Niagara Peninsula CONSERVATION nature for all

250 Thorold Rd 3rd Floor, Welland, ON L3C 3W2
905.788.3135 | info@npca.ca | npca.ca

July 29, 2024

City of Hamilton
Haldimand County
Regional Municipality of Niagara
Local Area Municipalities

SENT ELECTRONICALLY

Report No. FA-34-24 RE: Integrated Watershed Monitoring and Reporting

At the Board of Directors meeting held on July 19, 2024, the following resolution was passed:

> **Resolution No. FA-88-2024**
> Moved by: Stew Beattie
> Seconded by: Robert Foster
>
> **THAT** Report No. FA-34-24 RE: Integrated Watershed Monitoring and Reporting **BE RECEIVED**;
>
> **AND THAT** the Enhanced Integrated Watershed Monitoring Program and associated implementation recommendations **BE ENDORSED;**
>
> **AND FURTHER THAT** a copy of Report No. FA-34-24 RE: Integrated Watershed Monitoring and Reporting **BE CIRCULATED** to NPCA watershed municipalities for their information.

A copy of Report No. FA-34-24 and associated appendices are enclosed for reference. The Watershed Monitoring & Reporting team invites those interested in learning more about the integrated watershed monitoring & reporting program to connect for further discussion. Please reach out via email at mdavis@npca.ca if there is interest in learning more.

Sincerely,

Melanie Davis
Manager, Office of the CAO & Board
Niagara Peninsula Conservation Authority
905.788.3135 ext. 250

cc: Chandra Sharma, CAO / Secretary – Treasurer
Leilani Lee-Yates, Director, Watershed Strategies & Climate Change
Josh Diamond, Manager, Watershed Monitoring & Reporting

Report To: **Board of Directors**

Subject: **Niagara Peninsula Conservation Authority Enhanced Integrated Watershed Monitoring Program**

Report No: **FA-34-24**

Date: **July 19, 2024**

Recommendation:

THAT Report No. FA-34-24 RE: Niagara Peninsula Conservation Authority Enhanced Integrated Watershed Monitoring Program **BE RECEIVED**;

AND THAT the Enhanced Integrated Watershed Monitoring Program and associated implementation recommendations **BE ENDORSED**;

AND FURTHER THAT staff Report No. FA-34-24 RE: Niagara Peninsula Conservation Authority Enhanced Integrated Watershed Monitoring Program **BE CIRCULATED** to NPCA watershed municipalities for their information.

Purpose:

The purpose of this report is to provide an overview of the Niagara Peninsula Conservation Authority's (NPCA) Enhanced Integrated Watershed Monitoring Program (IWMP) and obtain the endorsement of the Board of Directors for the program's continued implementation.

Background:

NPCA's 2021-2031 Strategic Plan identifies the need to address watershed data gaps to support evidence-based decision-making for climate-resilient watersheds. The Strategic Plan further establishes specific goals to:

- Expand and enhance monitoring and associated tools to fill information gaps and research needs
- Lead water quality (e.g., surface and groundwater) and quantity monitoring throughout the NPCA jurisdiction

- Support municipal partners with watershed data collection and analysis to understand cumulative impacts
- Develop a solid understanding of climate impacts and risks on NPCA watersheds

Further, the *Conservation Authorities Act* and Ontario Regulation (O. Reg.) 686/21: Mandatory Programs and Services requires NPCA to develop a Watershed-based Resource Management Strategy that will need to be supported by an enhanced watershed monitoring program to address data gaps and support decisions for a healthy watershed. Work began in 2023, to develop an enhanced IWMP.

Discussion:

The "Niagara Peninsula Conservation Authority Enhanced Integrated Watershed Monitoring Program" document in Appendix 1, outlines the current monitoring and reporting programs run by the NPCA, either alone or with partners. It emphasizes programs essential for understanding watershed health and managing NPCA activities like hydrometry, water quality, ecology, regulatory compliance, community science, and restoration. The IWMP considers reorganizing and expanding monitoring efforts across various areas to better assess ecosystem health, gather data for NPCA programs, and continue to provide monitoring services to municipalities and other clients within the NPCA watershed jurisdiction.

Beginning in 2023, the NPCA Watershed Monitoring and Reporting team led the following key activities to inform the development of the enhanced IWMP:

- Inventory of existing NPCA monitoring programs;
- Comprehensive NPCA monitoring gap analysis;
- Formation of the internal Integrated Watershed Monitoring Program Advisory Group;
- A facilitated session with the Integrated Watershed Monitoring Program Advisory Group and additional technical staff;
- Municipal partner meetings;
- Engagement with the NPCA Public Advisory Committee; and
- Formation of an internal Project Intake Team.

The objective of the NPCA enhanced IWMP is to comprehensively assess the ecological health and resilience of the watershed through monitoring initiatives, to inform evidence-based conservation and management strategies for the NPCA watershed.

Integrated Watershed Monitoring Program Conceptual Model

To support the IWMP's objective, a conceptual model has been developed that identifies three key Watershed Monitoring Program areas and four key Monitoring Support Systems that are further detailed in Appendix 2.

The three Watershed Monitoring Areas are:
1. Long-Term Watershed Monitoring,
2. Corporate Support Services, and
3. Monitoring Service Provider.

The four Monitoring Support Systems include:
1. Corporate Services,
2. Data Management and GIS
3. Communications, and
4. External Partnerships and Data.

Within the purview of the IWMP are long-term monitoring initiatives encompassing water quantity, surface water, groundwater, terrestrial and watershed landscape components. These programs form the cornerstone of the NPCA's monitoring efforts, providing crucial data for informed decision-making and environmental management. The Program also identifies internal monitoring needs, while also providing opportunities for external environmental monitoring services.

Long-Term Watershed Monitoring and Reporting Program

The goals of NPCA's Long-Term Integrated Monitoring and Reporting Program area are:

- To establish baseline conditions by understanding natural variability and ecological thresholds within the NPCA watershed;
- To assess the temporal and spatial conditions of aquatic and terrestrial resources at various locations across the watershed compared to established baselines; and
- To identify potential stressors and emerging threats that could be addressed through other programs.

Monitoring Units for this Program include:

1. Surface Water Monitoring: Water chemistry, stream benthic macroinvertebrates and stream temperature, fish communities and fluvial geomorphology monitoring components.
2. Groundwater Monitoring: Water chemistry and water levels monitoring components.
3. Terrestrial Monitoring: Forest, wetland, and wildlife monitoring components.

4. Hydrometric Monitoring: Water quantity and climate monitoring components.
5. Watershed Landscape Analysis: Watershed scale analysis of various landscape components to monitor changes over time.

Components of the long-term watershed monitoring program are provincially mandated, such as the surface and groundwater Provincial Monitoring Networks implemented by the NPCA, and the hydrometric monitoring that supports NPCA's flood forecast and warning system.

Corporate Support Services Program

The goal of the NPCA Corporate Support Service monitoring area is to provide monitoring services and expert advice for NPCA's internal department programs and projects.

Monitoring Units for this Program include:

1. Environmental Permissions: Required regulatory monitoring related to NPCA Conservation Area services and infrastructure.
2. Conservation Areas Beach Monitoring: Monitoring of bacterial (E. coli) at NPCA swimming areas at Long Beach and Chippawa Creek Conservation Areas.
3. Restoration Monitoring Program: Monitoring of restoration project progression after implementation for adaptive management options.
4. Conservation Area Management Plans: Range of environmental inventories and monitoring studies to inform Conservation Area Management Plans.
5. Conservation Area Lands Ecological Monitoring: Range of monitoring programs for Conservation Areas to assess a variety of management areas for NPCA properties.
6. Climate Change: Climate change affects all aspects of the NPCA watershed and can be monitored through a variety of watershed components and functions.
7. Low Impact Development Monitoring: Low Impact Development Monitoring program can track the effectiveness of LID measures on NPCA lands.
8. Community Science Monitoring: This program partners with citizens and NGOs to collect various environmental monitoring data.

