 years show only a gradual increase in budget, this trend changes in subsequent years into the future. Overall average annual costs are forecasted to escalate in a staged manner, with at least three primary plateaus of costs over the 50 year analysis period. This is illustrated in Figure 8.4.

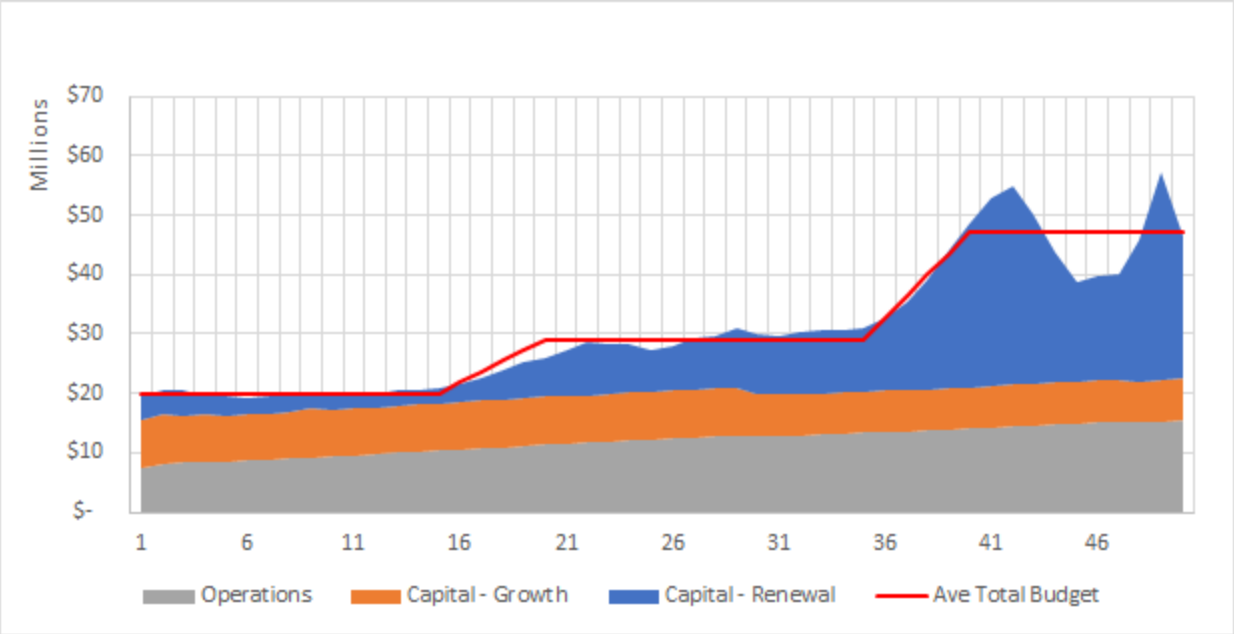


Figure 8.4 Forecast investment levels for all programs (Maintained Trees, Natural and Naturalization Areas) ($2020)

The average level of investment is relatively constant for the first 15 years, totalling approximately $20M on average over the period. In the following five years (Year 16-Year 20), this increases to approximately $29.1M for the next 15 years. As large portions of the Maintained Tree portfolio decline and die, forecasted expenditures escalate again over 5 years to an average of $47.1M between Years 40-Year 50 (2060-2070).

Additional observations regarding the overall forecast include:

- The combined operations budget for the three programs increases steadily over the analysis period. It more than doubles over 50 years, from approximately $7.1M in year 1 to $15.4M after 50 years. The increase is relatively consistent, year over year, and equates to an annual increase of 1.6%. Note this forecast is in constant dollars (2020) and inflation would be on top of the increases in the forecast.
- Capital investment to create new assets for growth (planting new Maintained Trees and new trees in Naturalization Areas) is also relatively consistent, with expenditures averaging $8.5 M in the first 29 years, and then decreasing to $7M thereafter. This decrease relates to completing the infilling of Maintained Trees within 30 years.
- The level of capital renewal needed to replace existing assets is predominantly the reason for the overall variation in the total budget. This is particularly true in the latter stages of the forecast as large portions of the City's maintained tree portfolio reach the end of life and require replacement.

Forecasting costs over a 50 year analysis period requires a number of assumptions. These assumptions increase uncertainty, the more distant the forecast travels into the future. For this reason, broad estimates such as these average investment levels are appropriate for budgeting, but should be periodically revisited to confirm and adjust assumptions. While the forecasted average investment level is informative, the annual investments forecasted in each individual year should not be considered to be precise, particularly the large variations in renewal investment in the latter

years of the planning horizon. Not all trees will require renewal precisely as anticipated, but the average trend can be considered accurate.

Additional assumptions and limitations are discussed in the next section.

Assumptions and Limitations

This section details the key assumptions made in completing the financial forecasts of required operating and capital expenditure and asset values, and carrying amount estimates. The forecasting process required an extensive number of assumptions that were reviewed and approved by City staff. Details associated with these assumptions can be found in Appendix D. Appendix E is a Technical Memo that documents all associated assumptions for all scenarios, including the selected management scenario employed for the financial plan. A summary table of the six scenarios modelled is provided in tableau format in Appendix E as a useful reference when reviewing the various forecast results. These extensive assumptions will not be duplicated in this section. However, several key assumptions impacting the AMP are noted in Table 8.8 along with the associated risks to the forecast.

Key Assumptions	Risk of Change to Assumptions
All costs are in in constant 2020 dollars	All estimates do not account for inflation. Future budgeting will require current dollar estimates that will escalate these forecasts.
Land and plant stock are available to meet the long term growth targets	The strategy and associated costs to achieve the growth targets are incorrect.
No land acquisition costs have been incorporated into the financial forecast	The City acquires Natural and Naturalization Areas through a variety of mechanisms. Should land purchase be required to achieve the levels of planting and canopy preservation assumed for the management scenario, these acquisition costs would be an additional cost.
Canopy from property owned by third parties increases substantially (70%) over the analysis period	This requires sustained, and effective incentives to encourage citizens, businesses and other stakeholders to plant tees and expand the canopy contribution to achieve the City's canopy performance target.
Climate change impacts such as drought have not been incorporated into the management scenario model	Drought has been observed to occur at approximately six year intervals in northern Alberta and last 1-2 years in duration. This frequency may be variable, and will have an impact on tree mortality, watering costs and other factors. The potential impact of this is discussed in more detail in Chapter 7.
Pest impacts such as Emerald Ash Borer and Dutch Elm Disease have not been incorporated into the management scenario model	While there is no definitive way to estimate the potential arrival of either pest, their arrival will be impactful. Past experience in other jurisdictions suggest all vulnerable trees are killed within 7 years of introduction. The City has significant elm and ash tree populations in the portfolio. Managing these impacts would be at an additional cost about the forecasted scenario. The potential impact of this is discussed in more detail in Chapter 7.

