Nickel District Conservation Authority

Nickel District State of the Infrastructure

Final Report

Prepared by:

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Date: January, 2019

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Revision History

Rev #	Date	Revised By:	Revision Description
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January 4, 2019

Project #
60579021

Mr. Carl Jorgensen
General Manager
Nickel District Conservation Authority
Sudbury, Ontario
401 – 199 Larch Street
Sudbury, ON P3E 5P9

Dear Mr. Jorgensen:

Subject: Nickel District State of the Infrastructure Final Report

Please find enclosed AECOM's final State of the Infrastructure Report.

We trust the enclosed meets your approval. Should you have any questions or require further information about our submission, please do not hesitate to contact Keir Thomas at 705-669-4713.

Sincerely,
AECOM Canada Ltd.

Keir Thomas, P.Eng.
Project Manager
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MS:mm
Encl.

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AECOM: 2015-04-13

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1. Introduction

The Nickel District Conservation Authority (NDCA) works to ensure the Wanapitei, Vermilion, and Whitefish River watersheds are properly managed and maintained in a way that protects life, property, activity and the environment. To do so, the NDCA must maintain a variety of infrastructure assets that secure settled floodplains, ensure safe passage of water through the watershed, monitor environmental health, and create positive interactions between human and environmental activities. The NDCA must maintain this infrastructure portfolio through operations, maintenance, and capital expenditures in a way that maximizes serviceable life and optimizes lifecycle costs and activities. As a result, the NDCA is interested in developing a means to rationalize lifecycle activities through an approach that is cost effective, optimized to the goals of the organization, and economically defensible, of which this report provides the first step.

1.1 Report Objectives

This report provides a review of NDCA's asset inventory, asset investments, and upcoming financial requirements. The objective of this report is to provide the Town with an understanding of valuation of its assets and the medium to long term forecasts of upcoming capital and operational expenditures.

This report presents the NDCA with the opportunity to build on ongoing asset management efforts being undertaken by the City of Greater Sudbury, allowing the two organizations to be fully aligned in their asset management objectives.

1.1.1 How to Use This Report

This report will provide the NDCA with data and information that should be used to plan for operations and maintenance requirements, capital budgets, and sustainable funding in the medium to long term. This report should be used to evaluate NDCA's current budget forecasting and reserves to help plan for future whole lifecycle asset management.

2. Asset Inventory

The process of organizational asset management begins with a thorough understanding of an owner's asset inventory. Asset Inventory provides a review of NDCA's assets, a valuation summary, and a hierarchical breakdown of asset holdings. Providing the current state serves as a preliminary step for understanding investment requirements in the medium to long term. For this assignment, understanding NDCA's inventory also included AECOM defining the asset hierarchy for the first time.

2.1 Inventory Review

Only through understanding the properties, quantities, location, condition, and classification of an asset inventory can an asset valuation be completed that serves as the basis for forecasting capital and operational expenditures. For this reason, this report begins with a summary of NDCA's asset holdings at the time of this report to serve as the foundation for findings of the financial forecast.

2.1.1 Inventory Sources

The inventory presented during this report originates from a number of key sources of data:

- **NDCA GIS Data**
  NDCA is currently developing a GIS database that will act as the source of truth for the locations of assets owned and operated by NDCA. These database currently only contains the name and location of assets. However, NDCA wishes to establish more attributes and a formal hierarchy (of which this report provides the first step). It is expected that the data provided for use in this report will become increasingly detailed in the future.
- **Public Sector Accounting Board Reports**
  NDCA maintains a schedule of tangible capital assets as part of annual financial statements disclosed in the Financial Information Return for Ontario municipalities. This schedule establishes when assets were procured, at what cost, and their expected service life (using an age-based estimate). Consolidation of these statements with information from reliable industry resources laid the foundation for the forecasting of future financial expenditures related to the NDCA inventory of assets.
- **Other NDCA Reports**
  NDCA has taken several steps to establish the condition and performance of several of its most critical assets. AECOM has reviewed a number of these assessment reports (listed in ***Section 2.2.1***) for additional context.

2.1.2 Asset Inventory

2.1.2.1 Approach – Asset Hierarchy

The organization of assets by their system, location, and functional role is known as an asset hierarchy. The asset hierarchy is a rolled-up data structure that is organized much like a family tree with each level encompassing more and more asset records, until reaching the top or most overarching entity or system. Once established, an asset hierarchy provides the basis for managing information, categorizing assets, and understanding an asset inventory on the basis of the different services, functions, and processes the assets provide or contribute to. Using an asset hierarchy in the organization of the asset inventory ensures assets are properly defined. Homogenous groupings of assets allow for methods of modelling and forecasting that carry valid technical assumptions applicable to all assets with the group.

For this assignment, AECOM has developed a simplified asset hierarchy for the NDCA that categorizes assets based on their location and functional role. The asset hierarchy is presented in **Figure 1**.

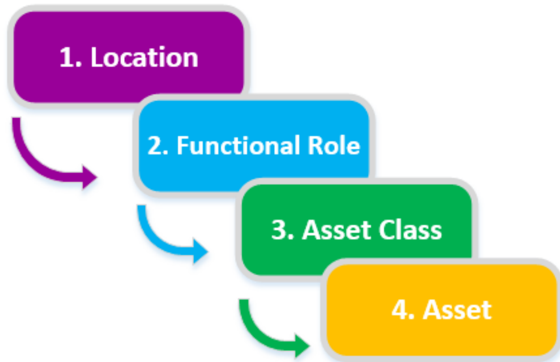


Figure 1: NDCA Asset Hierarchy Approach

Through development of the asset hierarchy, it was found that NDCA's assets serve a variety of key functions that can be broken into six distinct categories related to NDCA's overall role as a watershed manager (**Table 1**). Note that some asset classes perform multiple different functional roles (notably dams, weirs, and berms) depending on their design and implementation. Functional categories for each asset were assigned on a case by case basis using the understanding of the asset and the services it provided.

Table 1: Asset Classes by Functional Role

Functional Category	Flood Control	Water Level Control	Flow Conveyance	Erosion Control	Flood Monitoring	Customer Service
Asset Classes	-Dams -Weirs -Berms	-Berms -Dams -Weirs	-Box Culverts -Diversions	-Erosion Control -Gabion Baskets	-Flood Monitoring Devices	-Buildings

The approach to this assignment used the following definitions of the identified asset classes (**Table 2**) and functional roles (**Table 3**) that reflect the context of NDCA:

Table 2: Asset Class Definitions

Asset Class	Definition
Dam	Barrier constructed to hold back water to prevent loss of life and property caused by flooding.
Weir	A low dam built to raise the water level surface upstream to the structure or regulate its flow.
Berm	A flat strip of land, raised bank, or terrace bordering a river or wetland.
Box Culvert	A 4-walled structure that allows water to flow under transportation corridors.
Diversion	Structures designed to collect and divert stormwater runoff away from a location of interest.
Erosion Control	Structures used to control erosion caused by stormwater runoff.
Gabion Baskets	Gabions or rocks contained together through a wire mesh to increase the structural strength of erosion control structures at high volume and high velocity discharge points.
Flow Monitoring Device	Devices used for measuring the flow of surface waters.
Building	Building structures owned by NDCA used for operations or customer service delivery.

Table 3: Functional Role Definitions

Functional Role	Definition
Flood Control	Structures built to hold back floodwater and then release them under controlled circumstances to receiving water bodies. Structures built to store or divert floodwater for other uses.
Water Level Control	Structures capable of raising or lowering upstream and downstream water levels to manage and/or regulate the distribution of surface water between water bodies.
Flow Conveyance	Structures designed to facilitate the movement of stormwater runoff through or away from obstructions.
Flood Monitoring	Devices used for measuring the flow of surface waters.
Erosion Control	Structures used to control erosion caused by stormwater runoff.
Customer Service	Assets open to the public for information or recreation.

2.1.2.2 Inventory Results

Through a review of inventory sources, it was found that there are 36 assets that NDCA is required to operate, maintain, and/or inspect across 12 locations. The quantities of assets owned by NDCA are summarized by asset class in **Figure 2** and by functional role in **Figure 3**. Understanding of these quantities will be developed further in ***Section 2.3*** when the valuation of these assets is provided.

Results of gathering data for NDCA's 36 assets were comprehensive with the exception of the Grant Lake Weir. Record searches by NDCA for the Grant Lake Weir were not successful, meaning that documentation of this asset is a gap in the inventory. It is recommended that NDCA investigate further to identify age, ownership, construction cost, and other important information. For the purpose of this report, the Grant Lake Weir was assumed to be the same age and value as the Kelly Lake Weir. Valued at approximately $104,000 and installed in 1960, Kelly Lake is the oldest and most expensive weir held by NDCA, making the estimates for Grant Lake conservative.

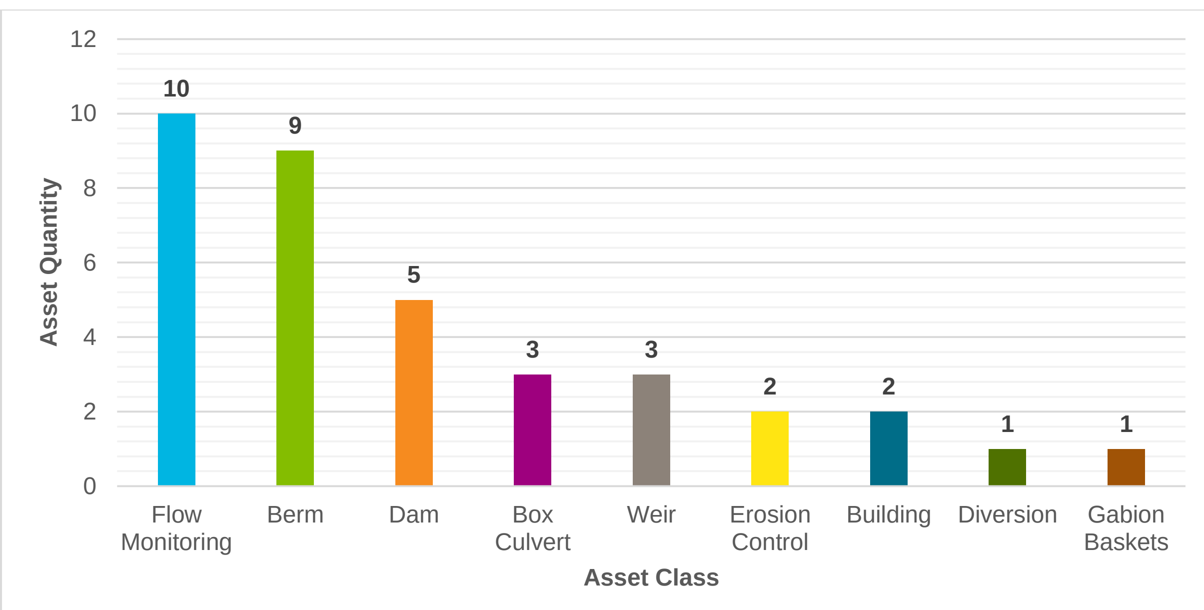


Figure 2: Asset Inventory Quantities by Asset Class

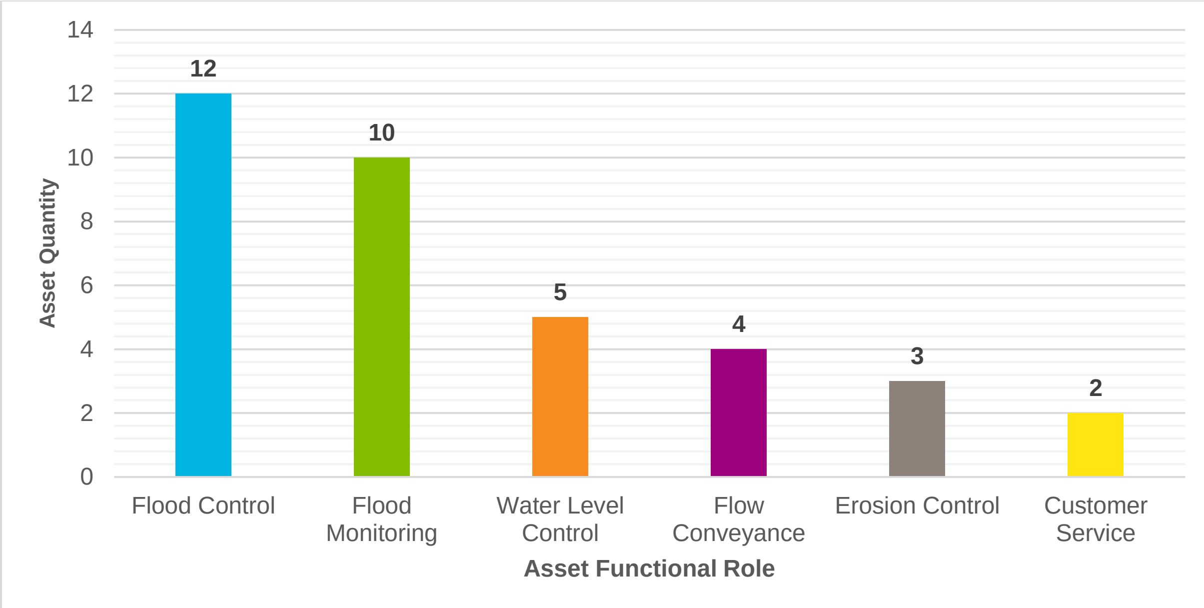


Figure 3: Asset Inventory by Functional Role

With a complete inventory, assets were then classified using the hierarchy developed for this assignment to provide NDCA with an organized and comprehensive summary. See **Figure 4** below. The resulting hierarchy provides NDCA with a means to organize data, facilitate whole-portfolio asset governance, and communicate the extent of NDCA's diverse and geographically dispersed asset holdings.