Monitoring Service Provider Program

The goal of the NPCA Monitoring Service Provider Area is to provide environmental monitoring services to external partners within the Niagara Peninsula watershed.

A wide range of environmental inventory and monitoring services can be made

available, such as ecological, environmental permissions, climate change and LID performance monitoring. Current projects include the Niagara Region surface water chemistry, City of Hamilton Glanbrook Landfill Bioassessment, and Hamilton International Airport Bioassessment.

Program Implementation

The “Niagara Peninsula Conservation Authority Enhanced Integrated Watershed Monitoring Program” document includes several recommendations to implement the Program. Each recommendation is accompanied by actions to be implemented by 2031. These recommendations are:

- Recommendation 1:
  That the NPCA **prioritize and enhance the Long-Term Watershed Monitoring program** within the IWMP, as it is essential for understanding and managing ecosystems, supporting scientific research, conservation initiatives, and inform decision-making to ensure ecosystem resilience against ongoing environmental changes.

- Recommendation 2:
  That the NPCA will **continue to regularly report results of its environmental monitoring programs** in an understandable and accessible format to support decision-making by the NPCA and its partners to enhance watershed health and community awareness.

- Recommendation 3:
  That the NPCA **ensures the IWMP has a robust Corporate Support Services Monitoring Area** to incorporate internal monitoring components through collaboration, optimize resource allocation, and better define the scope and capacity of crucial monitoring programs and projects across multiple departments and divisions.

- Recommendation 4:
  That the NPCA will **continue to increase the capacity of its monitoring and inventory services within the IWMP** to enable NPCA to become a comprehensive environmental monitoring provider for watershed partners, including municipalities, provincial and federal agencies, and private companies.

- Recommendation 5:
  That the NPCA will **continue to collaborate** with municipal and community partners, agriculture, academia, and indigenous communities moving forward.

- Recommendation 6:
  That the NPCA will **continue to explore efficiencies and innovations** to continuously improve the IWMP.

A Watershed-based Resource Management Strategy is to be developed by the end of 2024, as required under the *Conservation Authorities Act* and O. Reg. 686/21: Mandatory Programs and Services. The enhanced IWMP will be an integral part of the Watershed-based Resource Management Strategy.

Financial Implications:

There are no current financial implications associated with the preparation of the "Niagara Peninsula Conservation Authority Enhanced Integrated Watershed Monitoring Program" document. Further program development and scoping will be accounted for in future budgets, supported by a long-term budget plan guided by the Watershed-based Resource Management Strategy. Specialized monitoring services for municipalities and external stakeholders will be on a fee-for-service basis based on a Board-approved fee schedule.

Links to Policy/Strategic Plan:

The NPCA 2021-2031 Strategic Plan has identified an Integrated Watershed Monitoring Program as a critical priority to help achieve the goals outlined under the Healthy and Climate Resilient Watersheds strategic priority. The IWMP further advances the following additional goals in the 2021-2031 Strategic Plan:

Goal 3.1 – Create equitable access to greenspace for the health and well-being of people.
Goal 3.2 – Lead nature education, environmental stewardship, and volunteerism.
Goal 4.1 – Strengthen government relations toward collective outcomes and impact.
Goal 4.3 – Improve engagement with local First Nations, Métis, and Inuit peoples that support shared stewardship.
Goal 5.2 – Improve internal operations and processes.
Goal 6.2 – Optimize self-generating revenue using innovative approaches.

The program supports NPCA's vision of "Nature for all" that envisions a healthy and vibrant environment with shared greenspace and clean water that sustains life for future generations.

Related Reports and Appendices:

Appendix 1: Niagara Peninsula Conservation Authority Enhanced Integrated Watershed Monitoring Program (Draft)

Appendix 2: Niagara Peninsula Conservation Authority Enhanced Integrated Watershed Monitoring Program Conceptual Model

Authored by:

Original Signed by:

Joshua Diamond, M.Sc. C. Tech.
Manager, Watershed Monitoring and Reporting

Reviewed by:

Original Signed by:

Leilani Lee-Yates, BES, MSPL.RPD, MCIP, RPP
Director, Watershed Strategies and Climate Change
Interim Director, Planning and Development

Submitted by:

Original Signed by:

Chandra Sharma, MCIP, RPP
Chief Administrative Officer/Secretary-Treasurer

Niagara Peninsula Conservation Authority Enhanced Integrated Watershed Monitoring Program

July 19, 2024

Niagara Peninsula CONSERVATION nature for all

www.npca.ca

LAND ACKNOWLEDGEMENT

The Niagara Peninsula watershed is situated within the traditional territory of the Haudenosaunee, Attiwonderonk (Neutral), and the Anishinaabeg, including the Mississaugas of the Credit many of whom continue to live and work here today. This territory is covered by the Upper Canada Treaties (No. 3, 4, and 381) and is within the land protected by the Dish with One Spoon Wampum agreement. Today, the watershed is home to First Nations, Metis, and Inuit.

Through the NPCA's strategic plan, the NPCA re-confirms its commitment to shared stewardship of natural resources and deep appreciation of Indigenous culture and history in the watershed.

PROJECT ACKNOWLEDGEMENTS

Technical input and information by provided by several staff at the Niagara Peninsula Conservation Authority was instrumental to the completion of this document and their efforts are gratefully acknowledged:

Eric Augustino
Eric Baldin
David Deluce
Carly Fazekas
Kim Frohlich
Tara Gaade
Steve Gillis
Natalie Green
Ryan Kitchen
Leilani Lee-Yates
Megan Lalli
Carly Mason
Steve Miller
Amy Parks
Tom Proks
Geoffrey Verkade

Additional input from the NPCA Public Advisory Committee is also acknowledged.

The NPCA would also like to thank Andrea Dunn (Conservation Halton), Lesley McDonell (Hamilton Conservation Authority), Jon Nodwell (Credit Valley Conservation Authority) and Lyndsay Cartwright and Sue Hayes (Toronto and Region Conservation Authority) for meeting, sharing resources and discussing their monitoring programs with our staff.

To be cited as:

Niagara Peninsula Conservation Authority. 2024. Niagara Peninsula Conservation Authority Enhanced Integrated Watershed Monitoring Program. Thorold Ontario. 76 pages.

CONTENTS

TABLE OF ACRONYMS

BioMAP	Bioassessment of Water Quality
CLI-ECA	Consolidated Linear Infrastructure Environmental Compliance Approval
CCME	Canadian Council of Ministers of the Environment
CO	Conservation Ontario
CVC	Credit Valley Conservation Authority
ECAs	Environmental Certification Approvals
ECCC	Environment Climate Change Canada
ELC	Ecological Land Classification
EMAN	Ecological Monitoring and Assessment Network
GIS	Geographic Information System
HIA	Hamilton Internation Airport
IWMP	Integrated Watershed Monitoring Program
IT	Information technology
LID	Low Impact Development
MECP	(Ontario) Ministry Environment Conservation and Parks
MOU	Memorandums of Understanding
NAI	Natural Areas Inventory
NGO	Non-Governmental Organization
OBBN	Ontario Benthos Biomonitoring Network
OGS	Ontario Geological Survey

OSAP	Ontario Stream Assessment Protocol
NPCA	Niagara Peninsula Conservation Authority
PCBs	Polychlorinated Biphenyls
PFAS	Per - and polyfluoroalkyl substances
PTTW	Permit to Take Water
PWQMN	Provincial Water Quality Monitoring Network
PWQO	Provincial Water Quality Objectives
RGA	Rapid Geomorphic Assessments
RMN	Regional Municipality of Niagara
SLAs	Service-Level Agreements
SOP	Standard Operating Procedures
TRCA	Toronto and Region Conservation Authority
WSC	Water Surveys Canada
YSI	Yellow Springs Instruments

1.0 INTRODUCTION

The Niagara Peninsula Conservation Authority (NPCA) is developing a new comprehensive Integrated Watershed Monitoring Program (IWMP) in accordance with the 2021-2031 Strategic Plan. Under the strategic priority, “Healthy and Climate Resilient Watersheds,” Goal 1.1 – Support evidence-based decision-making for climate-resilient watersheds and shorelines, several actions related to integrate watershed monitoring are identified. The achieve Goal 1.1, the NPCA will:

- Expand and enhance monitoring and associated tools to fill information gaps and research needs
- Lead water quality (e.g., surface and groundwater) and quantity monitoring throughout the NPCA jurisdiction
- Support municipal partners with watershed data collection and analysis to understand cumulative impacts
- Develop a solid understanding of climate impacts and risks on NPCA watersheds

The performance indicator for Goal 1.1 is a robust data collection program established by 2023 and data gaps filled by 2026. Several metrics are included such as the number and types of data gaps identified (gap analysis), percentage of priority data collection gaps filled and number of surface water and groundwater samples. Work began in 2023, to develop the IWMP to achieve the actions for Goal 1.1 and position NPCA as a leader and partner of choice for collecting, analyzing and reporting on watershed data that supports evidence-based decision making for climate-resilient watersheds and shorelines.