Table 8.8 Key Assumptions made in financial forecasting

Funding Requirements

Current Budgets

Comparing the forecasted costs from the previous sections with the current budget for the 20-year period, helps to identify any possible funding shortfall or surplus. Shortfalls in funding on the maintenance program can lead to accelerated requirements for capital growth / renewal support. Shortfalls between historical budgets and the forecasted costs associated with the management scenario are summarized in Table 8.9.

Lifecycle Activities	Average Past Budget	Forecast Annual Cost ($000)						
		2021	2022	2023	2024	2025	2026-2030	2031-2040
Total Operations & Maintenance	**$7,009**	**$8,715**	**$8,381**	**$8,602**	**$8,720**	**$8,717**	**$45,241**	**$105,231**
Capital renewal & rehabilitation forecast	$2,459	$2,400	$3,053	$3,467	$2,308	$2,375	$11,357	$37,927
Capital new assets & disposal forecast	$1,553	$8,387	$8,966	$8,616	$8,456	$8,297	$41,935	$84,331
Total Capital	**$4,012**	**$10,787**	**$12,019**	**$12,083**	**$10,764**	**$10,672**	**$53,292**	**$116,258**
Total	**$11,021**	**$19,502**	**$20,400**	**$20,685**	**$19,484**	**$19,389**	**$98,533**	**$221,489**
Operations Shortfall		-$1,706	-$1,372	-$1,593	-$1,711	-$1,708	-$10,196	-$35,141
Renewal Capital Shortfall		$59	-$594	-$1,008	$151	$84	$938	-$7,337
Growth Capital Shortfall		-$6,834	-$7,413	-$7,063	-$6,903	-$6,744	-$34,170	-$68,801
Total Shortfall		**-$8,481**	**-$9,379**	**-$9,664**	**-$8,463**	**-$8,368**	**$-43,428**	**-$111,279**

Table 8.9 Financial forecast shortfall

The shortfall averages $9.0M for the first 15 years into the future. This escalates to a gap of $18.1M from year 20 to year 35, and then $36.1M between year 40-50. This is illustrated in Figure 8.5.

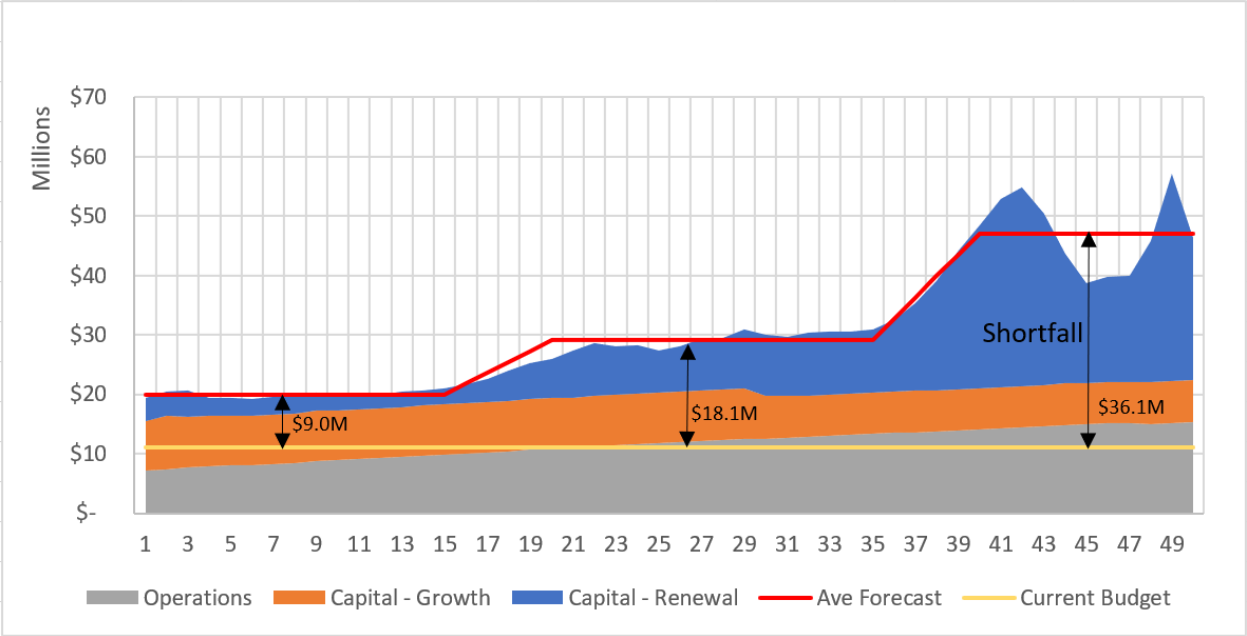


Figure 8.5 Average budget shortfall

The substantial gaps in the near, medium and long term reflect the increase in investment required to achieve the canopy performance target of 20% within the next 50 years. Closing this gap incrementally, rather than through a reserve fund mechanism aligns with the principle of service delivery. Future citizens will enjoy a larger urban forest, and this justifies a larger investment in the future as the canopy of the city expands. In the near term, the $9.0M gap must be closed to establish tree planting rates that allow the City's forest to mature and expand to achieve performance targets in the future.

Additional insight into the required investment to achieve the management scenario is provided by Figures 8.6 to 8.9. Existing operational and capital budgets on the left fund the programs for Maintained Trees, Naturally Wooded Areas, and Naturalization Areas. Activities included in each program area are quantified on the right hand side of the figure.

- Figure 8.6 shows the current budgets and program activities
- Figure 8.7 shows the funding gap in Year 1 to deliver the management scenario
- Figure 8.8 shows the funding gap in 30 years to deliver the management scenario
- Figure 8.9 shows the funding gap in 50 years to deliver the management scenario.

Each figure should be considered as a "snapshot" in time of forecasted expenditure for the City, based on the chosen management strategy.