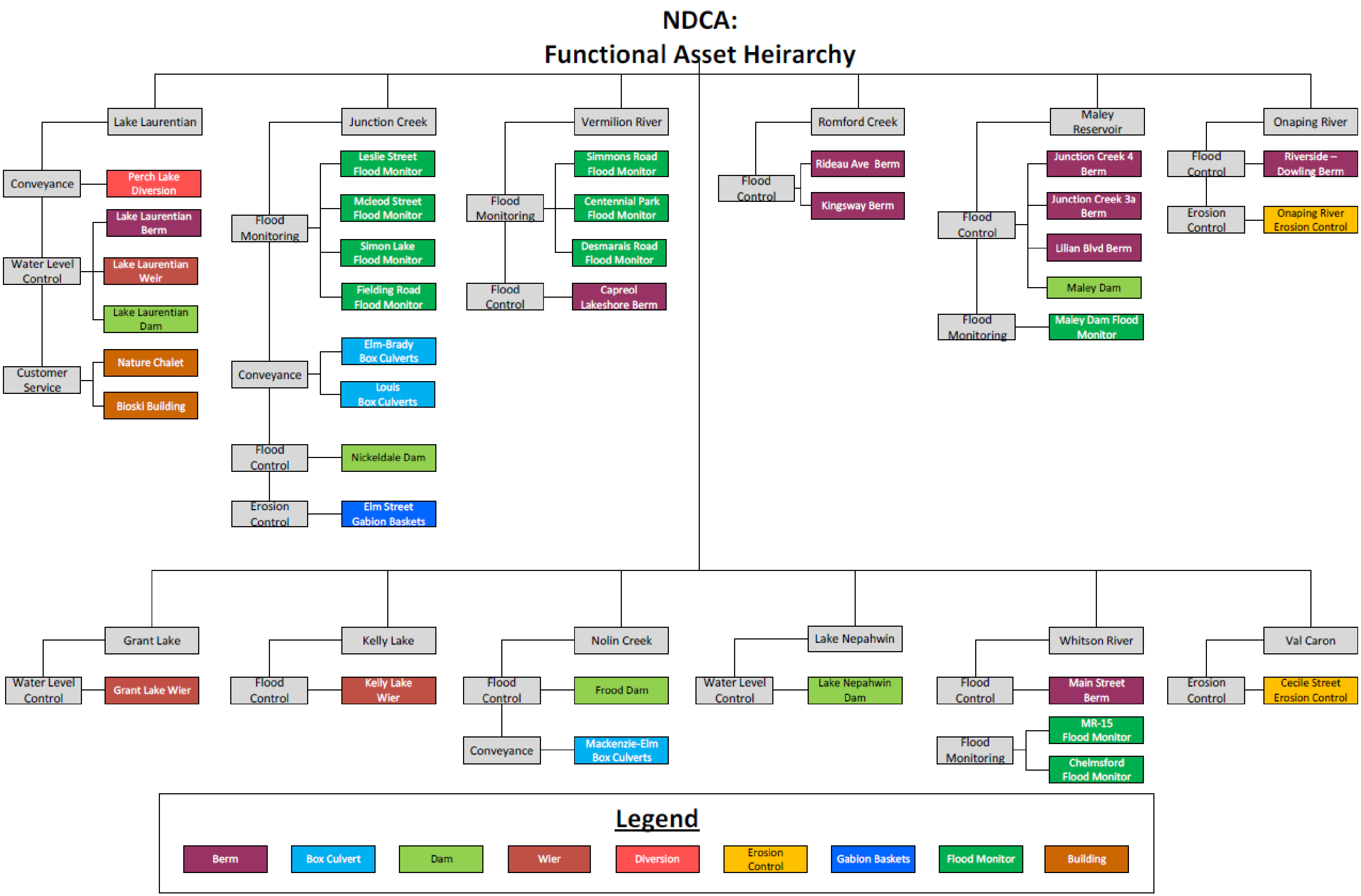


Figure 4: Asset Hierarchy and Inventory Results

2.2 Asset Age and Expected Service Life

An asset's expected service life (ESL) is that period of time which the asset is expected to be of use to the owner, after which it would need to be renewed or replaced. The age and ESL of an asset portfolio provides a key preliminary understanding of the state of the infrastructure. This information is typically readily available for most assets and provides a common metric of comparison. Based on asset age, some rough assumptions can be made about the predicted performance of the asset as a cursory method of evaluating medium-long term expenditures.

With ESL, it is assumed that specific asset classes will last a given amount of time based primarily on indexing of industry observed performance. Not all assets of a given type will fail exactly at their expected service life deadline. This means that a portion of the assets could fail before their ESL and a portion could last beyond their ESL.

Asset condition assessment should be conducted to understand current operational and structural performance and identify immediate needs for rehabilitation or replacement. In the absence of such information, age and ESL may be used to help contextualize the technical understanding of the owner for when and how to gather this information.

The method for applying age and ESL to evaluate the state of the infrastructure (to be introduced during ***Section 3***) in the absence of condition data are heavily reliant on install date information that accurately captures the age of the assets. This section will document the age and expected service life of the NDCA's infrastructure assets for an age-based understanding of the state of the infrastructure.

2.2.1 Asset Information Sources

Age and expected service life information was gathered using the consolidated financial statements identified in ***Section 2.1.1-Inventory Sources*** to ensure that the data used by AECOM was aligned with those used by NDCA for other reports.

As discussed in ***Section 2.2***, these values are meant to be used for medium to long term planning and should be refined based on the results of condition assessments and other monitoring activities. AECOM reviewed the available condition assessment reports held by NDCA and can highlight several important findings that should augment the results of examining age, expected service life, and investment planning (**Table 4**). **Section 2.3** will highlight where findings were incorporated for use in NDCA's investment planning.

Table 4: Summary of Condition Assessment Reports

Report	Comments
Maley Dam Alkali-Aggregate Reaction (AAR) Study, AECOM, 2017	Based on the recommendations of the 2014 Dam Safety Review (DSR) report for Maley Dam, an Alkali-Aggregate Reaction (AAR) study was performed in 2017. The purpose of this study was to determine whether the concrete in the Maley Dam exhibits AAR (a chemical reaction), and evaluate alternatives for repair/rehabilitation. Based on the results of this study, it was recommended that a concrete remediation program be commenced at the Maley Dam in the next one to five years to protect it from continued chemical reactions and environmental deterioration. It is proposed that the remediation be applied to the Spillways (upstream and downstream surfaces), abutment walls (exterior surfaces, both upstream and downstream of the spillway), and the three piers. The preliminary estimate for the above work is $2.45M (includes an allowance of engineering at 10% and a provision for contingency of 25%) and considers the work will be completed over 3 years.

Table 4: Summary of Condition Assessment Reports

Report	Comments
Maley Dam Safety Review Update, AECOM, 2014	Based on the findings of the Dam Safety Review (DSR), Maley dam is assigned a 'Very High Hazard Potential Classification (HPC)'. This classification is based on the consequence of failure with respect to the potential for loss of life, property losses, environmental losses, and cultural-built heritage losses. Based on technical assessment and visual observations, the DSR report made several recommendations, including localized repair of concrete defects (generally spalling) in several areas, replacing caulking in several joints and undertaking coring and testing to check for Alkali-Aggregate Reaction (AAR). The recommended timing for each of these items was one to five years. AAR study was completed in 2017. The next DSR is recommended for 2024.
Nickeldale Dam Safety Review Update, AECOM, 2014	Based on the findings of the Dam Safety Review (DSR), Nickeldale dam is assigned a 'Very High Hazard Potential Classification (HPC)'. This classification is based on the consequence of failure with respect to the potential for loss of life, property losses, environmental losses, and cultural-built heritage losses. Based on technical assessment and visual observations, the DSR report made several recommendations, including localized repair of concrete defects (generally spalling) in several areas, replacing caulking in several joints and continued monitoring of deterioration and repair as required. The recommended timing for each of these items was one to five years. The next DSR is recommended for 2024.
Box Culvert Repair Strategy, AECOM, 2012 **(Junction Creek and Nolins Creek Culvert System)**	This report provides a detailed review of rehabilitation strategies, with the objective of providing a long-term approach for effective and efficient cost/benefit rehabilitations to the Junction creek and Nolins creek culvert structures. The replacement value of the culvert system was estimated based on unit cost of $15,000/m, which is similar to culvert structures of the same span length. The replacement values represent the cost of replacement with a new structure of similar size. Based on the above, the total replacement value (structural cost only) of the Junction Creek and Nolins Creek culvert system was assessed as approximately $24,000,000 in 2012 dollars. This estimate does not include the portion of the structure not owned by NDCA. The rehabilitation costs for the culvert segments were estimated at $2,500,000 (2012 dollars), including a 15% allowance for engineering fees. A work plan is provided in the report recommending the rehabilitation efforts to be spread out over a span of 10 years. For prioritization, the assets have been categorized into Medium and High priority categories. The total estimated cost is approximately $1.13 M in 2012 Dollars for the 'High' priority rehabilitation (0-5 year time period) and $1.34 M for the 'Medium' priority rehabilitation (6-10 year time period). These costs were based on projected rehabilitation costs ranging from $2,000 and $2,500 per metre length of culvert. It was also recommended that the individual projects can be divided into six or seven projects, each valued in the range of $350,000 to $400,000.

2.2.2 Age and Expected Service Life Results

A comparison of age and ESL demonstrated that while some assets are relatively young, many are approaching or beyond their ESL. It is recommended that NDCA complete a review of the assets that are beyond their ESL to evaluate if capital improvement measures have been taken to rehabilitate these assets (ex. thereby extending the ESL) or if inspections have verified that the useful life is longer than previously expected. **Figure 5** plots the asset inventory by age. **Figure 6** plots the asset-level comparisons of age and ESL. Assets beyond the ESL are marked in red, while those with a remaining useful life are marked in green. In ***Section 3***, these results will be extrapolated to assist NDCA by forecasting the future capital expenditures based on these findings.

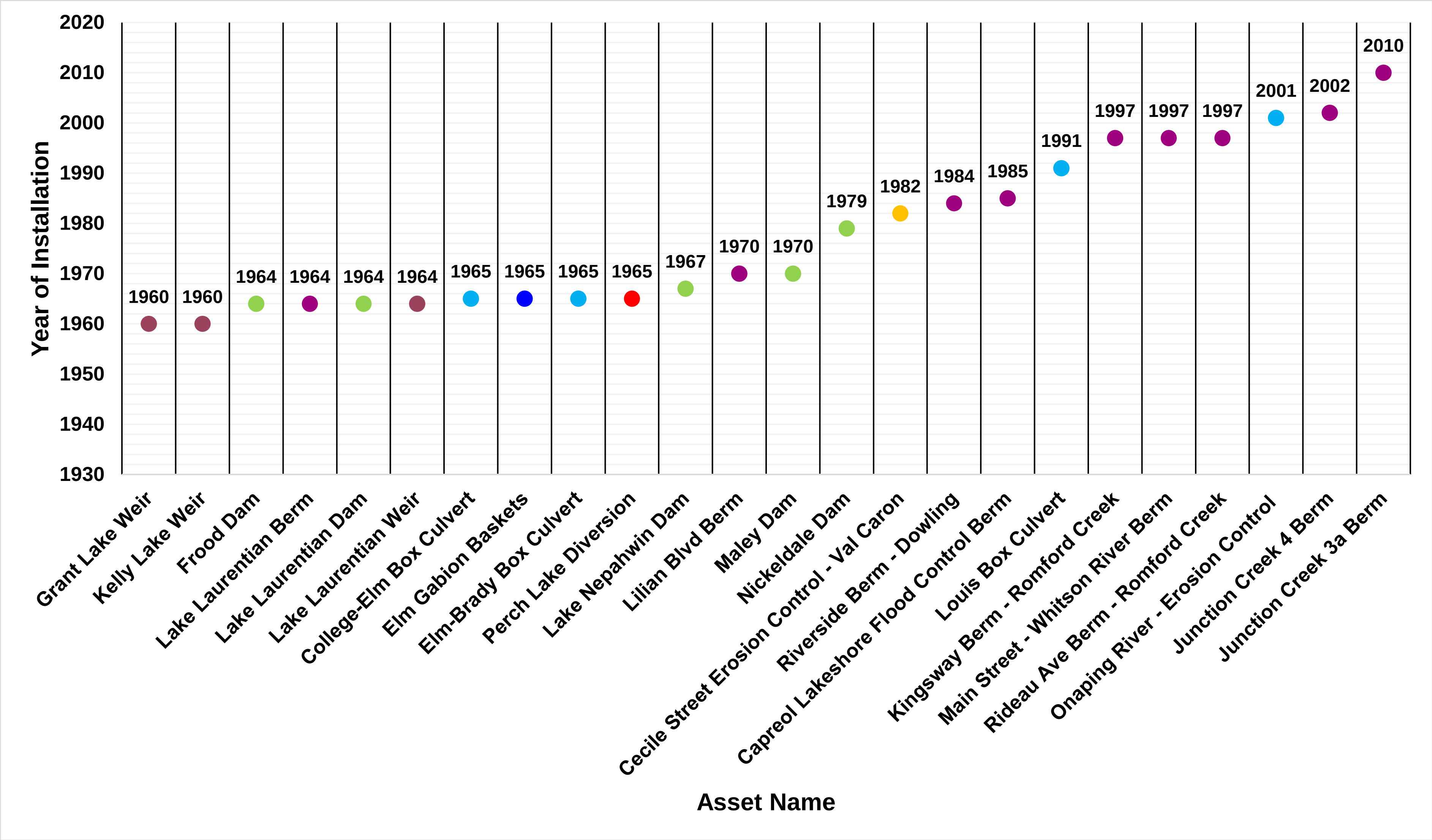


Figure 5: Asset Inventory by Year of Construction

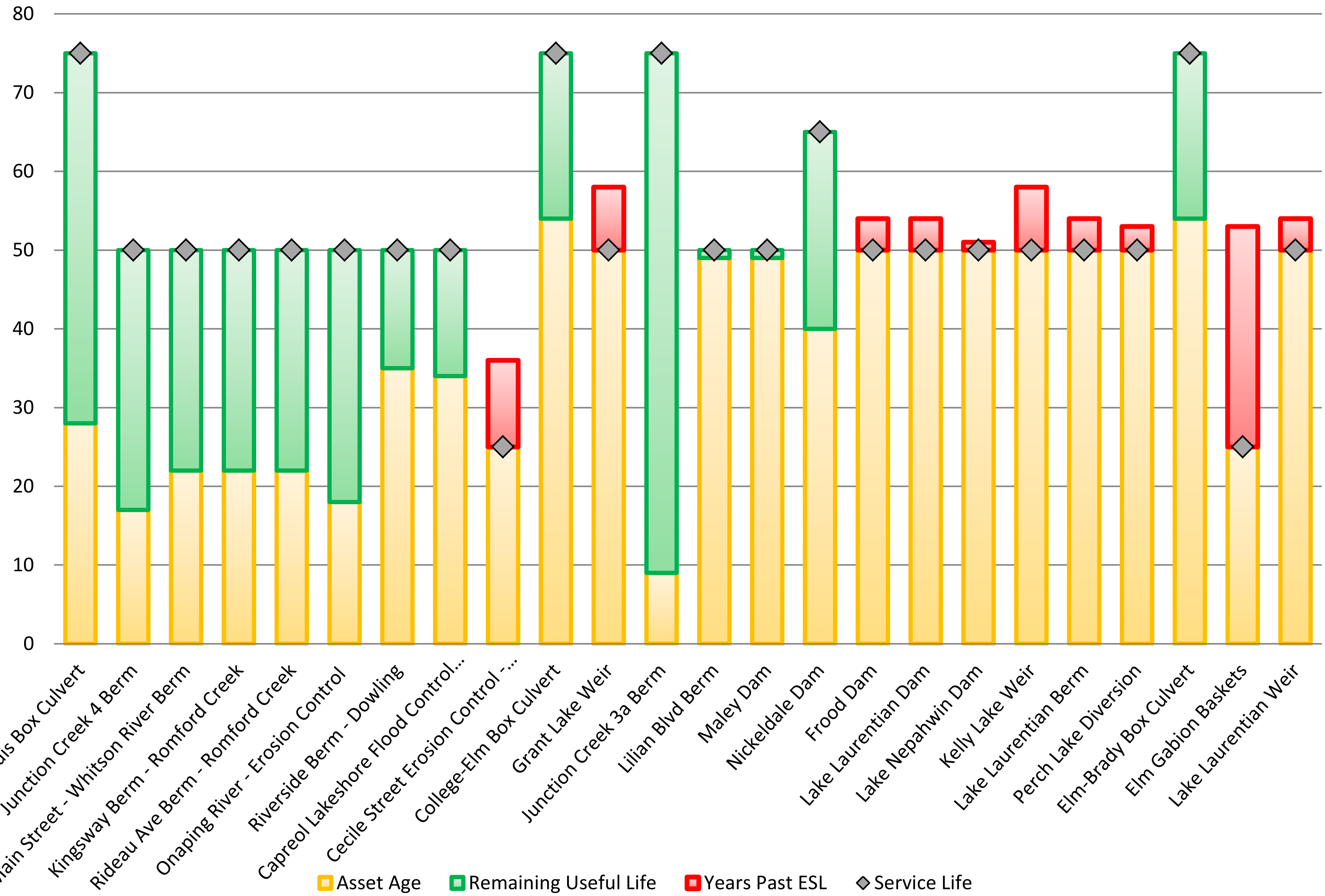


Figure 6: Infrastructure Asset-Level1 Comparison of Age and Expected Service Life