This “Niagara Peninsula Conservation Authority Enhanced Integrated Watershed Monitoring Program” document first describes monitoring and reporting programs currently implemented by the NPCA, either independently or through partnerships. It highlights the monitoring programs fundamental to the understanding of watershed health and informing the management of internal NPCA programs such as hydrometry, water quality, ecology, stewardship and community science, regulatory compliance, and restoration. This document contains expanded monitoring program considerations across several disciplines to allow for a more complete evaluation of ecosystem integrity, data capture for internal NPCA programs, and monitoring services for the municipalities and other clients within the NPCA jurisdiction. These range from short to long-term monitoring initiatives depending on the program. This transition to an integrated approach stresses a focused commitment to robust long-term monitoring initiatives across a variety of monitoring components that can more accurately identify watershed trends. Understanding these trends leads directly to changes in how the NPCA and its watershed partners manage and address impacts to watershed health. The IWMP will support the NPCA’s “Nature for all” vision of a healthy and vibrant environment with shared greenspace and clean water that sustains life for future generations.

2.0 CURRENT NPCA MONITORING PROGRAMS

NPCA's existing monitoring programs were implemented to support the delivery of programs and services that further the conservation, restoration, development, and management of natural resources in NPCA's watersheds, and vary in terms of scope and scale based on their intended purpose. The NPCA's monitoring programs have become an essential tool for flood risk protection, assessing the health of ecosystems, protecting biodiversity, evaluating the state of our watersheds, and promoting sustainable practices. These programs contribute valuable data for informed decision-making, policy development, and community engagement in environmental conservation efforts. Details regarding current monitoring programs that the NPCA administers are found in forthcoming sections.

2.1 NPCA Hydrometric Monitoring Network

2.1.1 Overview

The NPCA is responsible for managing and protecting watersheds, including addressing flood risks. On January 1, 2022, Ontario Regulation 686/21: Mandatory Programs and Services (O. Reg. 686/21) was implemented under the Conservation Authorities Act, requiring Conservations Authorities to provide programs and services related to the risk of natural hazards, including flood forecast and warning, and the management of water and erosion control structures that the Conservation Authority owns. The NPCA's Hydrometric Monitoring Program involves several key components:

1) **Hydrometric Monitoring**: Monitoring weather conditions, river levels, and other hydrological parameters is crucial for early detection of potential flood events. This monitoring is often done in real-time, and the data collected helps authorities make informed decisions.
2) **Forecasting and Warning Systems**: The objective of this program is to provide the delivery of timely and accurate flood forecasting information to the public, municipalities, first responders, and the media. Should conditions require that the NPCA issue a Flood Warning bulletin, the NPCA posts these messages on the NPCA website, social media platforms, and via email directly to municipalities, first responders, and the media. In the future, the NPCA would like to further develop forecasting models that predict potential flood events based on weather forecasts, river gauging, and other relevant data. These models will assist with issuing timely warnings to communities at risk, allowing for preparedness and evacuation measures.
3) **Community Outreach and Education**: Many programs include initiatives to educate the public about flood risks, emergency preparedness, and the importance of following evacuation plans. Public awareness campaigns contribute to community resilience and response during flood events.

4) **Infrastructure Management**: NPCA maintains infrastructure designed to manage water flow, such as dams. Regular monitoring, maintenance and upgrades are essential to ensure the effectiveness of these structures.
5) **Collaboration with Emergency Services**: NPCA often collaborates with emergency services, municipalities, and other relevant agencies to coordinate response efforts during flood events.

2.1.2 Monitoring Components

The first gauging of streams in the NPCA watershed in the 1950's was established by Environment Canada's Water Survey Division to quantify water resources. Over the years additional stream/river water level gauges were first added by Environment Canada and later by the NPCA. The NPCA modernized its Hydrometric Monitoring Network to include weather stations (rainfall, air temperature, wind speed and direction, soil moisture, barometric pressure, and solar radiation) and snow surveys (snow depth and water equivalent) (OMNR, 1985) across the NPCA watershed. All water quantity stations are shown in **Figure 1** and summarized in **Table 1**.

2.1.3 Data Management

NPCA Hydrometric Monitoring Network produces a large volume of stream level and climate data and currently stores this information in two separate databases. One is the WISKI Database, and the other is in the NPCA's SQL server. Staff are transitioning to process where data is configured and posted to Conservation Ontario's Web data viewer portal (https://co-opendata-camaps.hub.arcgis.com/) and Upper Thames River Conservation Authority Web data portal.

2.1.4 Program Reporting

The NPCA's Hydrometric Program is an integral component of the Flood Forecasting and Warning system, and its reporting requirements are those prescribed under regulation (O. Reg. 686/21). These reporting requirements include issuing flood messages to the municipalities and media within their jurisdiction as per respective flood message distribution lists. These messages are the result of NPCA staff providing on-going analysis and knowledge of current and forecasted local watershed and river conditions and flood potential within watershed jurisdiction. The NPCA provides near real-time hydrometric data to the public by posting to NPCA website (https://npca.ca/watershed-health#flooding-stream-flow-monitoring). Data can be observed or downloaded from the NPCA webpage.

2.2 Surface Water Quality Monitoring Program

2.2.1 Overview

The NPCA's Water Quality Monitoring Program focuses on the water quality conditions of streams, rivers, and water features of NPCA's watershed and Conservation Areas. Surface water quality monitoring within the NPCA watershed jurisdiction started with Ontario Ministry Environment Conservation and Parks (MECP) and the City of St. Catharines through the Provincial Water Quality Monitoring Network (PWQMN) dating back to the 1960s and 1970s. NPCA was involved in numerous

water quality related initiatives with its watershed partners but did not have a dedicated monitoring program until 2001, when the NPCA Water Quality Monitoring Program was initiated. The NPCA has since established an extensive network of monitoring stations located throughout its watershed jurisdiction with the purpose of gathering long-term data to assess the ambient water quality in local watersheds using a network of chemical and biological monitoring stations. The data collected contributes to the protection of aquatic ecosystems and public health. This monitoring also provides a high-level characterization of existing conditions on a watershed scale and allows for the identification of potential water quality issues in reference to the existing land uses present within the watershed. This network represents the largest and most comprehensive water quality monitoring program in the Niagara Peninsula. The NPCA monitoring network is operated in partnership with the MECP through the PWQMN, Regional Municipality of Niagara (RMN), Haldimand County and City of Hamilton. The NPCA's surface water monitoring program has been designed with flexibility in mind, enabling it to seamlessly integrate new monitoring initiatives. These include sampling programs to monitor contaminants of concern within the watershed, utilization of in-situ water quality datalogger technology, and the provision of fee-for-service biological monitoring services. The NPCA Surface Water Quality Program is summarized in **Table 2**.