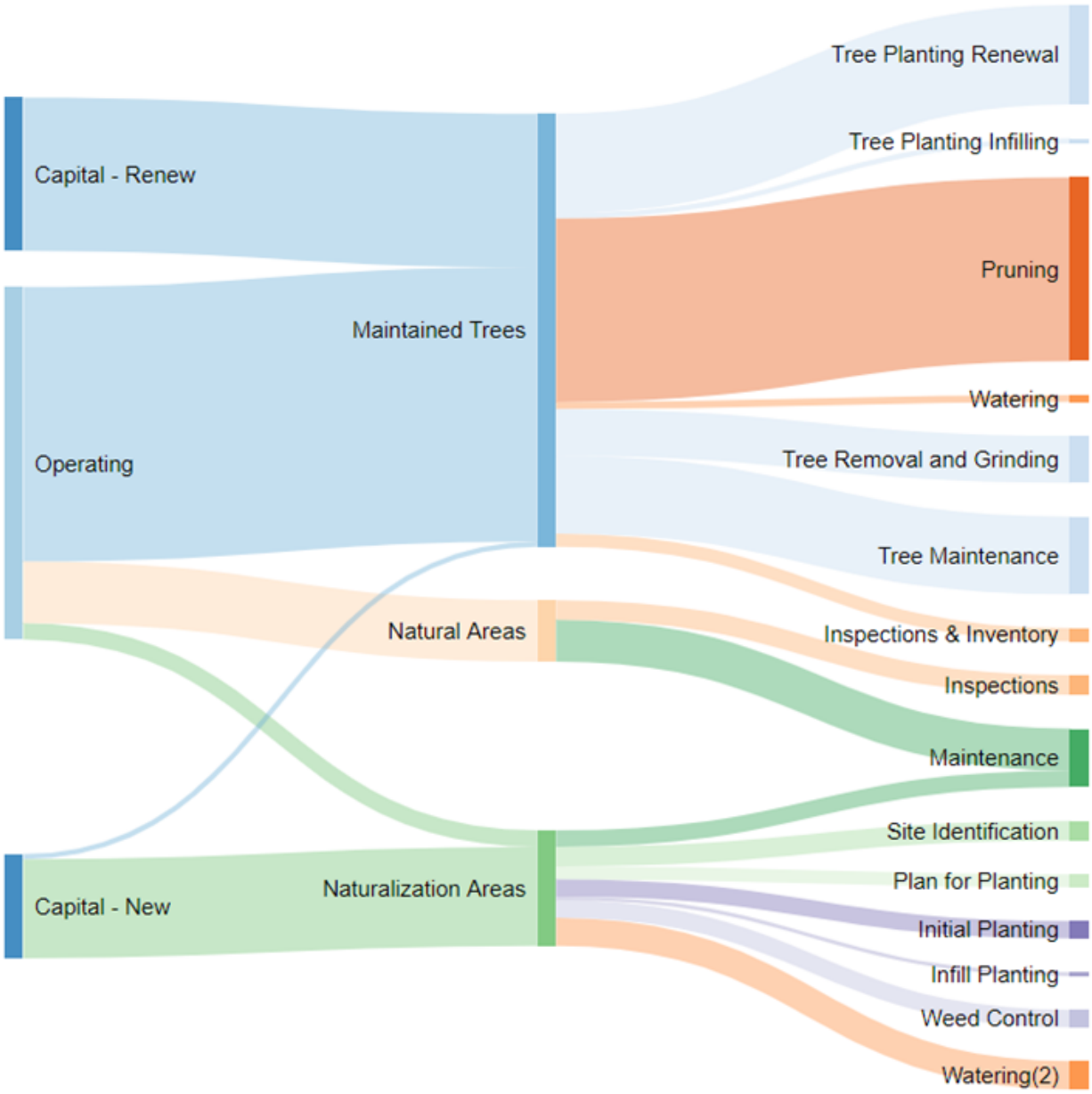


Figure 8.6 Funding flows for programs and their activities, current budget

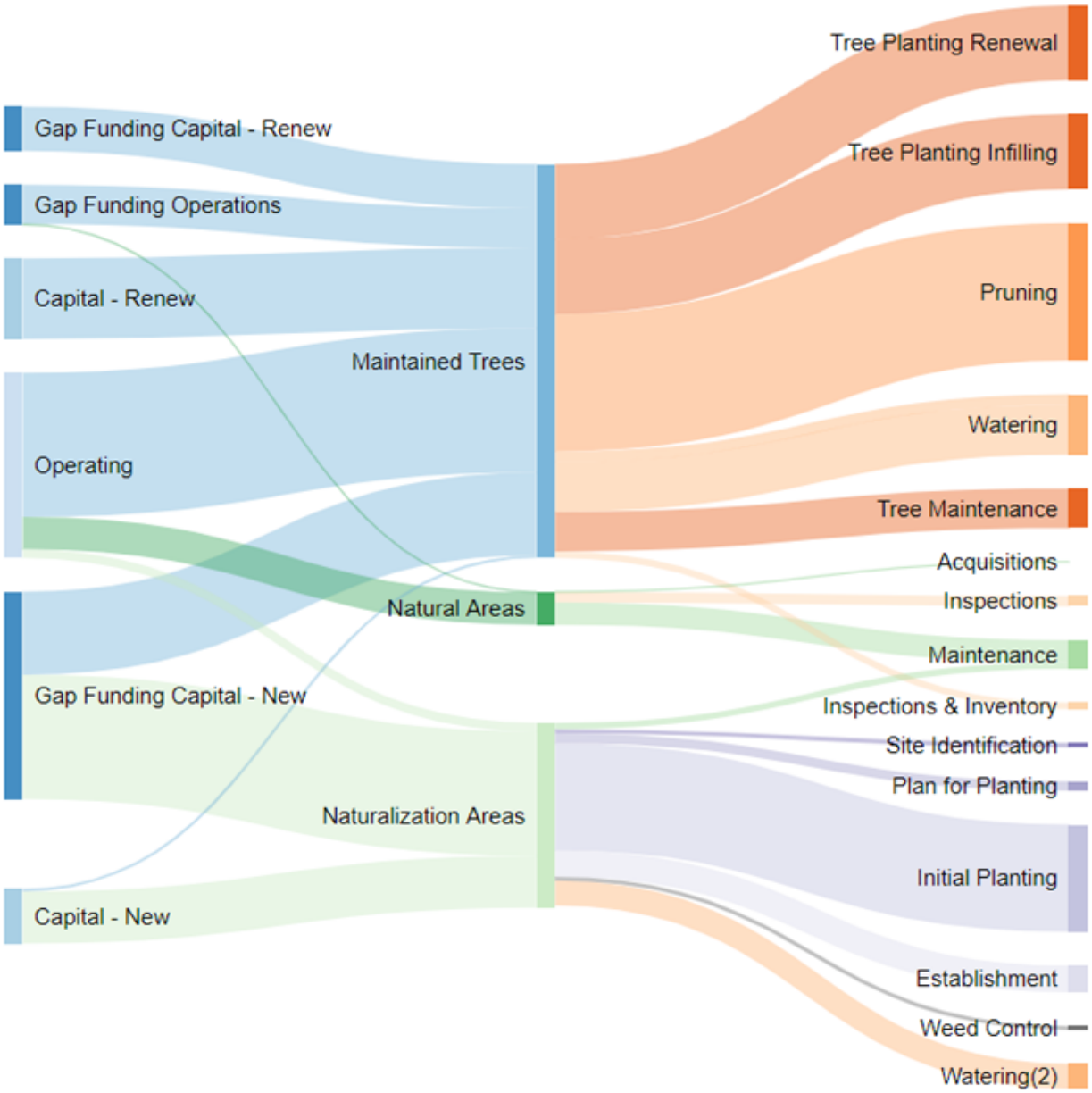


Figure 8.7 Funding flows for programs and their activities, year 1 of forecast

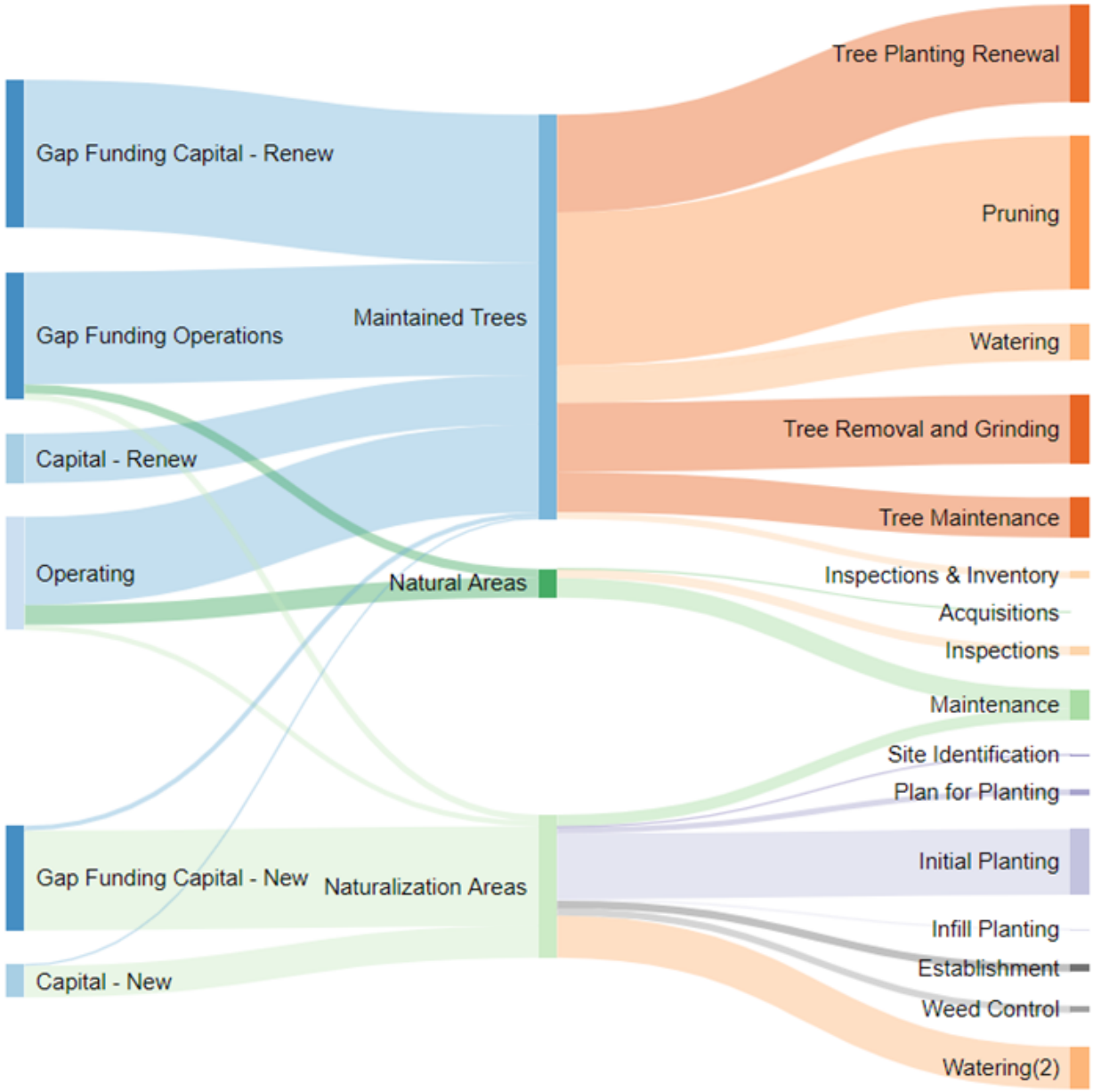


Figure 8.8 Funding flows for programs and their activities, year 30 of forecast

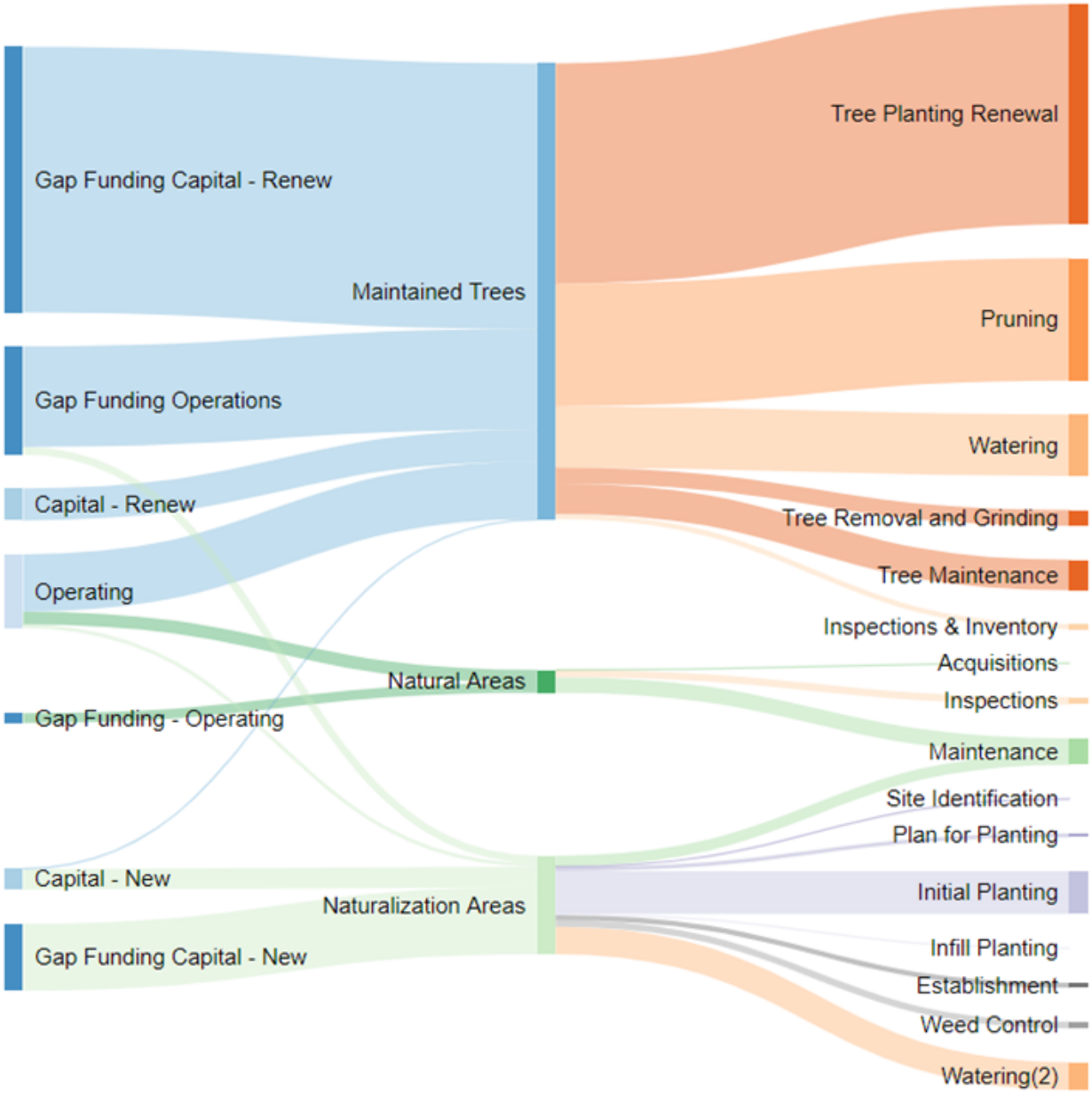


Figure 8.9 Funding flows for programs and their activities, year 50 of forecast

As shown in the figures, additional operational, renewal capital, and growth capital funds will be required to deliver the management scenario. Other key points include:

- **Gaps in required investments to meet canopy targets -** The incremental contributions (to canopy) of Naturalization Areas is similar to the increases contributed by Maintained Trees (+2% versus +2.2%, See Figure 8.1). The associated increases in required funding (the gap) for the Maintained Trees, however, is much larger than what is required for the naturalization areas. In other words, creating new maintained trees is a relatively expensive option for increasing canopy. This higher investment is partially justified by the additional

services Maintained Trees provide such as aesthetics and shade along road corridors and within neighbourhoods.