1. *Does not include buildings or flood monitoring equipment. As introduced in Section 2.1.2.2, a value for the Grant Lake Weir was unavailable. The value was assumed to be the same as the Kelly Lake Weir for this report, and should be investigated further.*

2.3 Asset Valuation

Before attempting to project any financial expenditure into the future, it is important to first understand the value of an asset portfolio if it were to be fully replaced or constructed as new assets (ex. the replacement cost). With time and increasing urbanization, NDCA has invested a significant amount of funds into infrastructure to date. The replacement value of this established asset portfolio serves as the basis for budgetting eventual replacements in the medium to long term. Asset replacement cost is important to understand, and provides a metric upon which to evaluate the state of the infrastructure, capital reinvestment plans, annual operations and maintenance budgets, and the long term financial planning required to replace or rehabilitate existing and aging infrastructure.

2.3.1 Valuation Methodology

To establish asset portfolio valuation, a review of Public Sector Accounting Board (PSAB) reports from 2013 to 2017 was undertaken by AECOM and the NDCA to establish the replacement costs of the NDCA's tangible capital assets. The value of assets used by the NDCA for public accounting was carried through this asset replacement cost valuation, and a review of historical contracts allowed values to be further delineated when a PSAB report captured a group of assets in a single line item.

When available, previous reports that analyzed NDCA's assets were reviewed by AECOM to obtain the most recent information about the asset (***Section 2.2.1-Asset Information Sources***). Review of the NDCA's Box Culvert Repair Strategy was the only instance where a replacement cost value was identified for NDCA assets in the available documents. Here, the box culvert replacement cost value obtained from the report did not match those disclosed in the PSAB reports. In this case, the value provided by the PSAB report was replaced in favour of the greater level of detail provided more recently in the Box Culvert Repair Strategy. This is an important change to highlight because of the order of magnitude difference between the replacement cost reported by the PSAB report and the cost reported by the Repair Strategy. Here, the PSAB report provided a replacement cost of approximately $2.8 M while the Box Culvert Repair Strategy provided a replacement cost of approximately $24 M. Given the magnitude of difference between these values for one of the NDCA's most critical assets, AECOM is recommending that NDCA further evaluate the replacement costs reported in PSAB for its most critical assets to ensure there is a full understanding of the replacement cost and future financial requirements of these assets.

Asset valuation replacement costs are provided in ***Section 2.3.2-Valuation Results***.

2.3.2 Valuation Results

The replacement cost of assets are summarized in **Table 5** and **Table 6**, and further illustrated in **Figure 7** and **Figure 8**. The total value of the NDCA's assets *excluding additions made between 2013 and 2017*[2] is about $35.9 million, representing a significant capital investment.

Evident from the results of the asset valuation is that dams and box culverts account for nearly 90% of the value of the NDCA's asset portfolio. Given the value of these assets, the importance of understanding the condition and operations and maintenance (O&M) requirements should be highlighted. The value of these assets should also translate to the amount of capital funds allocated to the flood control and flow conveyance functional roles provided by the NDCA, highlighting the importance of these services.

2. *See 2013-2017 NDCA Notes to Financial Statements – Table 8: Tangible Capital Assets*

Table 5: Asset Valuation

	Grant Lake	Junction Creek	Kelly Lake	Lake Laurentian	Lake Nepahwin	Maley Reservoir	Nolin Creek	Onaping River	Romford Creek	Val Caron	Vermillion River	Whitson River	Grand Total
Water Level Control	$104,000	$0	$0	$162,000	$153,000	$0	$0	$0	$0	$0	$0	$0	$419,000
Flow Conveyance	$0	$13,036,000	$0	$66,000	$0	$0	$12,000,000	$0	$0	$0	$0	$0	$25,102,000
Flood Monitoring	$0	$140,000	$0	$0	$0	$35,000	$0	$0	$0	$0	$105,000	$70,000	$350,000
Flood Control	$0	$3,462,000	$104,000	$0	$0	$4,072,000	$61,000	$213,000	$518,000	$0	$99,000	$535,000	$9,064,000
Erosion Control	$0	$518,000	$0	$0	$0	$0	$0	$238,000	$0	$34,000	$0	$0	$790,000
Customer Service	$0	$0	$0	$210,000	$0	$0	$0	$0	$0	$0	$0	$0	$210,000
Grand Total	$104,000	$17,156,000	$104,000	$438,000	$153,000	$4,107,000	$12,061,000	$451,000	$518,000	$34,000	$204,000	$605,000	$35,935,000

Table 6: Valuation Results by Asset

Asset Details	Asset Class	Location	Install Date	Valuation Source	Value
Junction Creek 4 Berm	Berm	Maley Reservoir	2002	PSAB	$716,000
Main Street - Whitson River Berm	Berm	Whitson River	1997	PSAB	$535,000
Kingsway Berm - Romford Creek	Berm	Romford Creek	1997	PSAB	$283,000
Rideau Ave Berm - Romford Creek	Berm	Romford Creek	1997	PSAB	$235,000
Riverside Berm - Dowling	Berm	Onaping River	1984	PSAB	$213,000
Capreol Lakeshore Flood Control Berm	Berm	Vermillion River	1985	PSAB	$99,000
Junction Creek 3a Berm	Berm	Maley Reservoir	2010	PSAB	$116,000
Lilian Blvd Berm	Berm	Maley Reservoir	1970	PSAB	$240,000
Lake Laurentian Berm	Berm	Lake Laurentian	1964	PSAB	$24,000
Louis Box Culvert	Box Culvert	Junction Creek	1991	Box Culvert Repair Strategy	$1,036,000
College-Elm Box Culvert [Note 1]	Box Culvert	Nolin Creek	1965	Box Culvert Repair Strategy	$12,000,000
Elm-Brady Box Culvert [Note 1]	Box Culvert	Junction Creek	1965	Box Culvert Repair Strategy	$12,000,000
Bioski Building	Building	Lake Laurentian	1983	PSAB	$32,000
Nature Chalet Building	Building	Lake Laurentian	1995	PSAB	$178,000
Maley Dam	Dam	Maley Reservoir	1970	PSAB	$3,000,000
Nickeldale Dam	Dam	Junction Creek	1979	PSAB	$3,462,000
Frood Dam	Dam	Nolin Creek	1964	PSAB	$61,000
Lake Laurentian Dam	Dam	Lake Laurentian	1964	PSAB	$122,000
Lake Nepahwin Dam	Dam	Lake Nepahwin	1967	PSAB	$153,000
Perch Lake Diversion	Diversion	Lake Laurentian	1965	PSAB	$66,000
Onaping River - Erosion Control	Erosion Control	Onaping River	2001	PSAB	$238,000
Cecile Street Erosion Control - Val Caron	Erosion Control	Val Caron	1982	PSAB	$34,000
Whitson River	Flow Monitoring (2 nos.)	Whitson River	1983	PSAB	$70,000
Vermilion River	Flow Monitoring (3 nos.)	Vermillion River	1983	PSAB	$105,000
Junction Creek	Flow Monitoring (4 Nos.)	Junction Creek	1983	PSAB	$140,000
Elm Gabion Baskets	Gabion Baskets	Junction Creek	1965	PSAB	$518,000
Grant Lake Weir [Note 2]	Weir	Grant Lake	1960	PSAB	$104,000
Kelly Lake Weir	Weir	Kelly Lake	1960	PSAB	$104,000
Lake Laurentian Weir	Weir	Lake Laurentian	1964	PSAB	$16,000
				Total	**$35,935,000**

Notes: ***1:*** *The Box Culvert Rehab Strategy Report estimated the replacement cost of these box culverts as $24M. Assuming the box culverts are of approx. same length, half of $24M is assigned to each box culvert. Note that the box culvert repair strategy did not include the Louis-Elm box culvert (as with all other assets, valuation was obtained from the PSAB report).*

2: *No data available for Grant lake Weir, which was constructed around the same time as Kelly Lake Weir. Assumed the same cost and year of acquisition as Kelly Lake Weir.*

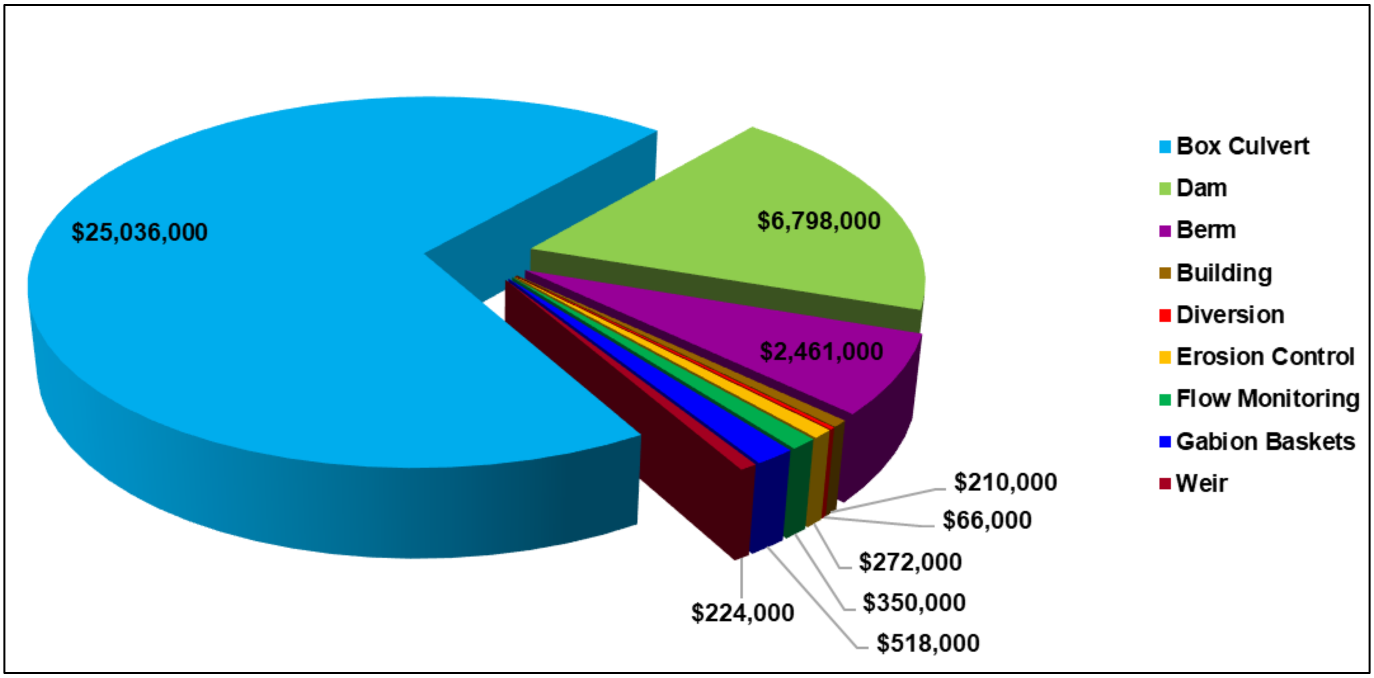


Figure 7: Asset Valuation by Asset Class

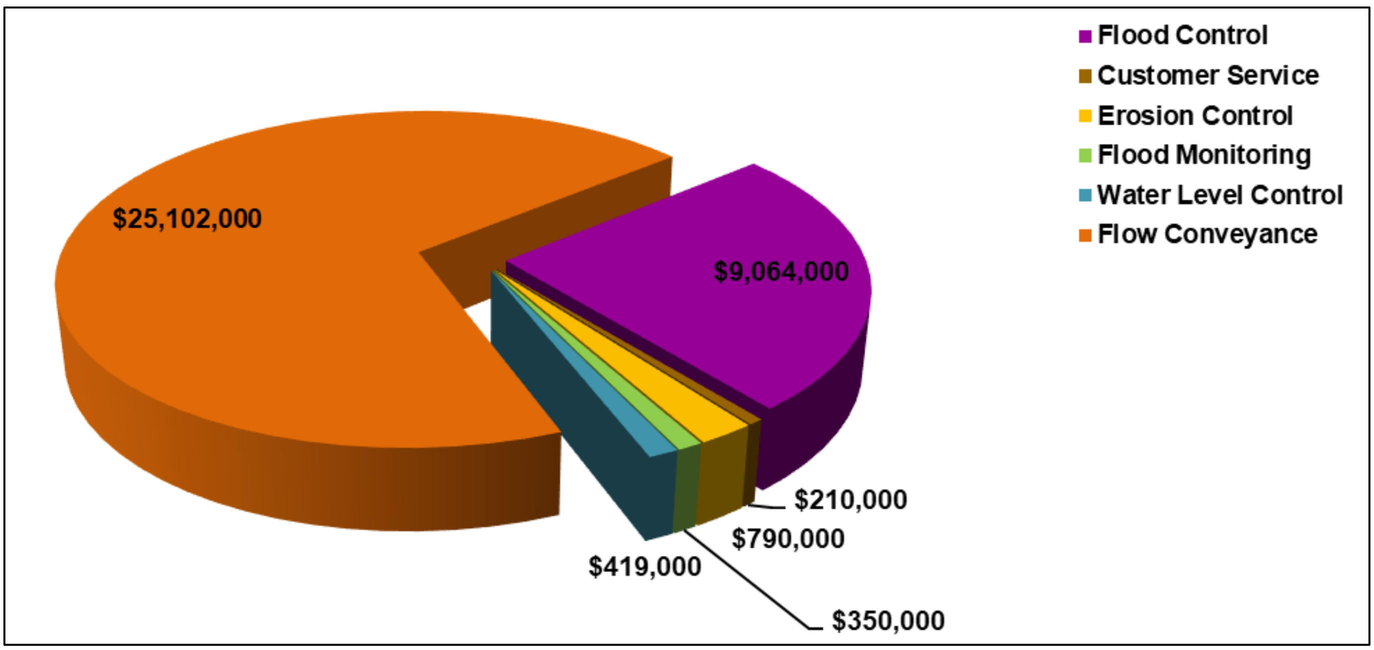


Figure 8: Asset Valuation by Functional Role

3. Capital Improvement Plan

3.1 Approach – Sustainably Funding Assets

3.1.1 Life Cycle Analysis

Life Cycle Analysis (LCA) is the practice of analyzing the financial implications of aging infrastructure assets and simulating a scenario by which assets are replaced as they reach the end of their expected service life (ESL). It involves gathering information about a collection of assets, documenting the age, understanding the condition and performance, and making predictions about the future using technical knowledge to determine the ESL of the assets. For this reason, the replacement cost valuation provided in ***Section 2.3*** serves as a key foundational step. A life cycle analysis will answer a number of questions important for financial and capital planning, including the following (**Figure 9**):