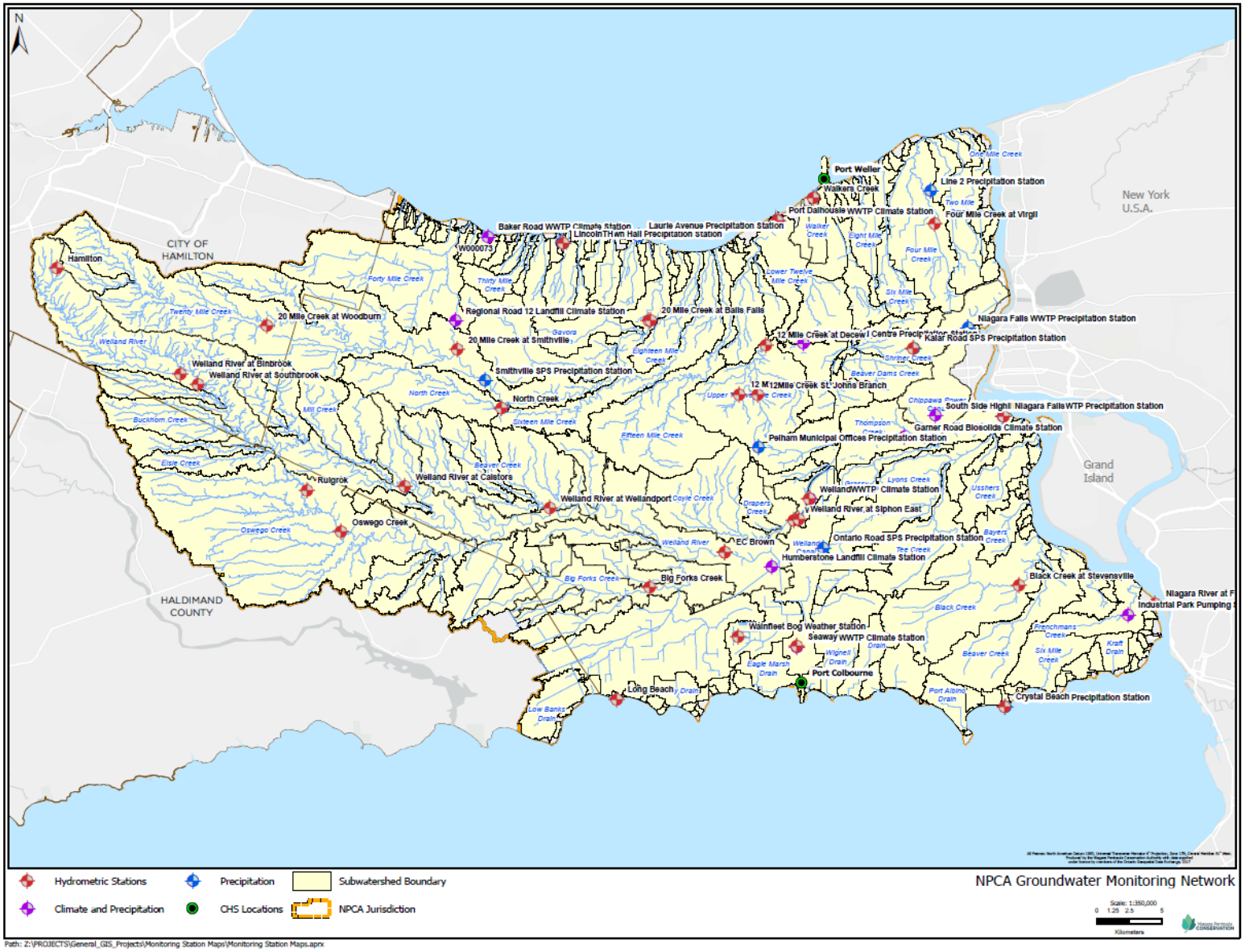


Figure 1. Current NPCA Climate and Hydrometric Network

Table 1: Summary of the NPCA the current Hydrometric Monitoring Network.			
NPCA Monitoring Programs	Monitoring Components	Support Programs	Program Purpose
Hydrometric Monitoring Network (Water Quantity and Climate) **(2009-present)**	➢ Water Level (19 Stations) & Flow (7 Stations) ➢ Snow Surveys (7 Stations) ➢ Air Temperature (7 Stations) ➢ Precipitation (11 Stations) ➢ Wind Conditions (7 Stations) ➢ Relative Humidity (2 Stations)	Water Surveys Canada (WSC) and Niagara Region	1) Watershed Management 2) Flood Forecasting and Warning 3) Climate Change Monitoring 4) Water Budgets (Source Water Protection and Development Applications) 5) Ontario Low Water Program