- **Small operational gaps in Natural and Naturalization Areas -** The longer-term operational costs associated with Natural and Naturalization Areas are very low in relative terms. Once established, these areas provide a low cost, regenerative method to maintain canopy for the City.

- **Growth capital predominates over the first half of the planning horizon followed by renewal capital as the major cost in later periods:** The incremental increase in new growth capital cost is higher in the first 10 years than renewal capital investment requirements. However, this trend reverses halfway through the planning period when the increase in renewal costs to replace current trees becomes higher than growth capital. New capital investment will fall to low levels as the canopy target is reached and renewal capital investment will predominate, particularly for the Maintained Tree program.

The next section provides some context for the required increases.

Funding Strategies

Currently operational budgets are funded through taxation revenues. It was assumed that the shortfalls in all three operating programs will be funded completely through this mechanism as well. To help with context, the forecasted costs and shortfalls have been quantified in terms of per capita cost, relative to assessed value and as a percentage of the existing operating budget. This is summarized in Table 8.9.

	Average Annual Forecasted Costs	Current Population	Total Assessed Value	2019 City-wide Operating Budget
2021-2030		Per capita	Per $100k assessed value	% of operating budget
City 2019 Statistics	Not applicable	972,223	$173.916B	$2.885B
Total Operations & Maintenance	$8,838,000	$9.09	$5.08	0.31%
Operations Shortfall	$914,000	$0.94	$0.53	0.03%
2021-2040				
Total Operations & Maintenance	$9,680,000	$9.96	$5.57	0.34%
Operations Shortfall	$2,671,000	$2.75	$1.54	0.09%

Table 8.9 Operating shortfall relative to city statistics

Several key observations can be made about the relative size of the operating shortfall.

- The majority of the operating shortfall relates to Maintained Tree activity.

- The average forecasted cost (and shortfall) is presented both for the first 10 years, as well as for the next 20 years. As illustrated previously, for the initial 15 years, there is a plateau of forecasted expenses. This escalates in the final 5 years of the next 20 years, increasing the average.

- The shortfall represents approximately an increase of $0.94 to $2.75 per capita over the next 10-20 years.
- The shortfall is between $0.53 and $1.54 per $100k of assessed value from tax revenues over the next 10-20 years.
- The overall average forecasted costs represent 0.03 to 0.34% of the City's overall operating budget.

The capital budget shortfall has been split between forecasted costs for renewals and forecasted costs for growth. Capital funding is available from multiple sources including pay as you go taxation. This process is managed by the finance team, and it was assumed any shortfall would be funded through taxation revenues.