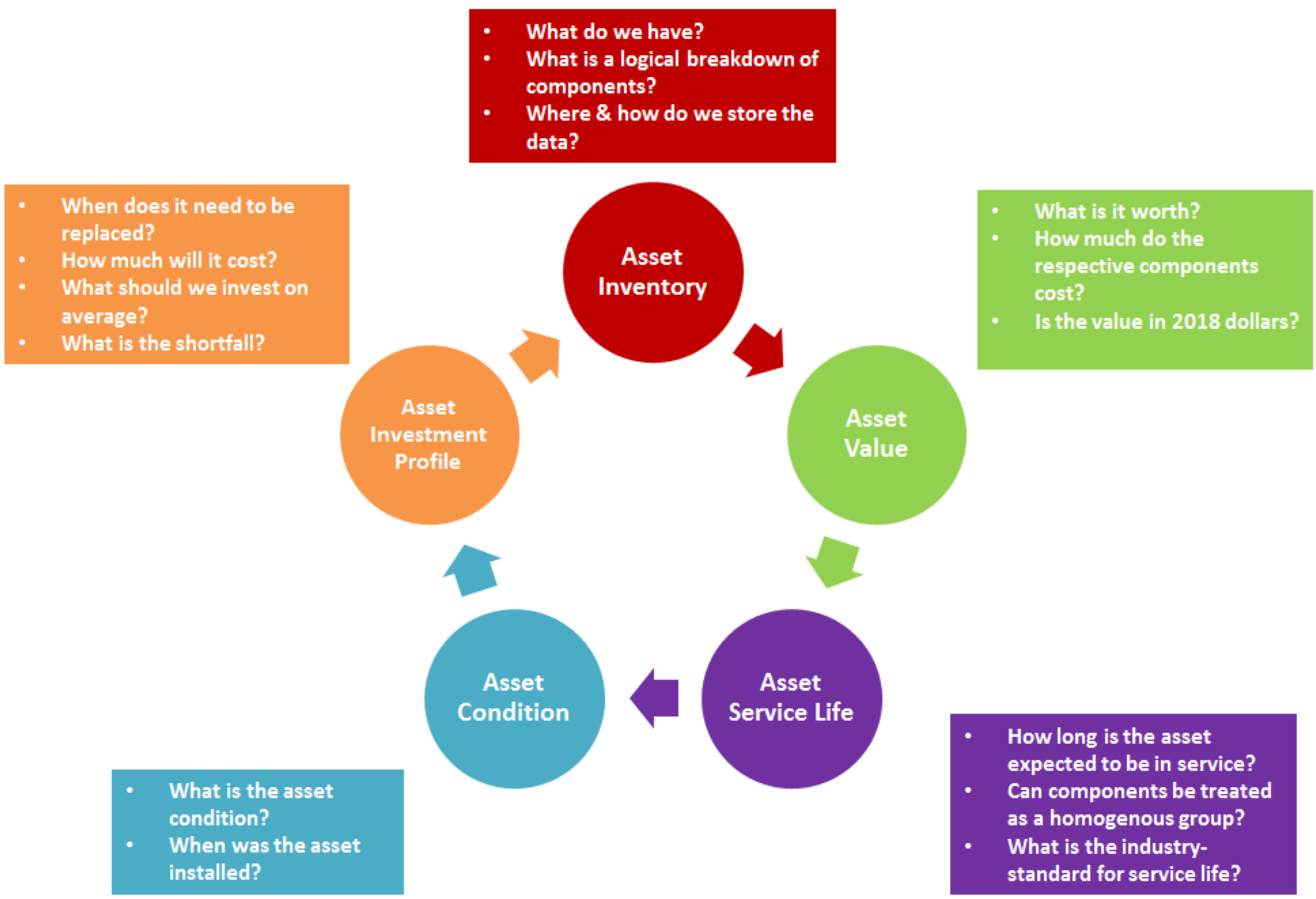


Figure 9: Asset Investment Profile Methodology

3.1.2 Defining Sustainable Funding

NDCA's investment profile (**Figure 11**, ***Section 3.1.3***) is characteristic of many Canadian municipalities and governing bodies, with the 1960s, 1970s, 1990s and 2000s typically being periods of economic growth and rapid development, as exhibited by the large amount of infrastructure added to city and town inventories over those periods. When NDCA was compared to these nationwide trends, it was observed that most growth took place in the 1960s, 1980s, and 1990s (see **Section 2.2.2-Age and Expected Service Life Results**). However, no infrastructure lasts forever, and cities are starting to see the increasing need to reinvest in their infrastructure to avoid loss of service and even catastrophic failure. In fact, it is precisely the large inventories of infrastructure generally built since the 1950s that are now starting to require replacement, as shown in **Figure 10**.

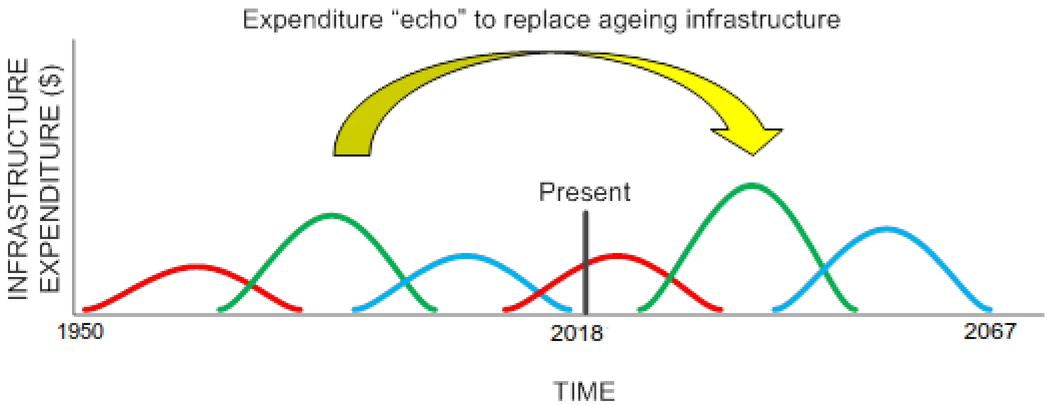


Figure 10: Theoretical Expenditure "Echo" to Replace Aging Infrastructure Assets

The preceding diagram might be an over-simplification of a very complex matter, but it serves to reveal a number of key points:

1. All infrastructure assets have a finite life.
2. Different types of infrastructure have different life expectancies / expected service lives. For example, sewers could be expected to last in the order of 80 years whereas a manhole may last between 40 and 60 years.
3. Depending on the installation date, infrastructure assets will require replacement sometime in the future predicated by its expected service life. From there, the "expenditure echo" shown in the diagram commences.
4. The particular" mix" of infrastructure assets in need of replacement in any given year will depend on the installation date and expected service life of the respective assets.
5. **A sustainable funding level could, in theory, be determined through a detailed review of infrastructure inventory, replacement value, condition, expected service life and investment profiling.**

As such, sustainable infrastructure funding is defined as the level of funding required to sustain assets in such a manner that meet present infrastructure needs without compromising the ability of future generations to meet their own infrastructure needs. Reaching an understanding of what sustainable funding is required for the owner of an asset portfolio is a key outcome of LCA.

3.1.3 Historical Investment Profile

Capital investment by the NDCA began with the construction of the Kelly Lake weir in 1960, a project that initiated a series of watershed management capital projects that continues to present day. **Figure 11** highlights the growth of the NDCA's asset system, leading to the current valuation of about $35.9 M. With the asset portfolio fully established, the focus of the NDCA now turns towards preparing for an expenditure "echo", during which many of its assets will require either rehabilitation or replacement to maintain a state of good repair.

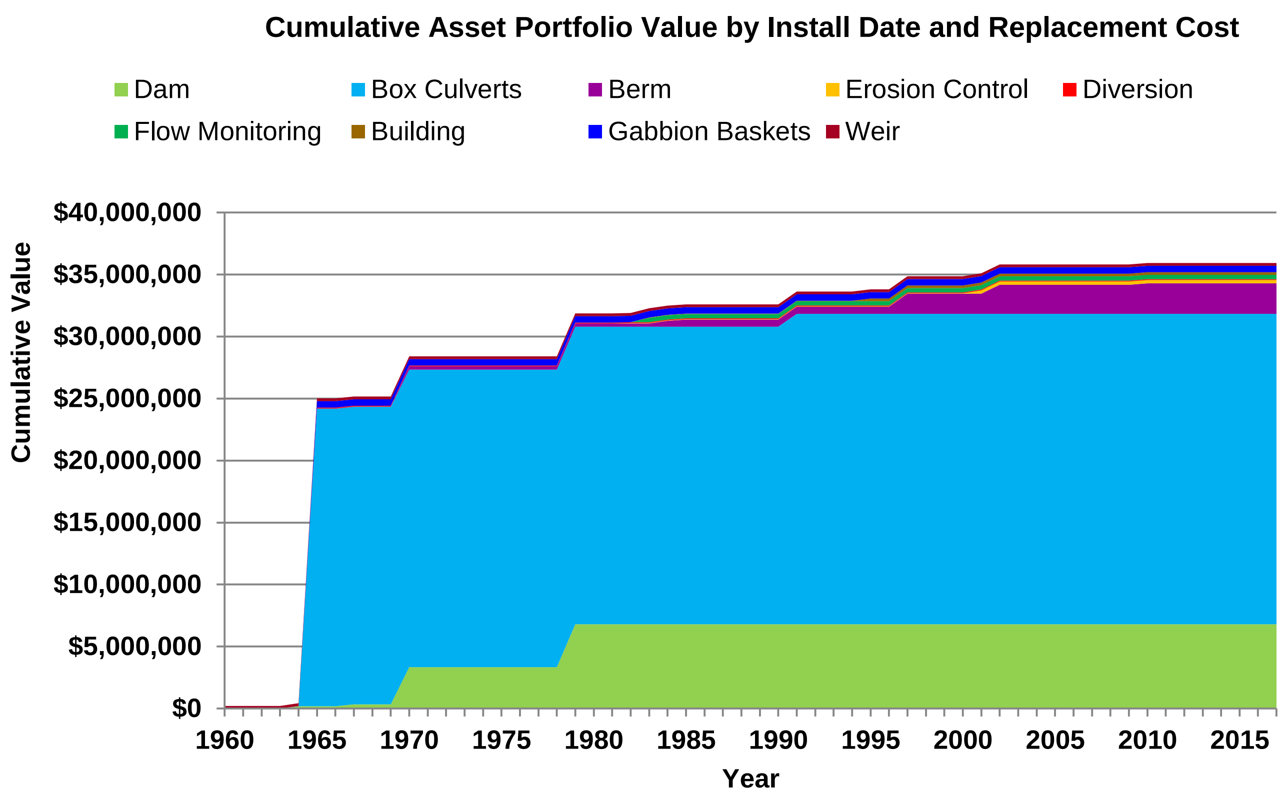


Figure 11: NDCA Asset Investment Profile

3.1.4 The Financial Model

AECOM uses an Excel-based Financial Model to perform LCA and model upcoming future expenditures in the medium to long term. The Financial Model is a tool that allows the NDCA to visualize the valuation of their facilities and forecasts of capital expenditures. This model is a key deliverable for the *State of the Infrastructure Report* and is built using the same data sources identified in ***2.1***.

With exceptions, the Financial Model works under the assumption that the NDCA will fully replace their assets at the end of their service life using the inputs for age, expected service life, and replacement value established in ***Section 2.3-Asset Valuation***. This analysis will not capture the proactive timing for replacements that may be required for the NDCA's most critical assets (such as a dam), where emphasis is placed on proactive measures that ensure safety of life and property over maximizing the useful life of the asset. As well, due to the nature of the NDCA's largest assets, assets such as dams and box culverts will likely never be fully replaced, instead rehabilitated and upgraded over time. As the NDCA plans its expenditures for the future it should incorporate these considerations. AECOM has started this process by reviewing the available condition assessment reports provided by the NDCA and incorporating the forecasted rehabilitation costs for some of the NDCA's most critical assets.

As identified in **Section 2.2.1-Asset Information Sources**, the NDCA has received recommendations to rehabilitate its box culverts and the Maley dam, with detailed quotes provided in each report. These findings were used to update the Financial Model. All other assets are still modelled under the assumption that they will be fully replaced at the end of their service life in the absence of studies or condition assessments prescribing otherwise.