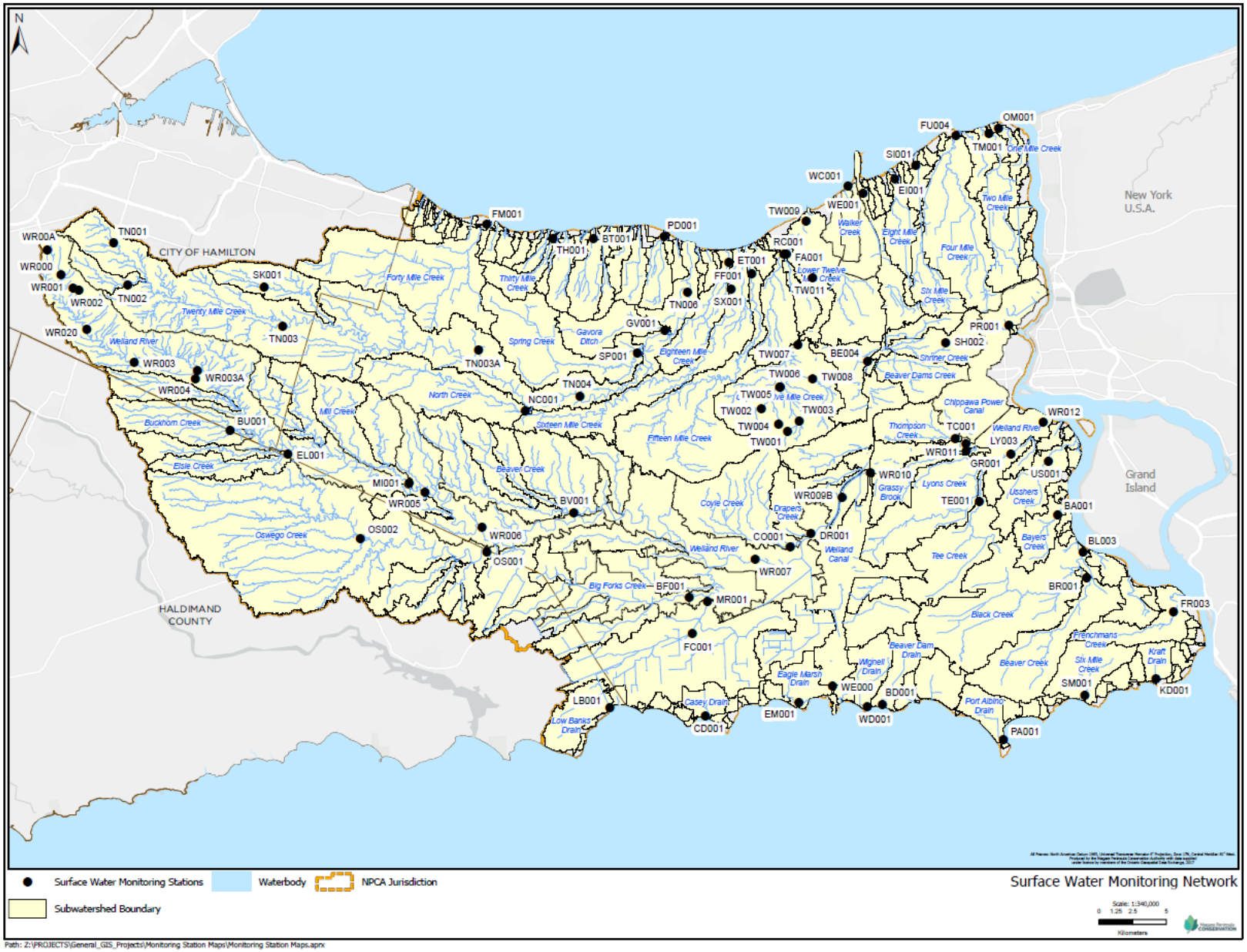


Figure 2: NPCA Surface Water Monitoring Network Program Stations

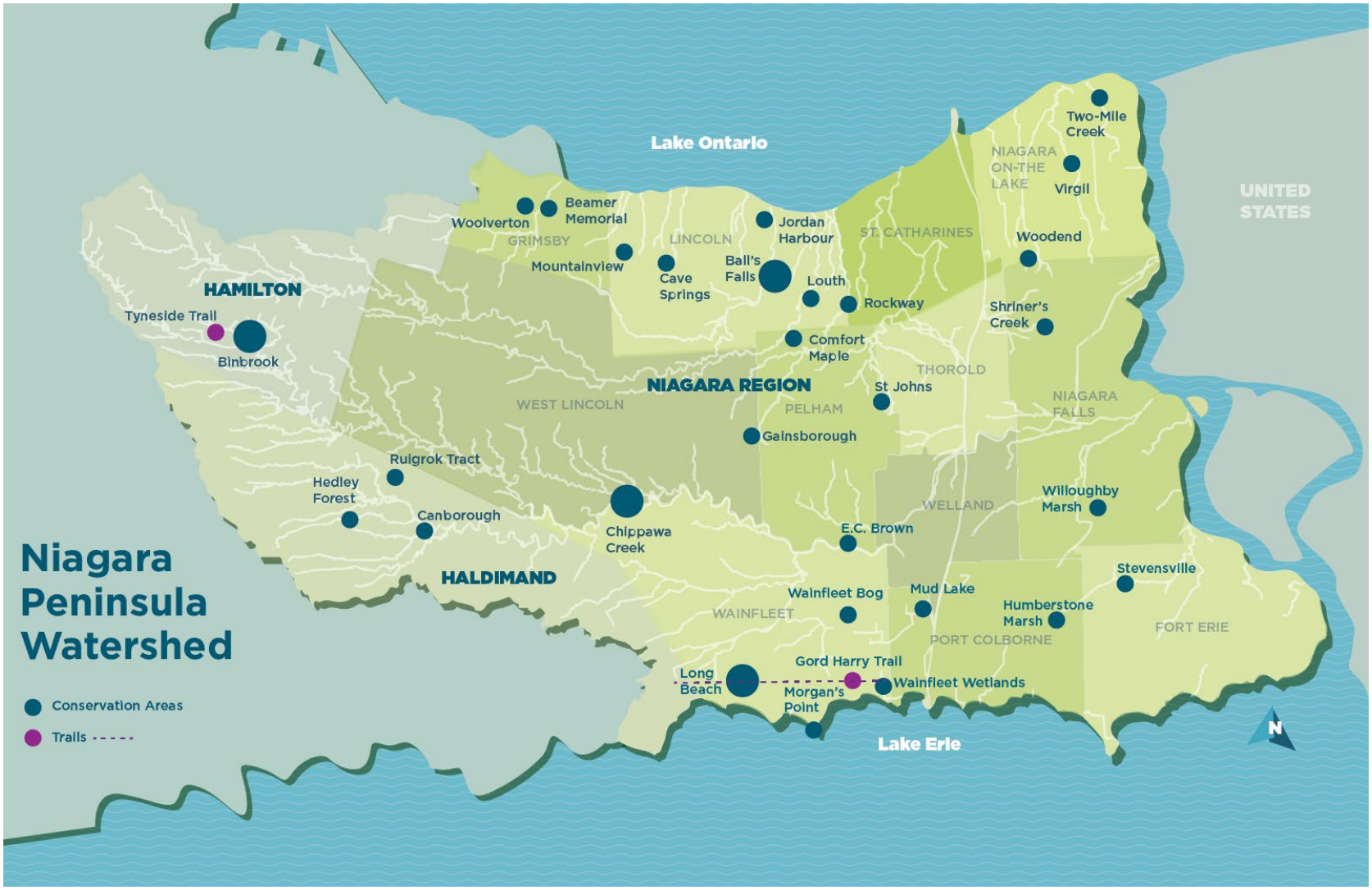


Figure 3. NPCA Conservation Area Properties

Table 2: Summary of NPCA Surface Water Quality Monitoring Program.			
NPCA Monitoring Program	Monitoring Components	Support Programs	Program Purpose
Surface Water Quality Monitoring Program (2001-present)	➢ Surface Water Chemistry (83 Stations) ➢ Benthic Macroinvertebrate Communities (65 Stations) ➢ In Situ-Water Quality Sensors (6 Stations) ➢ Stream Water Temperature (9-12 Stations) ➢ Special Contaminates Polychlorinated Biphenyls (1 Station) and Per-Polyfluoroalkyl (1 Station) ➢ Fluvial Geomorphology (40 Stations)	Ministry of Environment, Conservation and Parks (MECP)-Provincial Surface Water Quality Monitoring Program (PWQMN)	1) Watershed Management 2) Ambient Watershed Surface Water Chemistry 3) Conservation Area Surface Water Quality 4) Twelve Mile Creek Polychlorinated Biphenyls Monitoring 5) Lake Niapenco Per and Polyfluoroalkyl Substances Monitoring 6) Municipal Landfill Monitoring 7) Hamilton Airport Bioassessment 8) Coldwater Watershed Monitoring 9) Climate Change Monitoring

2.2.2 Monitoring Components

Ambient Watershed Surface Water Chemistry

As of 2023 the NPCA Surface Water Chemistry Program currently monitors surface water quality at 83 stations (13 PWQMN & 70 NPCA) across 52 watersheds (**Figure 2**). Surface water samples are collected monthly eight times each year during the ice-free season and analyzed for several parameters including nutrients, metals, bacteria, suspended solids, and general chemistry using PWQMN sampling protocols (MECP, 2020). The NPCA's surface chemical monitoring program is supported in partnership with MECP (PWQMN) and the Niagara Region. Since 2019, additional winter surface water sampling is made available through the MECP at PWQMN monitoring stations.

Biological Monitoring Benthic Macroinvertebrates

The NPCA monitors benthic macroinvertebrates communities as a biological indicator of water quality conditions and overall health of a waterbody because they are sensitive to pollution and human disturbance. For the NPCA's benthic invertebrate monitoring program, samples are collected at 20-25 water quality stations yearly with every accessible surface water station being sampled once every 3 years (**Figure 2**). From 1996 to 2016 the NPCA used the Bioassessment of Water Quality (BioMAP) protocol (Griffiths 1999) for sample collection. In 2017, the NPCA transitioned to the Ontario Benthos Biomonitoring Network (OBBN) sampling protocol (Jones et al. 2006).

In-Situ Stream Monitoring Program

Since 2014, the NPCA has deployed in-situ water quality monitoring probes at several key stations used with the watershed. These probes have various water quality sensors like pH, temperature, conductivity, dissolved oxygen, and turbidity. Data from these sensors are logged hourly and are downloaded at monthly intervals. Since 2017, the NPCA has integrated six EXO Yellow Springs Instruments (YSI) water quality monitoring probes with 5 NPCA hydrometric stations and 1 at Lake Niapenco.

Conservation Areas Surface Water Quality Monitoring Program

The NPCA Water Quality Monitoring Program was expanded in 2017 to include the waterbodies of the Conservation Areas: Chippawa Creek, Jordan Harbour, Lake Niapenco, Mud Lake, St. John's Pond, Virgil Reservoir, Wainfleet Wetlands and Wainfleet Bog (**Figure 3**). Water samples are collected quarterly or seasonally during the year and analyzed for general chemistry, nutrients, metals, and bacteria.