The management scenario actually shows a slight surplus for the renewal budget over the next 20 years, while the City's Maintained Tree portfolio remains relatively young. There is a large capital growth shortfall, due to a much higher level of tree planting to achieve canopy performance targets in 50 years. Similar to the table above, the relative values of anticipated shortfalls / surpluses are summarized below in Table 8.10.

	Average Annual Forecasted Cost	Current Population	Total Assessed Value	2019 City-wide Renewal Budget	2019 City-wide Growth Budget
2021-2040		Per capita	Per $100k assessed value	% of budget	% of budget
City 2019 statistics	not applicable	972,223	$173.916B	$1.957B	$2.7982B
Total Capital	$11,293,000	$11.62	$6.49	0.24%	
Renewal Capital	$2,844,000	$2.93	$1.64	0.15%	not applicable
Growth Capital	$8,449,000	$8.69	$4.86	not applicable	0.30%
Total Shortfall	$7,281,000	$7.09	$3.97	0.25%	
Renewal capital Shortfall	$385,350	$0.40	$0.22	0.02%	not applicable
Growth Capital Shortfall	$6,896.40	$7.09	$3.97	not applicable	0.25%

Table 8.10 Capital shortfall relative to city statistics

Several key observations can be made about the relative size of the capital budget shortfall.

- The vast majority of the shortfall relates to growth investment for planting maintained trees and trees in Naturalization Areas.
- The average forecasted cost (and shortfall) is presented for the 20 years. This shortfall is consistent throughout the period.
- The growth shortfall represents approximately $7.09 annual increase per capita over the next 20 years, or $3.97 per $100K of assessed value.

- The renewal shortfall is very small, representing only 0.02% of the existing renewal budget. This can be assumed to be consistent over the next 20 years.
- The average forecasted growth capital shortfall represents 0.25% of the City's overall growth capital budget.

These figures are all based on 2019 city statistics, which will change over time. No forecasted statistics such as population or property valuation were available beyond 2019. In addition, the shortfalls do not account for any risks associated with disease or drought. These issues are discussed in the next section.

Financial Risks

Table 8.11 lists potential events that could impact the financial forecast for delivering the Urban Forest service and supporting it to achieve the current Level of Service performance targets, particularly for canopy. The potential impact and mitigation measures proposed to try to prepare for and reduce any adverse impacts have also been included.

Risk	Potential Impact	Mitigation Measure
External impacts affecting City revenue	Reduction in budgets.	Preparing this AMP linking budgets to service levels and enabling budget scenario impacts to be understood.
Emerald Ash Borer and Dutch Elm Disease	Large portions of the Maintained Tree portfolio die prematurely, requiring large increases in renewal capital investment . Impact estimated to be $345.6M in addition to the forecasted costs for the management scenario.	Monitoring programs continue and inoculation options are available.
Increased Frequencies of Drought Events	Increases in tree mortality in both mature and newly planted trees. Impact estimated to be $105.3M in addition to the forecasted costs over a 50 year period.	Increased watering can help minimize the impact of drought, as well as selection of tree species that are resilient to drought.
Canopy growth on non-city owned properties is lower than planned	More new trees are needed than planned to meet the 20% canopy target increasing the forecasted costs.	Track canopy growth on non-city owned properties and adjust incentive programs as required.
Canopy growth on city owned properties is lower than planned	Viable land or resource constraints prevent the city from executing the growth planning plan as intended.	Additional land acquisition and augmented resources may be required to achieve canopy targets.
Fewer opportunities than planned to acquire Natural Areas and they are developed instead	More new trees are needed than planned to meet the 20% canopy target increasing the forecasted costs.	Update the City-wide Natural Area Management Plan to identify potential areas for protection.

Risk	Potential Impact	Mitigation Measure
Lower developer activity than planned	Fewer new trees are planted by developers increasing the City's costs to create new trees to meet growth targets.	Increase incentives for third parties to plant new trees on non-city owned properties.
Uncertain data on the age and expected useful lives of the maintained trees.	Inaccurate forecasts of the timing for renewing the inventory of maintained trees.	Expected useful lives were estimated by an arborist with expert knowledge of the Edmonton environment and reviewed by City staff. Constraints were added to the forecasting model to dampen renewal planting in the first 10 years recognizing the variable lifespans of existing mature trees.
Existing maintained trees cannot be renewed when they reach the end of their lives	The number of new trees needed to reach the 20% canopy target would be underestimated. Forecasted capital costs for maintained trees would be overestimated because the cost to plant a tree at a new location is lower than the cost to replant an existing tree. Stump removal is not required at a new location.	Collect data on the percentage of existing maintained trees that are not replaced to improve estimates in future plans.

Table 8.11 Financial fisks

Recommendations to Improve Future Financial Plans

Each of the previous chapters has contributed to the financial plan. As a result, the recommended improvements from the previous chapters will also improve financial plans in future AMPs. Additional recommendations on improvements include:

1) More detailed tracking of costs for operation and maintenance activities by asset category. This activity based approach to accounting will improve budget forecasts and help the City establish full cost accounting as directed in the City Plan for natural assets as part of capital planning and budgeting.

2) Develop a more detailed funding strategy and budget forecasts. This will improve the quantification of potential funding shortfalls in future AMPs.

3) Quantify the costs that have been excluded from this initial AMP including:

    a) Land acquisition to increase the quantities of Natural and Naturalization Areas.

    b) Budgets of other departments providing services such as Pest control.

c) Program costs to incentivize third party planting on both city owned and private property.

d) The lifecycle costs of other natural assets excluded from the scope of this AMP (e.g., wetlands, naturally non-wooded areas, and naturally non-vegetated areas). These other natural assets may merit their own strategy, but this plan is focused exclusively on the urban forest.

e) Mitigation activities to manage high risks other than drought, emerald ash borer, and dutch elm disease.

Asset Management Continuous Improvement Indicators

This section presents indicators for the continuous improvement of asset management practices related to understanding the current state of the asset infrastructure.

Continuous Improvement Indicator for the Asset Management System

Financial: Tracking financial performance in terms of forecast cost contributes to better understanding of financial sustainability. Continuous improvement performance trends can be tracked through the following indicators:

- Forecast Annual Expenditure
- Forecast Annual Revenue

9. Improvement Plan

Asset management for the urban forest is continually evolving and maturing. Continuous improvement is an important focus for the City and is a thread that runs through our entire asset management approach.