The updates made to the inputs of the Financial Model are summarized as follows:

- Box culverts (College-Elm Box Culvert and Elm-Brady Box Culvert) to be rehabilitated at a total cost of $2.5 M (as per the 2012 Box Culvert Repair Strategy).
- Louis Box culvert to be rehabilitated at a total cost of $175,000 (as per the rehabilitation cost of $2,500 per meter length for box culverts identified in 2012 Box Culvert Repair Strategy; culvert is estimated to be 70 metres long)
- Maley Dam to be rehabilitated at a total cost of $2.45 M (as per the Maley Dam Safety Review).
- All other assets to be replaced at the end of their service life using the inputs collected in ***Section 2.2-Asset Age and Expected Service Life.***

3.2 Capital Expenditure Budget and Reserves

The City has current annual budgets of $250,000 for capital expenses and $105,000 for operation and maintenance expenses. Any amount from the capital expenditure funding not used in the budget year is allocated to a Cumulative Surplus Fund. Per the 2017 Financial Statements, the cumulative surplus funds were recorded to be $1,443,380. These funds are broken down into separate categories based on the specific functions that they can be utilized for. Thus, of the available cumulative surplus funds in 2017, only $1,030,000 (Categories: Special Capital Infrastructure, Water Control Preventative Maintenance, and Junction Creek Water Management) can be used to offset any backlog capital expenses. This will be reflected when the NDCA's funding gap is examined using a comparison of current funding and what future funding may be required.

3.3 Results – Asset Expenditure Forecast

Using the system valuation and the LCA approach, the results of the asset expenditure forecast for NDCA can be summarized as illustrated in **Figure 12 and Figure 13.** The results demonstrate that given the diverse nature of the NDCA's mixed vintage portfolio, investment requirements will vary greatly from year to year.

The life cycle analysis identifies an immediate "backlog" of investment requirements for assets that are documented by financial statements as being past their expected service life. Investigating historical capital improvements such as rehabilitations, replacements or upgrades may reduce the backlog of investment and refine upcoming capital reinvestment requirements. Once verified, eliminating the backlog using a combination of cumulative surplus funds and increased future funding should be prioritized by the NDCA to avoid reactive spending practices.

The" medium-term" financial forecast (**Figure 12** and **Figure 13**) is presented to the NDCA using a 30-year time horizon. The results of analyzing expenditure requirements in the 30-year period show that in addition to the backlog of historically cumulative investment requirements, there may also be the immediate need to rehabilitate the NDCA's dams at a considerable expense. Outside of these requirements, there are only a few asset replacements forecasted on the 30-year time scale. The 30-year forecast identified about $12.14 M in total funding requirements and an annual requirement of approximately $405,000. Given the magnitude of difference in investment requirements from year to year, this annual requirement can be interpreted as the annual average required to build reserves and plan for large expenses but does not reflect the short-term funding requirements or what would be spent year to year.

The “long-term” financial forecast (**Figure 13**) is presented to the NDCA using a 100-year time horizon. The results of the long-term forecast show that once the immediate needs of the asset portfolio are addressed (over the medium term), the NDCA should prepare for an upcoming “wave” of asset replacements. Following a plateau of replacement costs from 2025 to 2039, expense requirements will begin to increase significantly from 2040-2074. This time scale presents NDCA with a key opportunity to build reserves and plan for the future. The 100-year forecast identified approximately $28.4 M in total funding requirements and an annual average requirement of approximately $284,000. Despite the future investment requirements, the long term annual average is lower than the rate presented for the medium-term forecast ($405,000) due to a longer period of observation for which expenses were averaged.

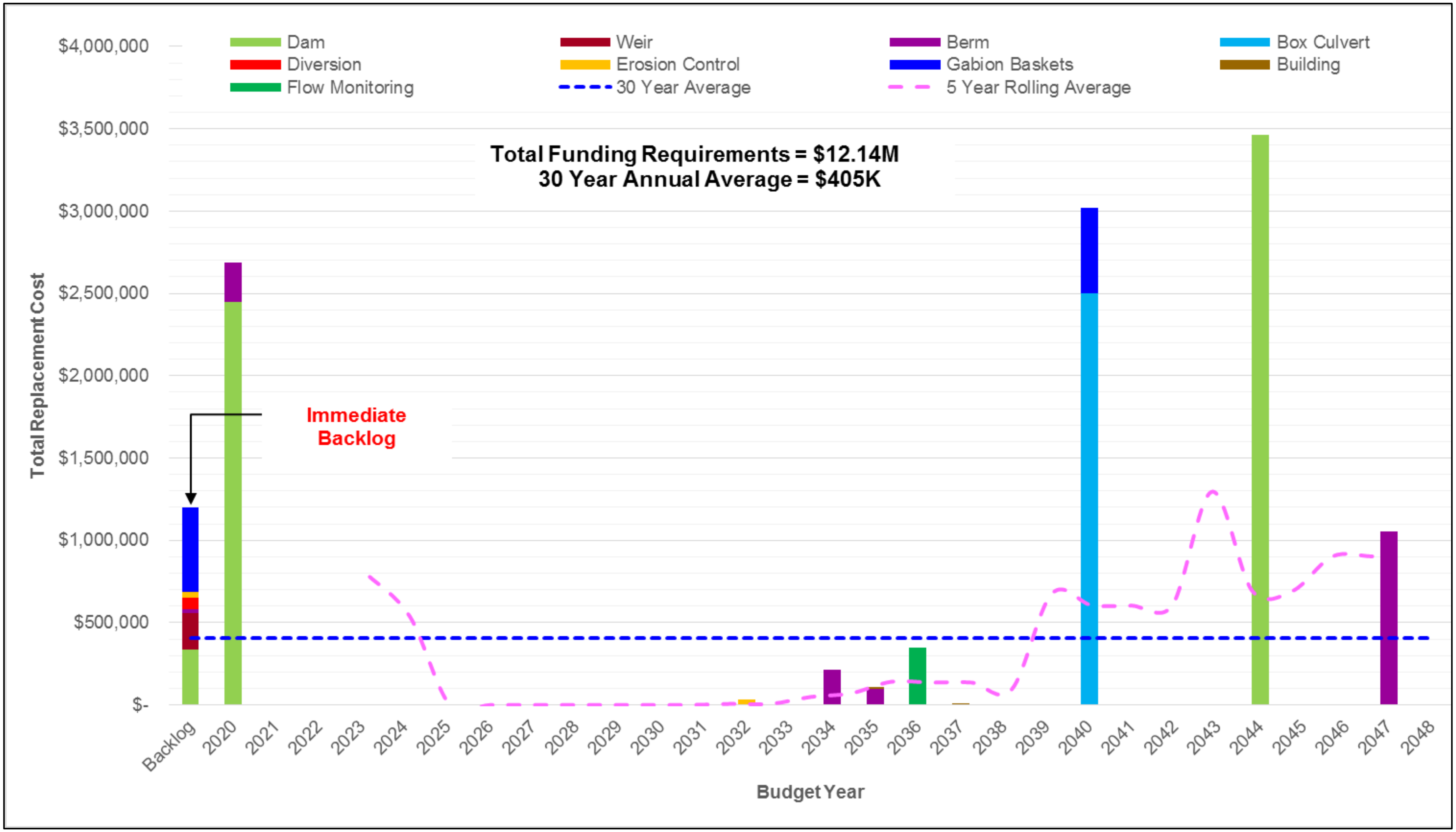


Figure 12: 30 Year Capital Improvement Expenditure Profile

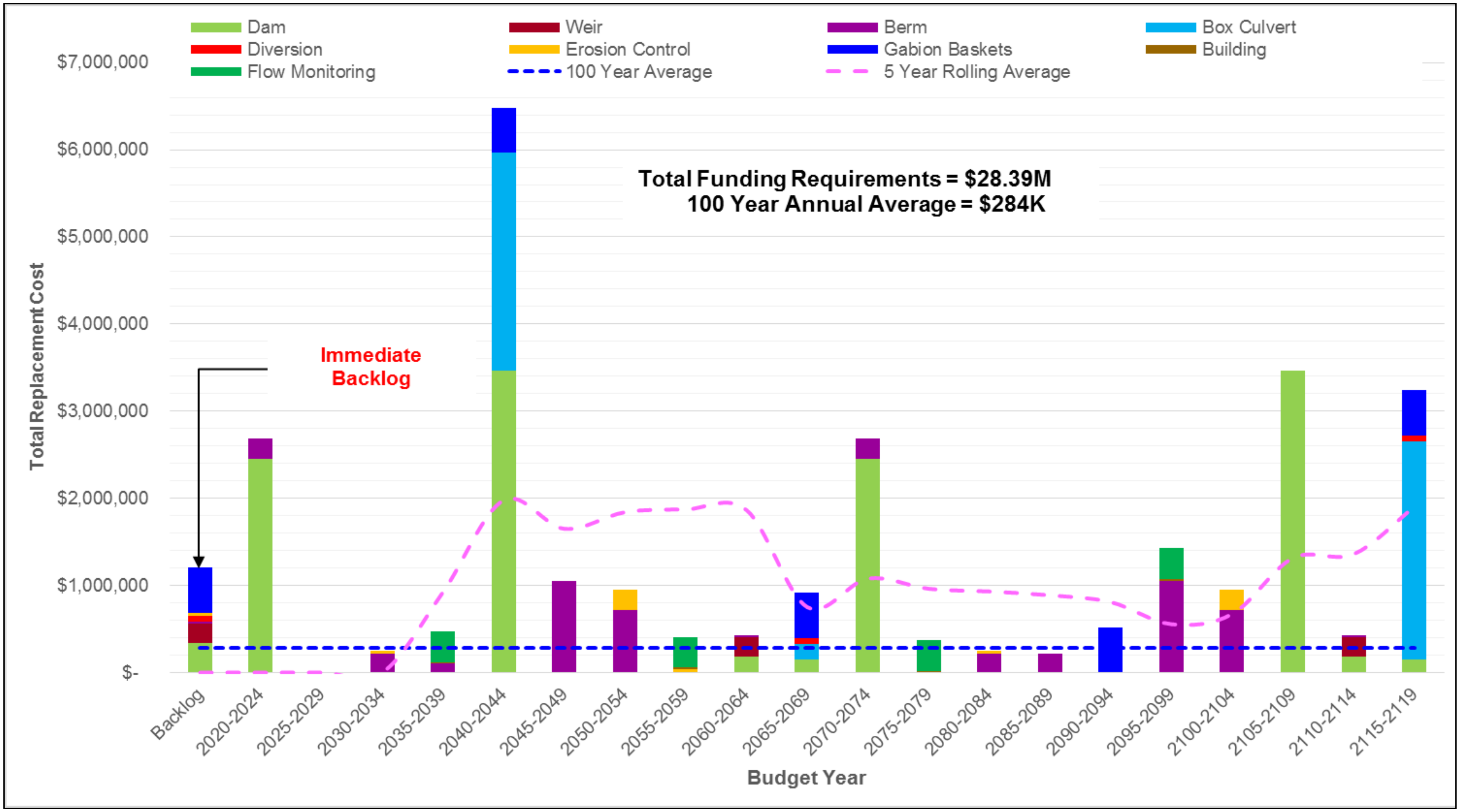


Figure 13: 100 Year Capital Improvement Expenditure Profile

4. Operations and Maintenance Plan

4.1 Introduction

Operations and Maintenance (O&M) describe the principal activities taken by asset owners to control assets in a manner that allows them to meet the objectives that they were obtained for. The cost of operations is the second input (after capital) required to understand asset lifecycle cost. How the NDCA uses and maintains the assets can impact performance, reliability, and productive life. Effective asset management involves co-ordinating plans and activities across the life cycle of an asset to maximize value.

The operations and maintenance of an asset will account for the majority of the asset's lifecycle. Across an asset lifecycle, asset owners will face continuing trade-offs between competing requirements for asset operation (e.g., delivering on the objectives of the asset) and asset maintenance (e.g., expending resources to maintain the asset, ensuring that it is performing as intended and operations do not pose significant risk). **Figure 14** demonstrates the different stages of an asset's life cycle.

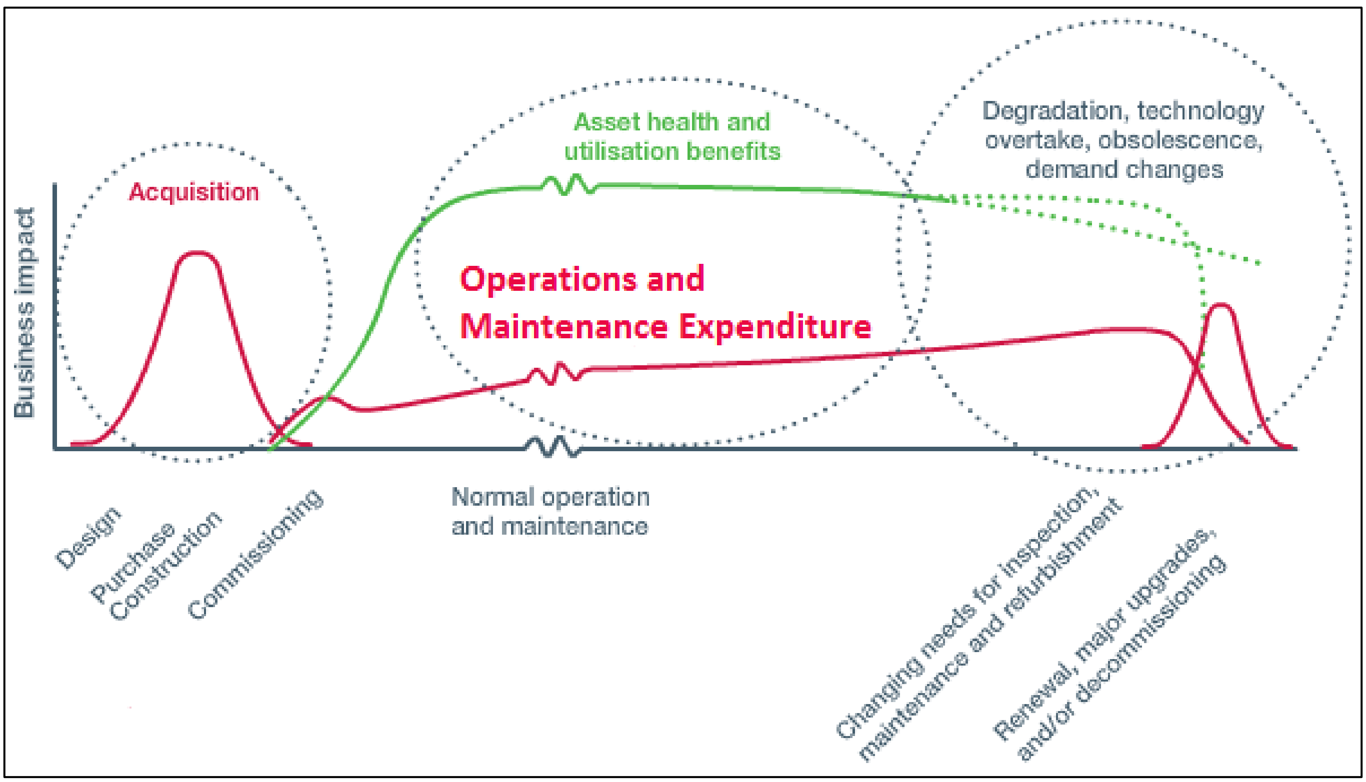


Figure 14: Maintenance Expenditure during an Asset Lifecycle

Every organisation has a variety of stakeholders, such as owners, customers, staff, regulators, suppliers and local neighbours. These groups all have different interests and priorities, so the organisation needs to find the best value compromise between conflicting interests. Therefore, realizing value involves finding the optimal mix of factors such as costs, risks and performance, while considering the longer-term consequences of a given approach. In the context of asset management, understanding and optimizing O&M serves as a critical component of managing the asset portfolio. Ultimately, an infrastructure system such as the NDCA's requires O&M practices that achieve the following:

- Maintain infrastructure in a state of good repair
- Ensure system performs as designed
- Ensure public safety and safe passage through the region
- Protects the environment

4.2 Methodology

With this understanding, AECOM prepared a cursory O&M budget for the asset portfolio by considering the costs for O&M activities such as cleaning, inspecting and repairing the assets. These costs were considered for all the assets under each asset functional group. The frequency for O&M activities was determined based on existing Operation and Maintenance Manuals (O&M Manuals) and industry best management practices. The frequency for some of the activities varied from monthly to annually, while some activities such as Dam Safety Reviews (DSR) and box culvert inspections being conducted much less frequently (two years and ten years respectively). For the Unit Cost of these activities, it was assumed that a crew of minimum two people would be required. The number of hours used for the completion of each activity and the material costs for repairs were assumed based on known operating costs within the NDCA's jurisdiction. For the inputs into the calculations see **Appendix A**.