Conservation Areas Beach Monitoring Program

In 2020, the NPCA initiated a Beach Monitoring Program at Long beach Conservation and Chippawa Creek Conservation Areas. This program replaced Niagara Public Health's Beach Monitoring Program. NPCA collects water quality sampling for bacterial (E. coli) counts every other week during the warmer

months, typically beginning in June, and through July and August Ontario (Ministry of Health 2019). The sampling is conducted at Long beach Conservation and Chippawa Creek Conservation Areas. After laboratory analysis, the NPCA posts most recent sampling data available on its webpage (https://npca.ca/parks-recreation/beach-conditions). The data collected through this program is not used to identify public health risk when swimming in natural water bodies but is used to determine long-term trends in the water quality at NPCA swimming areas over time.

Stream Water Temperature Monitoring

The focal point of this monitoring program is the upper Twelve Mile Creek watershed. This portion of the watershed contains the last remaining coldwater streams in the NPCA watershed. Coldwater streams are fed by groundwater, and they are characterized by sustained cold water temperatures year-round. These ecosystems support a unique aquatic community adapted for coldwater conditions and significant warming can impact coldwater species from these watersheds. Since 2013, the NPCA initiated a dedicated temperature monitoring program using a network of temperature dataloggers to identify and classify the thermal regime for the Twelve Mile Creek surface water sampling stations and identify any changes that may have occurred to the thermal stability of this watershed.

Per and Polyfluoroalkyl Substances Monitoring Lake Niapenco

Since 2012, the NPCA has been monitoring for Per - and polyfluoroalkyl substances (PFAS) in Lake Niapenco. PFAS were found in the plasma of snapping turtles at Lake Niapenco in 2009 and 2010 by an Environment Canada and Climate Change (ECCC) scientist as part of an organic toxins' accumulation study (de Solla et al. 2012). PFAS track down studies by MECP confirmed the presence of PFAS in Lake Niapenco and identified John C. Munro International Airport as the source of the contamination. The NPCA PFAS monitoring program consists of a single sample collected within Lake Niapenco in late June near the Conservation Area's beach area which provides data on the current PFAS concentrations within the lake.

Lower Twelve Mile Creek Polychlorinated Biphenyls Monitoring Program

In 2020, MECP and City of St. Catharines had been investigating potential offsite impacts on surface water of Twelve Mile Creek from a former industrial area. To support agency partners, the NPCA has developed a Polychlorinated Biphenyls (PCBs) sampling program that was initiated in September 2020. This program was designed to measure ambient water quality conditions upstream and downstream of the former industrial plant on 12 Mile Creek. This program included enhanced monitoring at the PWQMN station and reactivating a former monitoring site. Data from this program is sent quarterly to the City of St. Catharines and MECP staff.

Glanbrook Landfill Biomonitoring Program

At the request of the Glanbrook Landfill Committee, the City of Hamilton contracts the NPCA biennially (since 1996) to monitor macroinvertebrates upstream and downstream of the Glanbrook Landfill to assess any landfill impacts to the adjacent watercourses. The NPCA collects samples in the spring and fall of each monitoring year and a report is provided to the City of Hamilton and the Glanbrook Landfill Committee.

Hamilton Airport Biomonitoring Program

The Hamilton International Airport (HIA) contracts the NPCA to monitor macroinvertebrates in two watercourses that drain from the HIA property. The goal of this program is to determine if stormwater runoff and de-icing fluids such as propylene glycol are impacting surface water quality in two headwater tributaries of the Welland River. The NPCA has been collecting samples in the spring and fall of each since 1998 and the NPCA generates a separate report annually for the HIA for their exclusive information and use.

2.2.3 Data storage

The NPCA's Surface Water Quality Monitoring Program produces a large volume of data that includes stream water chemistry, benthic macroinvertebrate, geomorphological, and time series data through various water quality logger technology. The NPCA utilized several database options to manage these data. The NPCA uses an internal Microsoft Access database to store stream water chemistry data and Excel Database to store logger files. In addition, this program also uses KiWQM and KiECO, which are database management tools from KISTERS which stores both stream benthic macroinvertebrate and water chemistry data. NPCA staff can access the PWQMN data through MECP's Lab Online portal. The public can access PWQMN through the province's Open Data portal (https://data.ontario.ca/dataset/provincial-stream-water-quality-monitoring-network).

2.2.4 Reporting

The reporting of surface water quality is a mandated component of the NPCA's water quality monitoring program. The reporting component of the surface water quality data is implemented through the NPCA's water quality monitoring report that is published on an annual basis. This annual reporting uses both Provincial and Federal environmental thresholds such as the Provincial Water Quality Objectives (OMOE 1994) and Canadian Water Quality Guidelines (CCME 2011) and summarizes water chemistry data using the Canadian Water Quality Index (CCME 2001) and the Hilsenhoff Family Biotic Index (Hilsenhoff 1987). In addition, the annual reporting includes the NPCA's expanded surface monitoring programs such as in-situ water quality monitoring by data logger technologies and monitoring results of contaminants of concern. This product is published onto the NPCA webpage (https://npca.ca/watershed-health#water-quality-monitoring). The NPCA also participates with Conservation Ontario's Watershed Report Initiative and a portion of data from this program summarized

as part of Watershed Report Card (Conservation Ontario 2022) every 5 years (https://npca.ca/watershed-health#report-cards).

2.3 NPCA Groundwater Monitoring Program

2.3.1 Overview

The NPCA Groundwater Monitoring Network comprises of two parts. The first part is the Provincial Groundwater Monitoring Network (PGMN) which is a partnership between the MECP and the Conservation Authorities of Ontario. The PGMN was initiated in 2001 and is a province-wide groundwater monitoring program designed to collect long-term baseline data on groundwater quantity and quality in special areas of interest. The PGMN program has allowed for an accurate assessment of current groundwater conditions and provides information for making sound land use planning decisions. The information collected through the PGMN serves the critical need for baseline groundwater data in the NPCA watershed. Groundwater is monitored through a network of 15 PGMN monitoring wells located throughout the NPCA watershed in locally significant hydrogeological areas. The PGMN program allows for an accurate assessment of current groundwater conditions. It provides an early warning system for changes in water levels or in water quality and provides information for making sound land use planning decisions. The information collected serves the critical need for baseline groundwater data in the region. In 2014 and 2015, the NPCA expanded its groundwater monitoring through a partnership with the Ontario Geological Survey (OGS). Thirty-one monitoring wells were installed at 23 different locations across the NPCA watershed at the top of bedrock in an aquifer zone commonly known as the Contact-Zone Aquifer (**Figure 4**). Three of 23 locations have a set of nested monitoring wells installed at various depths within the overburden sediments. The NPCA Groundwater Quality Program is summarized in **Table 3**.

2.3.2 Monitoring Components

Groundwater Levels

The NPCA's Groundwater Monitoring Network measures groundwater levels in the major aquifers within the NPCA watershed. Groundwater monitoring wells are instrumented with Solinst Leveloggers which are water level dataloggers that use an absolute pressure sensor to detect the depth (or pressure) of water above the logger. These data loggers record groundwater levels hourly and are downloaded by staff 2 to 4 times per year. Groundwater level data files are corrected for barometric pressure from Solinst barologger. In addition, manual static water level measures are also taken to verify and correct water level data. These data assist the NPCA with characterizing the ambient groundwater conditions across the NPCA watershed.

Groundwater Chemistry

Since 2002, the NPCA has been collecting groundwater samples annually in the fall for PGMN monitoring wells. In 2022, sampling was expanded to include the sampling of overburden wells in the spring. NPCA staff use a variety of groundwater pump technologies to collect water samples that follow the MECP sampling protocol. Groundwater samples are submitted and analyzed at the MECP laboratory for general chemistry, nutrients, and metals. For the NPCA's expanded groundwater monitoring network, samples are collected annually in the fall using a protocol developed by the NPCA hydrogeology staff. Groundwater samples collected from these wells are sent to a lab for analysis.

2.3.3 Data storage

The NPCA's Groundwater Monitoring Program produces a large volume of data that includes hourly groundwater level data and water chemistry data. The NPCA utilized several database options to manage these data. For PGMN, the MECP has uses WISKI, a database management tool from KISTERS which stores both groundwater level and water chemistry data. NPCA staff can access the PGMN data through the province's ONE KEY portal. In addition, PGMN data can also be accessed by the public through a website (https://www.ontario.ca/page/map-provincial-groundwater-monitoring-network). The NPCA also stores the PGMN water chemistry data with an internal Microsoft Office Access database. The NPCA stores non-PGMN groundwater data that includes groundwater levels and water chemistry data on an NPCA KISTERS WISKI database.