Improving asset management is a commitment to obtain the greatest benefit from the City's investments in infrastructure. This can be achieved by implementing a consistent and holistic approach to how the City manages our assets.

Improving the AMP

Table 9.1 lists all the improvements identified as part of the AMP. Each task has a unique identification number and has been grouped by high, medium, and low priority, where:

- High – To be completed within 1 year
- Medium - To be completed within 1-3 years
- Low - To be completed within 3-5 years

The prioritization in the table was based on the general strategy of:

- Determining over the next year the information needed to improve asset management and the next AMP (high priority);
- Collecting this information between years 1 to 3 (medium priority);
- Applying the information to update the AMP in year 4 (low priority).

The improvements in the table are grouped by high, medium, and low priority, and have not been further prioritized within the groups. They are listed in order of the chapter they apply to in the AMP. The first digit of the Task No. refers to the relevant chapter. More detailed prioritization and scheduling for these tasks is provided in a separate Implementation Strategy document.

Task No.	Task Name	Description	Priority
3.2	Develop a data management strategy and plan	The plan should identify: • Attributes to be included for each asset including ownership for natural areas, naturalization stage for naturalization areas, location and removal date for maintained trees • The database structure including integration with GIS • Database management to create a persistent database that can be updated over time and analyzed to identify and monitor trends in future AMPs. • An administrative process that helps ensure there is a "single source of truth" for the inventory that represents the most reliable and up to date information available.	within 1 yr

Task No.	Task Name	Description	Priority
3.6	Collect data on trees that are removed	When maintained trees are removed: • Complete a stump survey for a sample of tree species to compare the measured DBH with the actual age of the tree to get a database for age vs. DBH for older trees. • Collect the necessary data to analyze the reasons for losing young trees during the 10 year period after establishment (i.e. years 4 to 13).	within 1 yr
3.9 6.4	Develop a condition assessment approach and collect data for natural and naturalized areas	The approach should align with the five point scale in the City's asset management template. The current assessment tool for monitoring the ecological health of natural stands may be a good starting point.	within 1 yr
4.1	Develop performance measures for ecological connectivity and diversity of native species	Develop performance measures for ecological connectivity and diversity of native species in areas as these are key strategic service goals of the urban forest assets.	within 1 yr
4.7 5.5	Update the master plans for the urban forest assets	Update the master and management plans for the urban forest assets and establish targets for quantities of each asset type required to achieve the key goal of 20% canopy cover.	within 1 yr
5.2	Work with utility companies and developers to find new ways to create and share green space	Occupational health and safety standards are expected to become more stringent requiring larger utility corridors to ensure adequate space for utility and green infrastructure. If the space is inadequate, then existing trees cannot be replaced as they reach the end of their lives, and new trees cannot be created.	within 1 yr
5.4	Confirm assumptions underlying demand forecasts in this plan	Further analysis to confirm the assumptions underlying demand forecasts in this plan including: • Research to develop canopy estimates for the different types of maintained trees by level of maturity (young, semi-mature, mature and old), species, and the different types of areas. • Analysis to confirm the current canopy on non-city owned properties • Confirming and tracking canopy coverage provided by both city and non-city owned assets. The growth in canopy coverage on non-city owned properties will be a key factor in determining the quantity of assets the city will need to provide to meet its performance target of 20% canopy coverage.	within 1 yr
6.5	Plan for and improve the Emergency Response Plan	Ensure that the team is ready for emergency work and manage the shift between emergency work and planned work	within 1 yr

Task No.	Task Name	Description	Priority
7.1	Prepare a risk framework for assessing and identifying unacceptable risks to infrastructure assets	The framework should align with the RIMS methodology.	within 1 yr
3.1	Create an asset register	Develop a database to store accurate, detailed, and current asset information based on the hierarchy included in this AMP. The register should be the single source of truth for urban forest asset data.	1 - 3 yrs
3.3	Update data on conifer age or DBH for maintained trees	The ages of conifer trees were underestimated because the DBH data was out of date. The DBH data should be updated.	1 - 3 yrs
3.4	Develop age class attributes for naturally wooded areas	Research and develop age class attributes using successional stages for naturally wooded areas.	1 - 3 yrs
3.7	Collect data on the attributes of the soil for maintained trees	Attributes should include characteristics that would affect tree health and help select the best species for renewal such as quantity of grow space and other soil and drainage characteristics.	1 - 3 yrs
4.2	Collect performance data	Collect data to report on current performance for the measures identified in this plan. If there are no plans to collect the required data, then review options for the performance measures that would be based on available data.	1 - 3 yrs
4.3	Quantify the ecological benefits of the urban forest	Improve collaboration between the urban forest operations team and the Environmental Strategies team to quantify the ecological benefits of the urban forest such as tonnes of pollution removed, carbon sequestered, and quantity of stormwater runoff retained.	1 - 3 yrs
4.5	Review performance measures for new plans developed by the City	Review measures from new plans such as the Breathe Implementation plan and use the relevant ones for reporting the performance of urban forest assets. In other words, use readily available measures from strategic plans where possible. This will reduce the costs of measuring performance, and strengthen the links between urban forest levels of service and broader, more strategic goals.	1 - 3 yrs
4.6	Update performance measure targets including those identified as TBD	Update targets after measuring and assessing current values for performance measures.	1 - 3 yrs