4.3 Results

The results of forecasting the NDCA's potential O&M requirements was a cycle of funding requirements dependent on which activities were required for the year in addition to normal annual activities (ex. a Dam Safety Review). The annual funding levels ranged from approximately $55,000 to approximately $295,000. The budget estimates for O&M can be summarized in **Figure 15**.

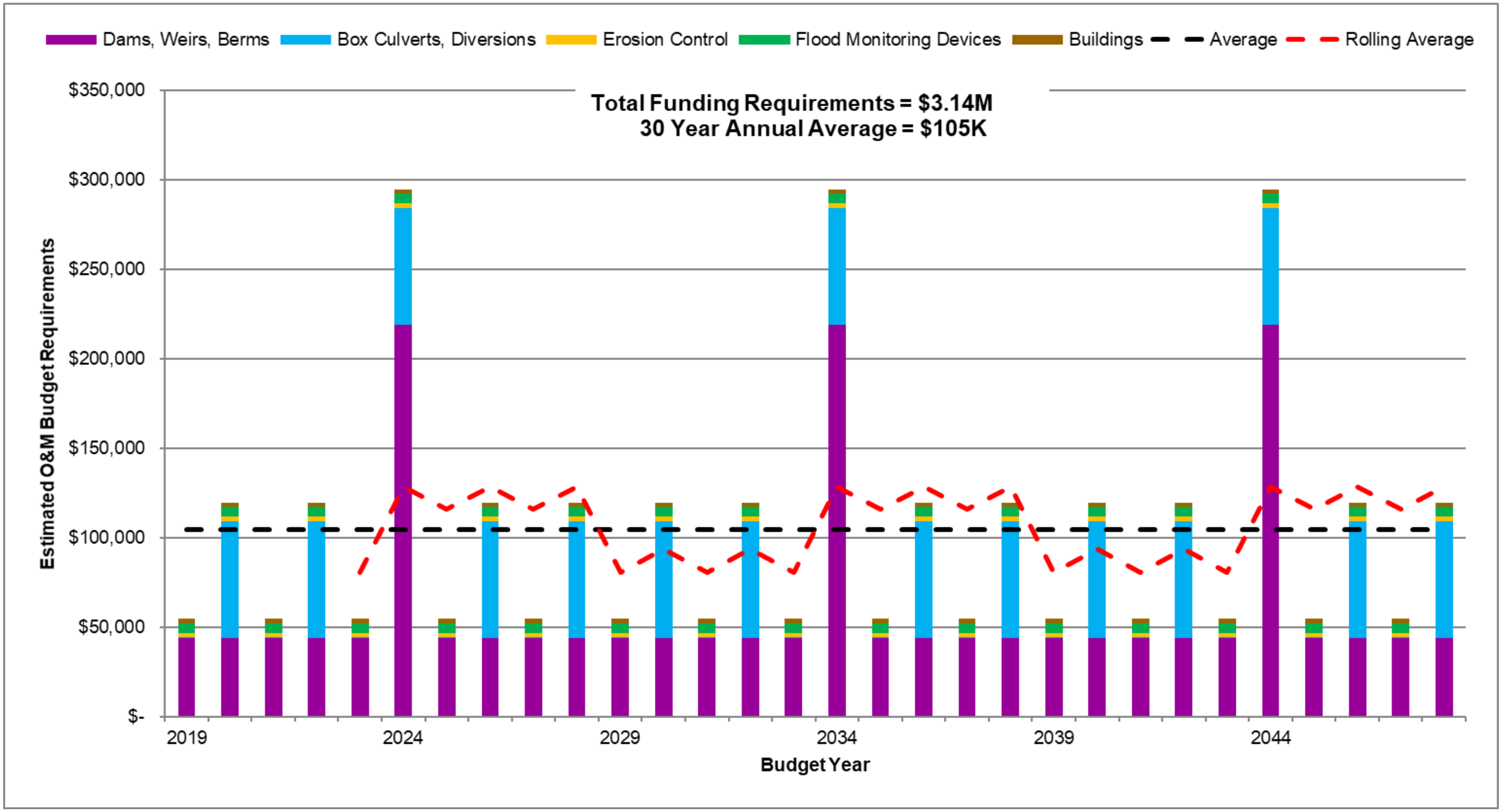


Figure 15: Annual Estimated O&M Requirements for NDCA Assets

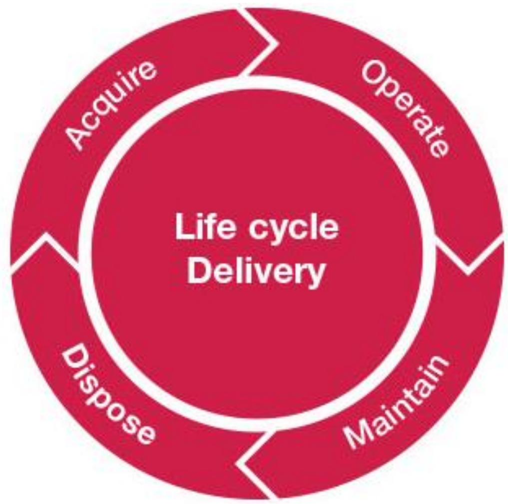
5. Total Lifecycle Cost

The results of ***Section 3*** and ***Section 4*** provide the NDCA with a comprehensive view of the potential funding requirements for assets across the lifecycle, as a function of both capital and operational inputs. With this understanding, planning can be made to secure the required funds and develop a strategy for funding asset lifecycle costs.

5.1 Asset Lifecycle

Total asset lifecycle cost represents the sum of all costs associated with an asset. Costs associated with an asset inventory occur well beyond the expense of acquiring an asset. Steps in an assets lifecycle will generally include:

- **Asset creation and acquisition**, where NDCA needs are identified and the right solution is determined;
- **Asset operation**, where the assets are operated in a manner that achieves deliverables, while optimising the value of the asset and ensuring the control of risk;
- **Maintenance delivery**, which involves scheduling and delivering inspections, planned maintenance activities that are compliant with asset plans, the control of activities to meet agreed criteria and the management of faults and incidents, and;
- **Asset decommissioning and disposal**, which includes the safe removal and disposal of assets from the system.



The gap between the total lifecycle cost figures presented in this report and the current level of funding would be known as the “infrastructure funding gap”. The infrastructure gap is generally considered as the difference between the amount needed to properly maintain, or replace existing assets, and the amount actually budgetted at the moment. Overtime, an infrastructure gap can accumulate to create a larger “backlog” of funding needs, leading to reactive practices. The infrastructure funding gap is an excellent communication tool for a high-level observation of how much further resources will be required to meet the needs of NDCA’s assets, relative to what resources are being devoted at present.

A gap analysis of the total lifecycle cost of NDCA’s assets was performed using the annual funding level of $355,000 (*Capital Expenditure Budget = $250,000 + O&M Expenses = $105,000*) reported during project discussions**.**

5.2 Results

Figure 16 and **Figure 17** provide the results of integrating the forecasted capital and operational expenses for NDCA’s assets across medium and long-term time horizons. The 30 year forecast in **Figure 16** shows the need to plan for annual operations and maintenance costs in addition to the larger investments required to address upcoming rehabilitation requirements as well as a cumulative backlog of reinvestment requirements. The 100 year forecast in **Figure 17** demonstrates the increases in investment requirements that the NDCA could experience with time, notably when capital reinvestment requirements accelerate from approximately 2040-2074 as O&M costs remain constant. **Figure 18** and **Figure 19** depict a funding gap analysis of the NDCA's current annual budget ($355,000) and the asset total lifecycle cost. Both results demonstrate that the current annual funding level does not address the annual requirements for capital improvements or reflect the variation in funding that is required from year to year due to the nature of the NDCA's portfolio. Furthermore, this funding level will not simultaneously address the capital and O&M needs of the assets. These realities result in a cumulative funding gap. The results demonstrate that the NDCA should increase funding levels to address the immediate funding requirements while preparing for the future.