2.3.4 Reporting

The reporting of groundwater data is a mandated component of the NPCA's water quality monitoring program. The reporting component of the groundwater data is implemented through the NPCA's annual water quality monitoring reports. The annual report presents groundwater data using charts that show groundwater level data for the entire time record for each monitoring well in the program. In addition, groundwater chemistry data compared against Ontario Drinking Water Standards (MOE 2003) and is summarized in the NPCA's annual report (NPCA 2024). This product is published onto the NPCA webpage (https://npca.ca/watershed-health#water-quality-monitoring). The NPCA also participates with Conservation Ontario's Watershed Report Initiative and a portion of data from this program summarized as part of Watershed Report Card every 5 years (https://npca.ca/watershed-health#report-cards.

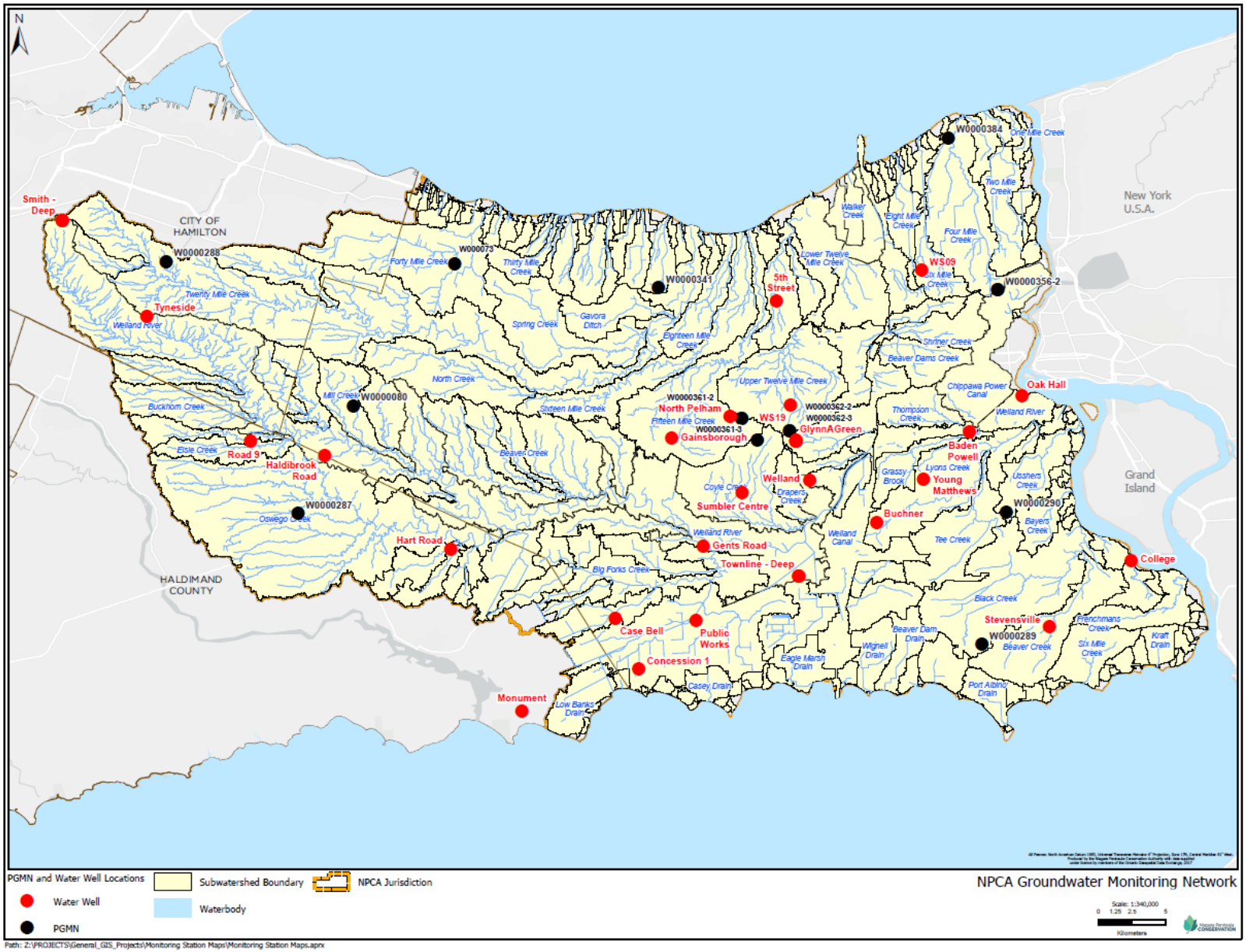


Figure 4. NPCA Groundwater Monitoring Network Program Stations 2023

Table 3: Summary of NPCA Groundwater Quality Monitoring Program			
NPCA Monitoring Program	Monitoring Components	Support Programs	Program Purpose
Groundwater Monitoring Program **(2002-present)**	➢ Groundwater Chemistry (36 Stations) ➢ Groundwater Levels (46 Stations)	Ministry of Environment, Conservation and Parks (MECP)-Provincial Groundwater Monitoring Program (PGMN)	1) Watershed Management 2) Ontario Low Water Program (groundwater) 3) Ambient Watershed Ground Water Quality 4) Ambient Watershed Ground Water Quantity 5) Climate Change Monitoring 6) Water Budgets and Resource Assessment

2.4 NPCA Ecological Monitoring Program

2.4.1 Overview

The NPCA manages 41 Conservation Areas (**Figure 3**) within the Niagara Peninsula watershed and includes forests, wetlands, areas of natural and scientific interest, recreational lands, natural heritage, and cultural sites, as well as land for flood and erosion control. The forests, wetlands, and other natural features and ecosystems found within the NPCA's Conservation Areas protect and improve water quality and quantity, reduce flooding, act as drinking water sources, and provide habitats for a wide range of wildlife, fish, and birds. Ecological monitoring of NPCA's Conservation Areas informs our ecological restoration efforts, helps to identify areas that require management activities, and assists with maintaining biodiversity on our NPCA properties, which can help to prevent and reduce the harmful impacts of climate change. The NPCA has developed several ecological monitoring programs for its Conservation Areas to assess a variety of management areas.

2.4.2 Monitoring Components

The Ecological Monitoring Program consists of a variety of flora, fauna, ecosystem, and groundwater components established throughout the NPCA's 41 Conservation Areas. These programs are summarized in **Table 4**.

2.4.3 Data storage

The NPCA's Ecological Monitoring Program's datasets are complex and contain a variety of species lists, population, and observation data. This program also generates large volumes of logger data associated with groundwater monitoring and bat monitoring files. For data storage and maintenance staff use Microsoft Excel databases. Staff have also developed a data dictionary ensuring information can be accessed by all staff. Data can be accessed by partners and the public through data requests to NPCA staff.

2.4.4 Reporting

The NPCA's Ecological Monitoring Program produces technical ecological reports and summaries related to Conservation Area land management and monitoring programs as required. These reports are not currently published publicly, however, data can be requested through NPCA staff. Monitoring and inventory results may also be used to support watershed and subwatershed planning and research initiatives.