Task No.	Task Name	Description	Priority
5.1	Identify primary demand factors for forecasting future quantities of urban forest assets	Ideally, the primary factors for forecasting future quantities of maintained trees, natural areas, and naturalization areas would be available from other more strategic plans such as the City Plan, the Breathe Implementation Plan (in progress), Ribbon of Green plans (e.g. SW and NE, and 2022 completion), and Connect Edmonton. Potential factors that could be used to forecast the future demand for urban forest assets include estimated quantities of: • Areas to be developed; • New housing starts; • Park space, greenways, or transportation corridors to be created; • Non-city owned natural areas that could be secured. • Quantities of naturalization areas being created by developers.	1 - 3 yrs
5.6	Coordinate urban forest growth forecasts with Climate Action Plan goals	Coordinate growth planning work and assessment with Climate Action Plan Goals of accelerating nature based solutions to achieve the City's climate resilience goals.	1 - 3 yrs
6.1	Complete and keep team level work plans current, and develop a work plan for naturalization areas	The sections on the annual program, resource allocation, and procurement plan have important information for longer term, tactical level planning.	1 - 3 yrs
6.2	Improve the estimates of unit costs for naturalization lifecycle activities	Track costs and quantities of work delivered for naturalization maintenance activities, infill planting, and restoration of disturbed lands.	1 - 3 yrs
6.3	Update the asset lifecycle strategies to include planning and design	Update the asset lifecycle strategies to include planning and design activities and track these costs separately from the asset operations, maintenance, and renewal activities, e.g. updating specific Natural Area Management Plans.	1 - 3 yrs
7.2	Apply the framework to assess the risks identified in this plan	Review and assess the risks identified in Appendix J.1 and J.2 of this plan using the framework and populate the risk register for the next version of the AMP.	1 - 3 yrs
7.3	Develop strategies to mitigate unacceptable risks	Develop and estimate the costs of strategies to manage risks assessed as unacceptable using the framework, i.e. mitigate, accept, transfer, avoid.	1 - 3 yrs
7.4	Assess options to mitigate unacceptable risks	Use the information from this AMP and other plans and reports to assess the benefits and costs of the future mitigation options listed in Table 7.4 and decide which ones to implement.	1 - 3 yrs

Task No.	Task Name	Description	Priority
7.5	Update the risk register	Document the selected risk mitigation actions in the risk register and use it as a tool to regularly monitor and report on risks.	1 - 3 yrs
8.1	Introduce activity based accounting for asset operation and maintenance activities	More detailed tracking of costs for operation and maintenance activities by asset category will improve budget forecasts and help the City establish full cost accounting as directed in the City Plan for natural assets as part of capital planning and budgeting.	1 - 3 yrs
8.2	Develop a more detailed funding strategy	Develop a more detailed funding strategy and budget forecasts for operating and maintenance, renewal capital, and growth capital.	1 - 3 yrs
8.3	Quantify costs for activities and assets not included in this AMP	Quantify the costs that have been excluded from this initial AMP including land acquisition, budgets of other City departments providing services, program costs to incentivize third-party planting, lifecycle costs of natural assets excluded from the scope of this AMP, mitigation costs for high risks.	1 - 3 yrs
6.6	Consider options to the existing strategies to identify the least cost approach for providing the levels of service	Review alternative methods for achieving the performance measures described in Section 4 including: Pruning cycles for trees by neighbourhood, species and possibly by age class structure; Lower planting densities for naturalization areas; and Service level thresholds for interventions.	1 - 3 yrs
3.8	Include other types of natural areas in future plans	Include wetlands, naturally non-wooded, and naturally non-vegetated areas in the updated plan in 4 years.	3 - 5 yrs
4.4	Estimate ecological performance measures annually	Develop simple relationships using the results from improvement item 4.3 to estimate the ecological benefits of the urban forest on an annual basis as the urban forest inventory changes.	3 - 5 yrs
5.3	Identify trends where possible for key performance indicators identified in Section 3	Determine historical performance where possible for key performance indicators identified in Section 3, and track ongoing performance. These can then be used over time to extrapolate trends and develop relationships based on key factors.	3 - 5 yrs
7.6	Include mitigation options and costs in future AMPs	Include the selected mitigation actions and their costs in future AMPs.	3 - 5 yrs

Table 9.1 Improvement Plan

Performance Monitoring

Asset class objectives and continuous improvement indicators have been identified within this AMP. Monitoring the performance of these indicators gives an overview of the overall asset management practices performance. Table 9.2 provides a summary of the continuous improvement indicators and the monitoring plan for these.

AMP Section	Continuous Improvement Indicator	Monitoring Plan
Data Confidence	Average confidence grades for critical assets	Maintained trees - C+ Naturalized Areas - C Naturally Wooded Areas - C
Data Confidence	Existing confidence grades and target confidence grades for urban forest assets	Grade C
Asset Condition	Average condition state of assets	Not available
Asset Condition	Minimum condition state of assets	Not available
Asset Condition	Average Remaining Useful Life of maintained trees	73% of useful life remaining 43 out of 59 years
Levels of Service	Percentage of Levels of Service performance measures for which current performance is recorded	51%
Levels of Service	Percentage of Levels of Service performance measures for which current performance meets target performance	41 LOS measures were identified Insufficient data were available to assess performance for 19 of the measures Targets have been met for 5 of the remaining 22 which represents 23%
Risk Management	Number of risks mitigated or removed	34 high risks identified with a range of responses. Further analysis was not completed due to the lack of a risk framework
Financial	Forecast Annual Expenditure	$21.0 million over 20 years $30.6 million per year over 50 years
Financial	Forecast Annual Revenue	$11.0 million (average historical budget)

Table 9.2 Continuous improvement performance monitoring

The Continuous Improvement Indicators are monitored and reported on annually. Results will be reported as an annual summary against target outcomes.

Evaluation & Lessons Learned

As part of the Continuous Improvement Indicators annual reporting process, results are evaluated for gaps in performance and key lessons learned are developed. A summary of these outcomes is included in Table 9.3.

Continuous Improvement Indicator	Performance Gaps	Lessons Learned
Data confidence	Asset data was available from numerous sources that did not always produce the same results	A single source of truth for green infrastructure data would improve asset management and planning
Asset condition	Condition data was not available for individual assets	Condition data collection approach has been revised to collect and report the results for Maintained Trees by tree
Levels of service	Options for future growth to achieve key performance measures were not available	There are numerous growth scenarios for achieving the Preferred City Plan Scenario and 20% canopy coverage target. A Master Plan assessing their viability, benefits, and costs would improve planning for future demand.
Risk	The City has identified and currently manages a wide range of risks. The risks and management strategies have not been formally prioritized.	It was difficult to assess the relative levels of various risks without a common assessment framework.
Financial	The gap between current budgets and forecasted costs is large ranging from approximately 50 to 180%.	Investment in the urban forest will need to increase substantially to achieve the Preferred City Plan scenario and a 20% canopy cover.

Table 9.3 Gap Analysis & Lessons Learned

Review of This Plan

This asset management plan is treated as a live document, and where applicable, it has been updated as changes occur. The AMP will be reviewed and finalized on a 4-yearly basis and submitted on 1 December every four years.

Appendices