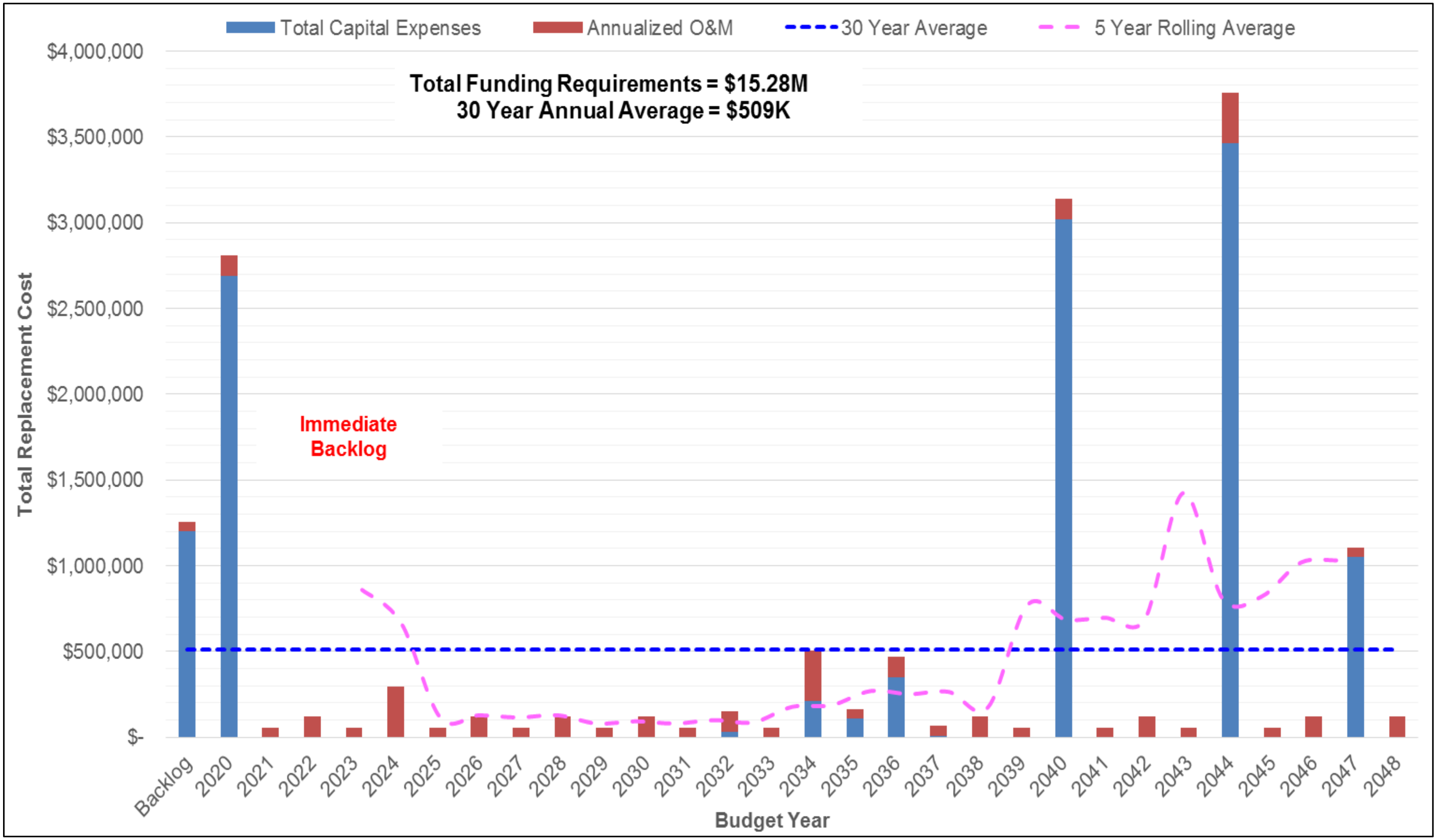


Figure 16: Total Asset Lifecycle Cost, 30 Years

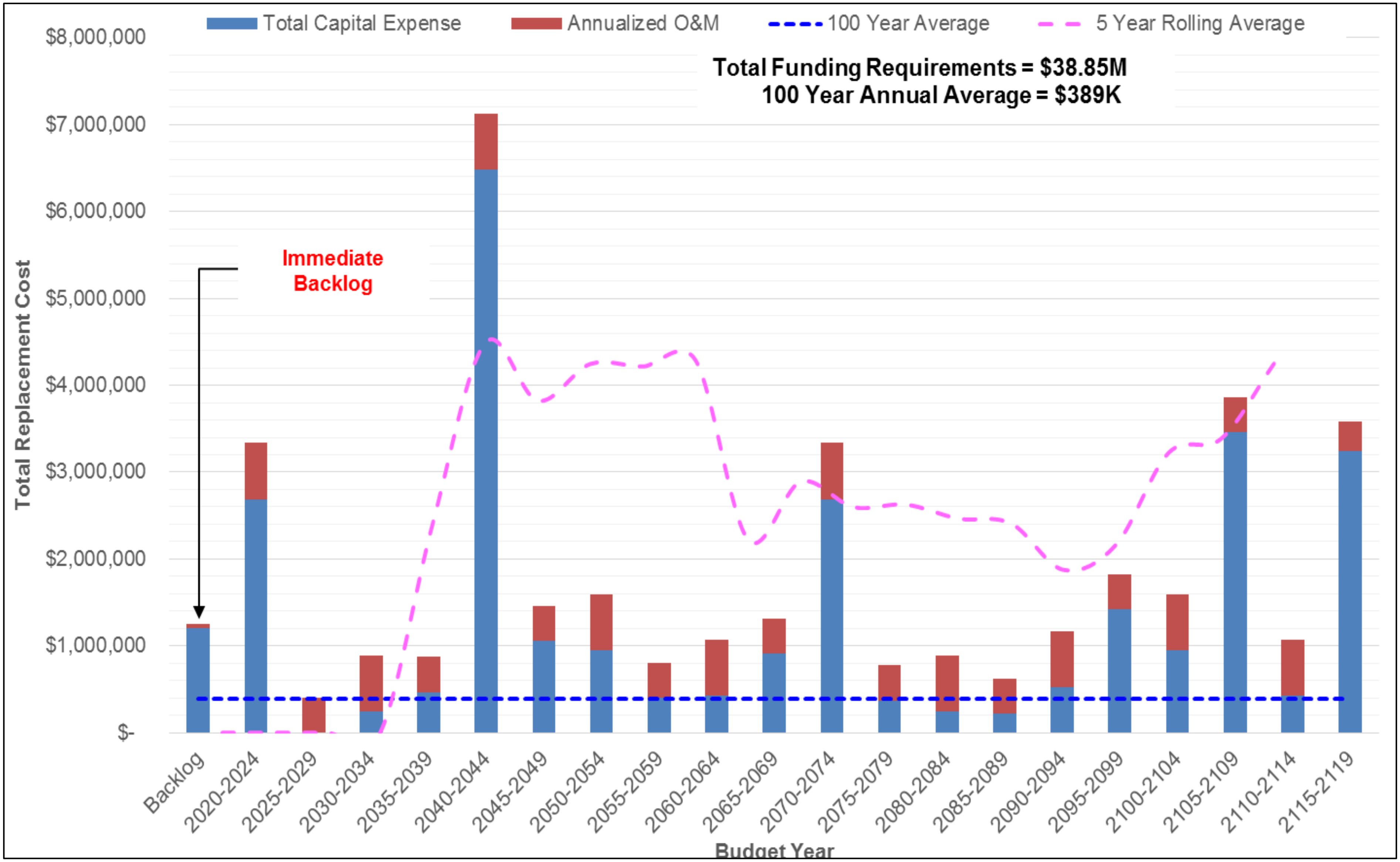


Figure 17: Total Asset Lifecycle Cost, 100 Years

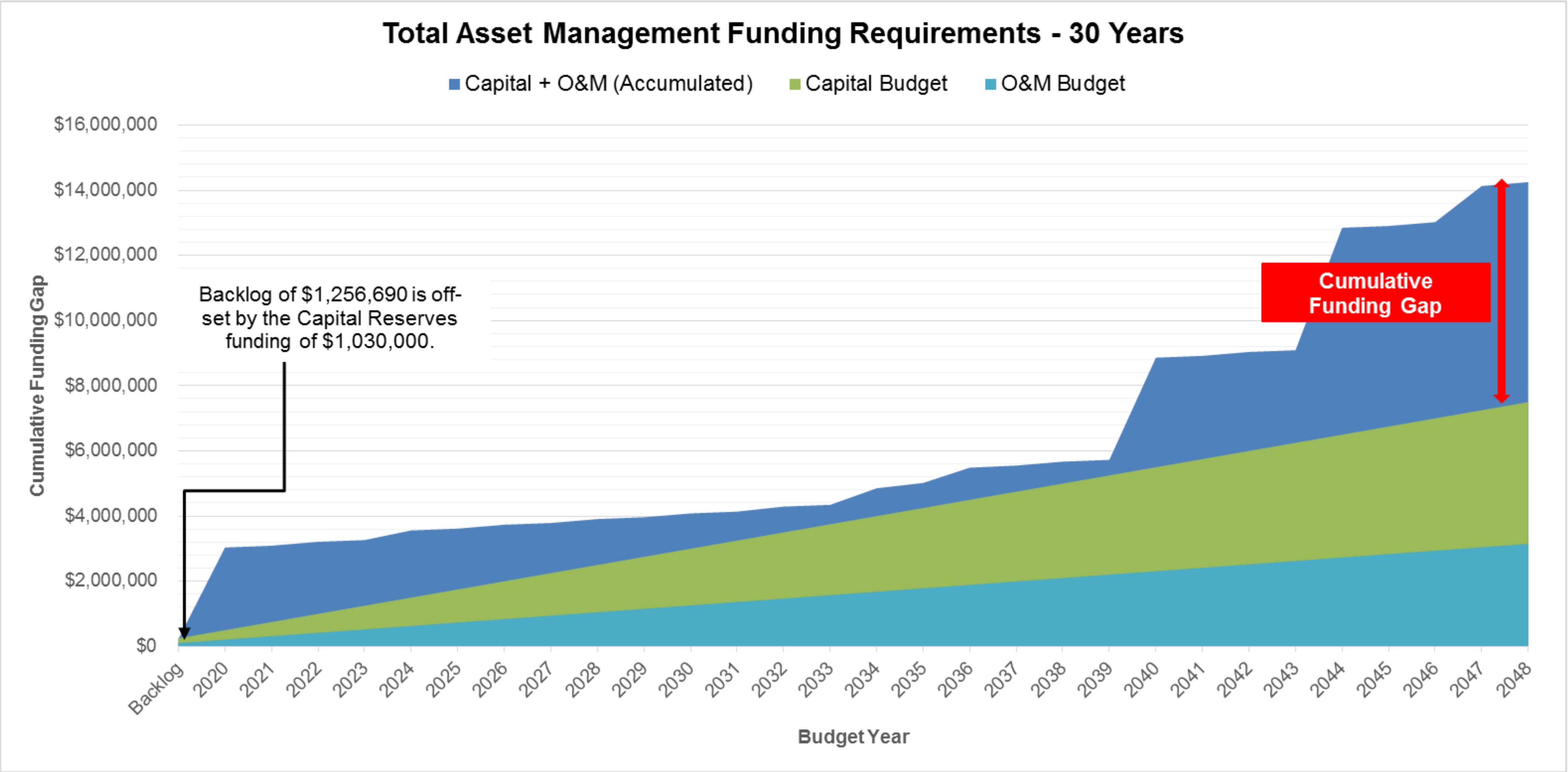


Figure 18: 30 Year Funding Gap Analysis

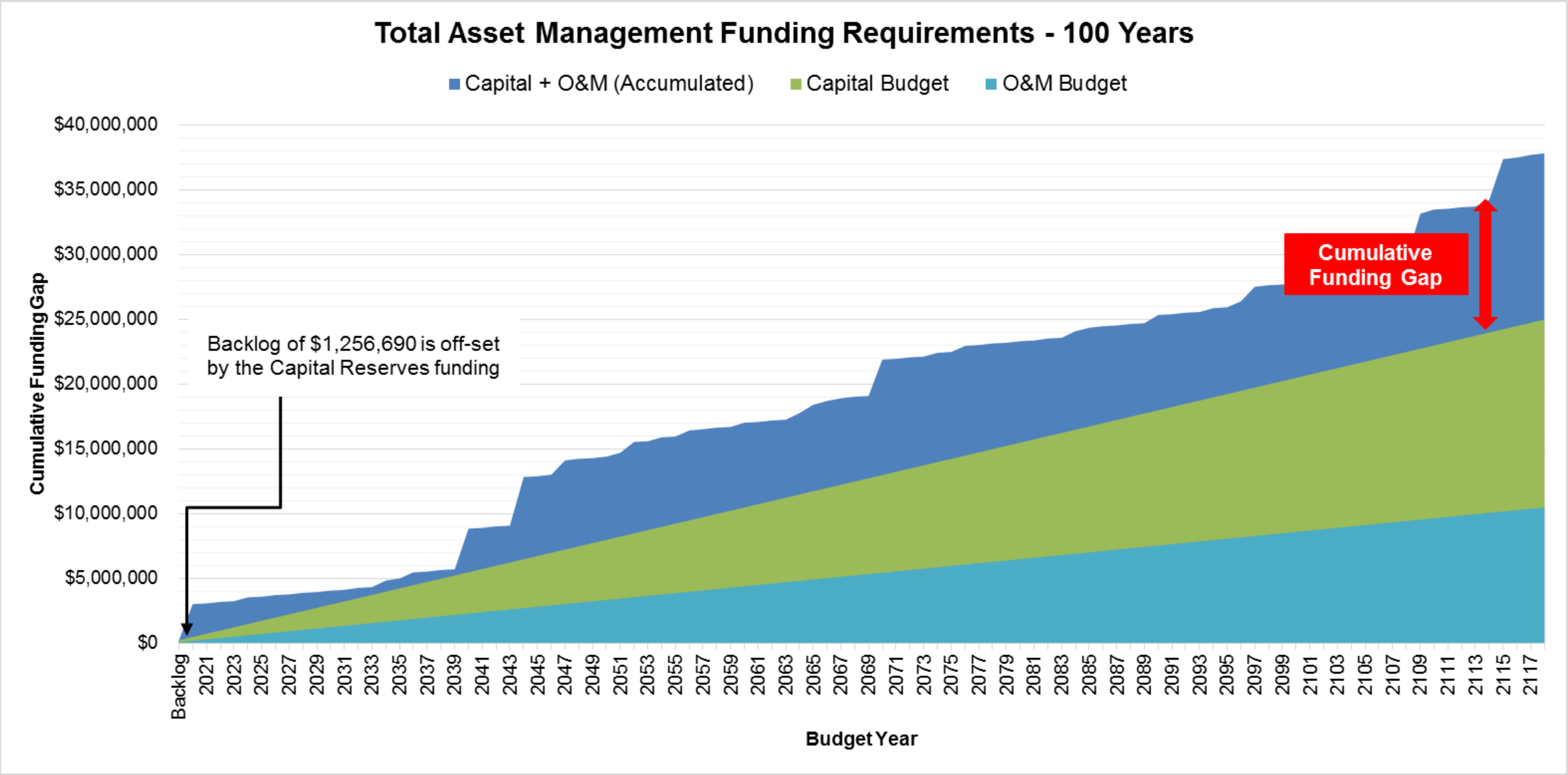


Figure 19: 100 Year Funding Gap Analysis

6. Conclusions and Recommendations

6.1 Conclusions

The NDCA maintains a variety of infrastructure assets that provide function roles include flood protection, water level control, and conveyance. The NDCA must maintain this infrastructure portfolio through operations, maintenance, and capital expenditures in a way that maximizes serviceable life and optimizes lifecycle costs and activities. NDCA should be applauded for making significant investments in infrastructure and has being proactive in inspecting and planning rehabilitations of its most critical assets. The system has a replacement cost of approximately $35.9M, and the most critical assets are regularly assessed in compliance with provincial regulations.

There are still significant opportunities for improvement - evident from the results of estimating total lifecycle cost is that the NDCA has a number of significant investment requirements in the medium to long term management of its assets that may suffer under its current funding. The current approach to annual funding does not address the varying requirements of assets year to year, and preparations need to be made for several costly asset expenditures in the future. On average, the current level of funding falls short of what is required to achieve what is required to address asset lifecycle costs, as a function of capital and operational expenditures.

Based on the life cycle analysis, NDCA may expect funding needs of approximately $509,000 per year over the 30-year planning horizon (totaling approximately $15.3 million) to address the combined costs of capital reinvestment, and operations and maintenance. This is assuming the city would have utilized part of its cumulative reserves to offset the backlog expenses. Year to year requirements can vary significantly for both O&M and capital, depending on the mix of assets requiring replacement or rehabilitation as well as the regulatory requirements of the year for O&M (ex. costly dam safety reviews occur every 10 years). The results of the analysis demonstrate that NDCA must prepare for both an increase in funding requirements as well as significant variation in the year to year requirements.

At present, the NDCA meets its capital and operational objectives using funding provided by the City of Greater Sudbury as dispended on an annual basis. In the past, the NDCA’s funding model also incorporated a contribution from the Ontario government, a disbursement that has since been delegated to municipalities. Certain conservation authorities can qualify for need-based funding from the province, but the NDCA does not receive such funding at present. To achieve sustainable funding, NDCA and the City must strategize a way to ensure that funds are matched to the asset lifecycle cost and are reliably available for an extended period of time.

Given that the NDCA maintains a small but critical asset portfolio that is expensive and operationally challenging to replace, the approach to sustainably funding these assets should be focused on preparations for periodic but costly expenditures associated with major rehabilitations or replacements, coupled with an annual budget focused on operations, maintenance, and condition assessment. NDCA infrastructure is not in expansion (the network is well established), but legacy assets will need to be maintained, rehabilitated/repaired, or upgraded in the future. Fixed funding does not address the varying reinvestment requirements that occur at different asset lifecycle stages. Planning and proactive assessment should be in place so the municipality can have a better predictive understanding of year to year funding needs of the NDCA (which results demonstrate may vary significantly).

6.2 Recommendations

Aside from the overall findings of this report, there are several recommendations that will assist the NDCA in continuing to conduct asset management planning and refine the State of the Infrastructure:

1. The asset valuation is currently based on a combination of financial reports (PSAB) and condition assessment reports. Review of these reports found that three of NDCA's most critical asset classes (the box culverts) were reported with a significantly different asset valuation between the two reports. AECOM recommends a review of asset replacement or rehabilitation costs to ensure that the proper valuations are being used for capital improvement planning.
2. NDCA should work to refine the expected service life estimates provided by its financial reports (PSAB). Given the sensitivity of lifecycle analysis to valuation and service life inputs, inspections or condition assessments can greatly enhance the accuracy of financial planning.
3. NDCA should incorporate the developed asset hierarchy with its GIS and develop a data schematic of the asset attributes that will enhance asset management planning. These should include design criteria (such as material, diameter, design standards, manufacturer, etc.), lifecycle information (install date, expected service life, etc.), ownership and NDCA responsibilities (ex. duty to inspect, duty to maintain etc.), O&M information (inspection requirements, date of last inspection, inspection records, etc.) and financial information (replacement cost, rehabilitation cost, etc.).
4. NDCA should develop Asset Management Plans (see ***Section 6.3-Next Steps)*** for each of its assets to define what services will be delivered, what O&M is required, when capital reinvestment should take place, and what the total lifecycle cost is at a level of detail greater than what is provided in this report. Asset-level planning will allow for the development of a financing strategy that addresses these requirements.
5. NDCA should engage the City of Sudbury with the findings of this report, highlighting the upcoming needs for increased funding and the need to develop a strategy to meet the varying annual spending requirements for the total lifecycle cost of its assets.
6. NDCA should use the findings of this report to engage with other funding opportunities including those from the Ministry of Environment, Conservation and Parks, as well as Conservation Ontario. This report can be used to highlight the needs for increased funding.

6.3 Next Steps

This State of the Infrastructure report provides the initial steps required for an asset management approach to operating and maintaining NDCA assets. Going forward, there are several steps that the NDCA can take to enhance its management approach including defining Levels of Service, completing a risk assessment, and building asset management plans. Though not explicitly required by Conservation Authorities such as the NDCA, establishing these elements of the asset management approach would align with the upcoming requirements of *O. Reg. 588/17 - Asset Management Planning for Municipal Infrastructure.* In addition, establishing an asset management mindset towards its assets may enhance the NDCA's business case for requesting local and provincial infrastructure disbursements by demonstrating efficient and effective asset planning as outlined in the Province of Ontario's *Building Together Guide*.

6.3.1 Building Together Guide

Published in 2012, the Building Together Guide provides Ontario asset owners the guidance for taking an asset management approach to maintaining municipal infrastructure. Working towards the requirements of Building Together by answering the fundamental questions of asset management (**Figure 20**) would be a key step towards enhancing the business case for requesting provincial funds, while demonstrating NDCA's commitment to whole-portfolio governance.

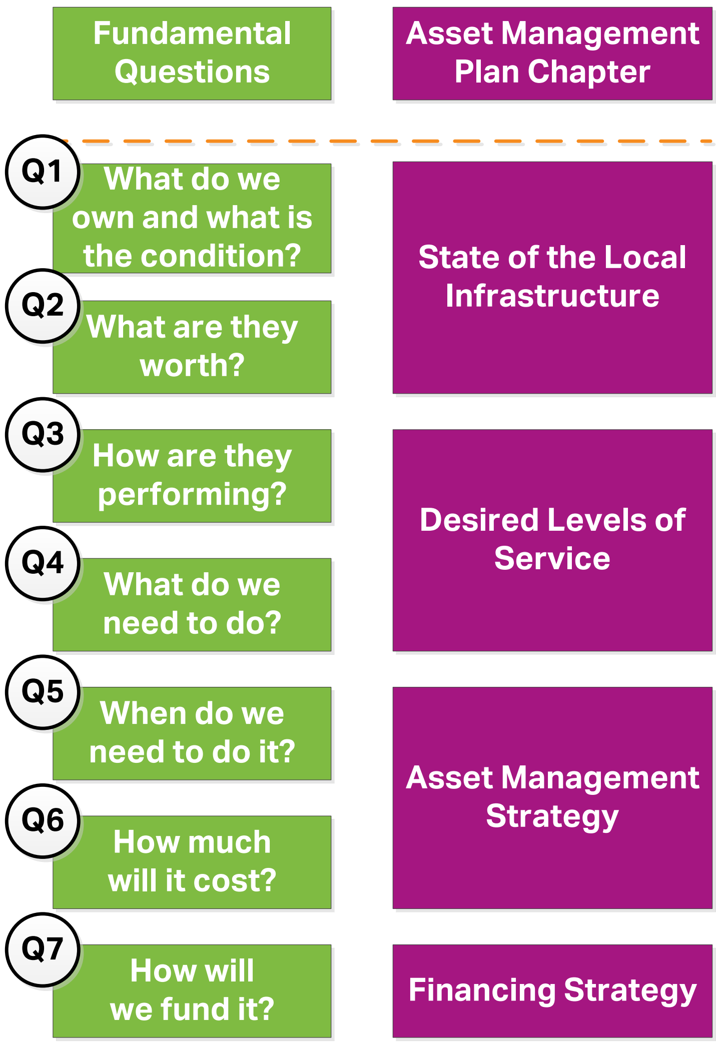


Figure 20: The Building Together Guide Addresses the Seven Fundamental Questions of Asset Management

6.3.2 O. Reg. 588/17 - Asset Management Planning for Municipal Infrastructure

Though NDCA is not directly regulated by O.Reg. 588/17, NDCA should be aware of the requirements for the regulation, which will apply to assets that are owned by the City of Sudbury but operated and maintained by NDCA.

The requirements of the regulation are summarized in **Table 7**. NDCA, a key stakeholder for the City and the regulation, should continue to engage with the City of Sudbury as they work to meet the requirements of the regulations.

Table 7: O. Reg. 588/17 Deadlines

Deadline Date	Regulatory Requirement	Additional Information
July 1st 2019	All Municipalities are required to prepare their first **Strategic Asset Management Policy.**	The Strategic Asset Management Policy must be reviewed and, if necessary, updated at least every five (5) years.
July 1st 2021	All municipalities are required to have an **Asset Management Plan** for its entire **core municipal infrastructure.**	Assets under Core Municipal Infrastructure are: water assets, wastewater assets, stormwater assets, roads, bridges and culverts.
July 1st 2023	All municipalities are required to have an asset management plan for infrastructure assets not included under their core assets.	Other assets not identified in the Core Assets above.
July 1st 2024	All Asset Management Plans must include information about the levels of service that the municipality proposes to provide, the activities required to meet those levels of service, and a strategy to fund activities	

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Appendix A

Operation and Maintenance Budget: Inputs and Assumptions

Appendix A, Table 1 - Activity Based Operations and Maintenance Budget

Asset Class	O&M Activity Name	Task Description	Asset Quantity	Desired Activity Frequency (Annual Basis)	Unit Cost	Total Desired Annual Cost
Flood Control Dams	Clean	Cleaning of flow control structures owned by the city (ex. Debris or other obstructions must be cleared from the inlet, the outlet and from within the pipes in the concrete weir and through the east embankment. The removal of debris should be performed anytime that debris that may hinder the natural flow of water or proper movement of the gate is noticed.), clear the area around dam embankment (excess vegetation).	5	12	$ 180	$ 10,800
	Inspect (Monthly)	General condition of the embankments and concrete structure. Visually inspect the embankments, roadway, spillway, weir, piping, gate house and gate well, and areas immediately upstream and downstream of the dam. Check for sediment accumulation. Any conditions that may affect the performance of the dam. Refer O&M Manual for further information.	5	12	$ 180	$ 10,800
	Inspect (Annually)	**ANNUAL DAM SAFETY INSPECTIONS (DSI):** A complete Dam Safety Inspection is to be carried out on an annual basis by a qualified engineer experienced in dam safety inspections. The dam inspection is to include the embankments, roadway, spillway, weir, piping, gate house and gate well, and areas immediately upstream and downstream of the dam. Additional inspections may be carried out following significant events that are likely to affect dam integrity. The dam safety inspection report shall identify areas of concern and present recommendations to address them as well as a priority assessment. Refer O&M Manual for further information.	5	1	$ 270	$ 1,350
	Inspect (DSR)	**DAM SAFETY REVIEWS (DSRs):** The purpose of a DSR is to ensure the existing design maintains an adequate margin of safety as determined by current engineering practices. The condition of the overall facility is assessed and the performance of the dam is reviewed. DSR includes the following: collection of all available dam records, field inspection, detailed investigations and possibly laboratory testing. It then proceeds with a check of structural stability and operational safety of the dam, beginning with a reappraisal of basic features and assumptions. Refer O&M Manual for further information.	2	Dicennial (Every 10 Years)	$ 50,000	$ -
			3		$ 25,000	
	Repair	Repairs of flow control structures owned by the city. For example, re-paint the scratched surfaces of weir gates, grease the hinges to ensure the weir can be smoothly operated, secure the bolts of the weir, re-surface concrete, remove woody vegetation and excess vegetation on embankment (mowing), replace rip-rap etc.	5	1	$ 1,720	$ 8,600
Flood Control Weirs	Clean	Clear the crest of the weir from all deposits like debris. Remove debris from also the downstream of the weir.	3	3	$ 180	$ 1,620
	Inspect	Inspect the weir to check if there is any leakage around the structure and also for signs of damage and wear, check if the weirs are plumb (not leaning forward or backward in the flow channel), check for debris accumulation; check for deteriorated or loose nuts and bolts and for evidence of rusting on weir plate. Also check for debris and sediment accumulation downstream from the weir.	3	1	$ 180	$ 540
	Repair	Remove debris, tighten loose bolts, repair minor structural deformities.	3	1	$ 860	$ 2,580

Appendix A, Table 1 - Activity Based Operations and Maintenance Budget

Asset Class	O&M Activity Name	Task Description	Asset Quantity	Desired Activity Frequency (Annual Basis)	Unit Cost	Total Desired Annual Cost
Flood Control Berms	Clean	Remove litter and debris, mow grass.	9	1	$ 180	$ 1,620
	Inspect	Check for signs of erosion or bare soil and invasive plant species.	9	1	$ 180	$ 1,620
	Repair	Replace thinny or patchy vegetation and other signs of erosion, remove invasive/nuisance plant species, eliminate any areas where excessive ponding is occurring. Reshape berms as needed and replace lost or dislodged rock, brush, and/or filter fabric.	9	1	$ 460	$ 4,140
Flow Conveyance Box Culvert, Diversions	Clean	Cleaning of flow conveyance structures (Debris or other obstructions must be cleared from the inlet, the outlet and from within the structure). Removal of debris and excess vegetation at and near the inlet and outlet components.	4	1	$ 180	$ 720
	Inspect	An element by element visual assessment of material defects, performance deficiencies. Check the structure for any material defects like cracks or deterioration and its stability, inlet and outlet components to confirm if they are able to perform their intended function, i.e. no blockages or damages that would impact the flow.	4	Biennial (Every 2 Years)	$ 15,000	$ -
	Repair	Clear the structure and inflow and outflow components of any debris and heavy vegetation. Re-surface delaminated or spalling areas that are determined to not cause strength reduction.	4	Biennial (Every 2 Years)	$ 1,220	$ -
Erosion Control Erosion Control, Gabion Baskets	Clean	Remove heavy sediment and debris accumulation.	3	1	$ 180	$ 540
	Inspect	Inspect for undercutting and other signs of stability. Inspect wire baskets and mattresses for signs of degradation, rust and breakage. Inspect for growth of undesirable vegetation and heavy silt accumulation. Inspect for undermining at toe of the structure.	3	1	$ 180	$ 540
	Repair	Remove undesirable vegetation and silt. Hand grade and/or infill undermined area with rocky material.	3	1	$ 460	$ 1,380
Flood Monitoring	Clean	Clean devices of any dirt or debris affecting its intended function	10	1	$ 180	$ 1,800
	Inspect	Inspect to confirm the flow monitoring device is operating properly and is calibrated as per the manufacturers specification.	10	1	$ 180	$ 1,800
	Repair	Repair any issues affecting its function	10	1	$ 180	$ 1,800
Customer Service	Clean	No cleaning required.	2	1	$ 180	$ 360
	Inspect	Perform a visual inspection of different building components like the walls, foundations, columns, beams and girders, connections and slabs to check for defects like cracks, spalls, corrosion of re-bars and deformation under loads.	2	1	$ 180	$ 360
	Repair	Repair minor defects like cracks and spalls and other issues that could lead to major defects if unattended.	2	1	$ 860	$ 1,720
					TOTAL	**$ 54,690**

NOTES

Dam Safety Review (DSR) are performed once every 10 years and are thus not presented in the total desired annual cost column.

Box Culvert inspections and repair are assumed to be once every 2 years and are thus not presented in the total desired annual cost column.

The total annual desired cost with fringe is estimated to be ~$55,000 (for the year without DSR and Culvert Inspection); the total annual desired cost with fringe is estimated to be ~$120,000 (for the year without DSR but with culvert inspection and repair); the total annual desired cost with fringe is estimated to be ~$295,000 (for the year with DSR and culvert inspection and repair)

Of the 5 dams, Maley and Nickledale Dams are considered to be large dams and estiamted to cost $50,000 for a DSR; the other 3 dams are considered to be small dams and estaimated to cost $25,000 for a DSR

Appendix A, Table 2 - Unit Costs per Event

Asset Class	O&M Activity Name	Source of Labour	Contractor Cost	Unit Cost (CAD) (Per FTE / Hr) (includes fringe costs, 50% of labour)	No. of FTEs	No. of Hours	Material Cost	Total Unit Cost Per Event
Flood Control Dams	Clean	FTE	-	$ 45	2	2	0	$ 180
	Inspect (Monthly)	FTE	-	$ 45	2	2	0	$ 180
	Inspect (Annually)	FTE	-	$ 45	2	3	0	$ 270
	Inspect (DSR)	Contractor	$ 50,000	-	-	-	0	$ 50,000
	Repair	FTE	-	$ 45	2	8	1000	$ 1,720
Flood Control Weirs	Clean	FTE	-	$ 45	2	2	0	$ 180
	Inspect	FTE	-	$ 45	2	2	0	$ 180
	Repair	FTE	-	$ 45	2	4	500	$ 860
Flood Control Berms	Clean	FTE	-	$ 45	2	2	0	$ 180
	Inspect	FTE	-	$ 45	2	2	0	$ 180
	Repair	FTE	-	$ 45	2	4	100	$ 460
Flow Conveyance Box Culvert, Diversions	Clean	FTE	-	$ 45	2	2	0	$ 180
	Inspect	Contractor	$ 15,000	-	-	-	0	$ 15,000
	Repair	FTE	-	$ 45	2	8	500	$ 1,220
Erosion Control Erosion Control, Gabion Baskets	Clean	FTE	-	$ 45	2	2	0	$ 180
	Inspect	FTE	-	$ 45	2	2	0	$ 180
	Repair	FTE	-	$ 45	2	4	100	$ 460
Flood Monitoring	Clean	FTE	-	$ 45	2	2	0	$ 180
	Inspect	FTE	-	$ 45	2	2	0	$ 180
	Repair	FTE	-	$ 45	2	2	0	$ 180
Customer Service	Clean	FTE	-	$ 45	2	2	0	$ 180
	Inspect	FTE	-	$ 45	2	2	0	$ 180
	Repair	FTE	-	$ 45	2	4	500	$ 860

Notes

Two staff are assumed to be present for all O&M field work (clean, inspect and repair).

Labour rates have a fringe rate incorporated at 1.5 times the base labor cost.

Fringe and labour rates are based on those used in the City of Sudbury.

Where possible, the roles of NDCA FTEs and contractors have been delineated.

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