Table 4: Summary of NPCA Conservation Areas Ecological Monitoring Program			
NPCA Monitoring Program	Monitoring Components	Support Programs	Program Purpose
Conservation Areas Ecological Monitoring Program **(1998-present)**	➢ Fish Communities ➢ Wildlife Communities ➢ Forest Vegetation ➢ Benthic Macroinvertebrate Communities ➢ Wetland Vegetation ➢ Tree Health	Ontario Ministry of Natural Resources and Forestry	1) Conservation Area Land Management 2) Gypsy Moth Population Monitoring 3) Wainfleet Bog Groundwater Level Monitoring 4) Conservation Area Restoration Projects 5) Species at Risk Monitoring 6) Old Growth Monitoring 7) Red Mulberry Propagate Monitoring 8) Bat Monitoring 9) Mud Lake and Wainfleet Wetlands Monitoring 10) Invasive Species Monitoring 11) Conservation Area Resource Inventory 12) St. Johns Pond Monitoring 13) Climate Change Monitoring

2.5 NPCA Restoration Program Monitoring

2.5.1 Overview

The NPCA's Restoration Monitoring Program was developed in 2021 to allow staff to track project progression after implementation, provide a quality control mechanism and measure project success. The data from this program is used for adaptive management to guide decision-making, inform on future project plans and budgets, and develop more efficient management strategies for future projects.

2.5.2 Monitoring Components

This program monitors a variety of components including survival rates for planting sites (tree and shrub sites) and general growth/progress of other restoration projects (herbaceous ground cover and water retention for wetland projects, erosion and cover for instream projects or grassed waterways). Qualitative data such photo monitoring points, landowner surveys and quantitative data are collected through circle plots, survival assessments, and GIS project points/lines/polygons. Project monitoring is initiated in year 1, and continues to year 4, and year 10 after project implementation and completion. The Restoration Monitoring Programs is summarized in **Table 5**.

Table 5: Summary of NPCA Restoration Monitoring Program

NPCA Monitoring Program	Monitoring Components	Program Purpose
Restoration Monitoring Program (2022-present)	➢ **Forest and Wetland Vegetative Communities**	**1) Watershed Management** **2) Restoration Program Adaptive Management**

2.5.3 Data storage

The Restoration Monitoring Program uses an ArcGIS Survey 123 App developed in-house by NPCA GIS staff for monitoring surveys accessible to staff through a web browser in tables and dashboards. This program also uses ArcGIS Pro and Field Maps for all circle plot points and project points/lines/polygons. Photo monitoring data created in Field Maps are saved in ArcGIS Pro webservice and backed up in ArcGIS Pro geodatabases. Additional data and photos are stored in Microsoft SharePoint in Excel spreadsheets, Microsoft Word documents, and photo folders.

2.5.4 Reporting

The Restoration Division Staff create reports summarizing monitoring efforts including key findings, notes about relevant sites, and a list of projects that require follow-up work. Where required, projects are stamped by a professional forester and submitted to funding agencies with invoices to receive external funding.

2.6 Environmental Permissions

2.6.1 Overview

MECP and Public Health Units require the NPCA to have monitoring programs in place to support a variety of environmental permissions related to Conservation Area services and infrastructure. These include Environmental Certificate Approvals, Public Health Directives and Permit-to-Take Water. These monitoring programs are summarized in **Table 6**.

Table 6: Summary of NPCA Environmental Permissions

NPCA Monitoring Program	Monitoring Components	Program Purpose
MECP Environmental Permissions	➢ **Water Chemistry (3 Sewage Sites & 4 Drinking Water Systems Sites)** ➢ **Surface Water Levels (2 Sites)**	**1) Environmental Compliance Approval for Septic Systems and Sewage Lagoons Monitoring Program.** **2) Public Health Directive for Small Drinking Water Systems** **3) Permit to Take Water Reporting Requirement**

2.6.2 Monitoring Components

Environmental Compliance Approvals

The NPCA currently operates 3 on-site sewage treatment facilities that require a MECP Environmental Compliance Approval (ECA). These facilities include:

1) Balls Falls Centre for Conservation

2) Balls Falls Field Centre, Event Barn, and Washrooms building.

3) Long Beach Sewage Lagoons

The MECP requires through ECAs that all these facilities to be monitored to ensure the effectiveness of the Works through the collection of samples. For the Balls Falls Centre for Conservation, monthly samples of treated effluent are required. For the Balls Falls Field Centre facilities triannual (spring, summer, and fall) samples from two groundwater monitoring wells (two wells down-gradient from the Field Centre system Type A Dispersal Bed) and triannual samples from two surface water stations on Twenty Mile Creek (one upstream and one downstream of the Works) is required. The ECA for Long Beach Sewage Lagoon facility requires spring sampling of lagoon samples in Cell 1, Cell 2, and the

receiving ditch. NPCA is required to collect samples until the MECP effluent limits are met. For discharge of the sewage lagoon the NPCA is also required collect 1 sample from the receiving ditch during the release, and after the release.

Small Drinking Water Systems

The NPCA's Small Drinking Water Systems are located at Balls Falls, Binbrook, Chippawa Creek, Long Beach and Balls Falls Conservation Areas (**Figure 3**). The NPCA is required by the Health Protection and Promotion Act, Ontario Regulation 319/08: Small Drinking Water Systems to sample, test, monitor and report on the water quality of the small drinking water systems. Public health inspectors have been mandated to conduct a site-specific risk assessment on small drinking water systems in the province.

Permit to Take Water

As a requirement of the MECP's Permit to Take Water (PTTW), the NPCA monitors water levels at Binbrook Reservoir and Virgil Dams (**Figure 3**). At the Virgil Dams, water levels are monitored using data loggers. These sensors collect data at specific logging intervals at designated locations as per the requirement of the PTTW. In the case of the Binbrook Reservoir, estimates of dam discharges for the PTTW based on engineered rating curves determined by NPCA hired consultants.

2.6.3 Data storage

Data collected through the Environmental Permissions Monitoring Programs are stored and maintained by staff using Microsoft Excel databases.

2.6.4 Reporting

There is a different reporting requirement for each of the environmental permissions.

Environmental Compliance Approvals (ECAs)

The ECA requires that a performance report for all these facilities be completed within 90 days following the end of each operational season. NPCA generates a separate report for the MECP for their exclusive information and use.

Small Drinking Water Systems

To ensure there the NPCA provides safe drinking water, the public health units have required the NPCA to collect bacteria samples. The NPCA is subject to health unit inspections, required to maintain sampling records and report any adverse results of small drinking water systems.

Permit to Take Water

The NPCA provides the MECP with annual reporting for the PTTW for the Binbrook Reservoir and Virgil Dams. The NPCA generates a separate report for the MECP for their exclusive information and use.

2.7 Stewardship and Community Science Monitoring

2.7.1 Overview

The NPCA's stewardship and community science monitoring program are interconnected approaches that involve community engagement and active participation in the protection and understanding of the environment. The stewardship component emphasizes responsible resource management, while the community science monitoring component harnesses the collective power of community members to contribute to scientific research and environmental monitoring. The data from this program is used for adaptive management to guide decision-making based around stewardship and community science monitoring.

2.7.2 Monitoring Components

The NPCA's Stewardship and Community Service Monitoring program include the following:

1) The NPCA's Community Stewardship Monitoring tracks volunteer statistics such as number of volunteers, number of planting days and number of projects as a tool to assess community engagement and management decisions.
2) The NPCA's Bluebird Box Community Science Monitoring Program is led by the NPCA but implemented by volunteers. The monitoring site locations include Ball's Falls, Binbrook and the St. John's Valley Centre. Volunteers for this program monitor the boxes and report on the species nest types, number of eggs, number of fledglings and predation. Volunteers also clean the boxes out in the spring each year to make room for new nests.
3) The NPCA is a regional coordinator of the Birds Canada Marsh Monitoring Program. With this program, volunteers are required to select a sample station from a designated list and visit the same station 3 times throughout spring to summer and record either amphibian or bird species that are calling. The protocol used for this program is from Birds Canada.
4) The NPCA's Turtle Tally program uses volunteers to monitor specific road crossings daily between spring and fall to record turtle deaths and sightings at those crossings and locations.
5) The NPCA Trail Ambassadors allows volunteers to use NPCA-created Apps to report incidents, issues, and concerns on NPCA trails to trigger reports that are managed by NPCA staff.

2.6.3 Data storage

The NPCA's Stewardship and Community Service Monitoring datasets are stored and maintained by staff using Microsoft Excel databases. Data can be accessed by partners and the public through data requests to NPCA staff.

2.6.4 Reporting

There is no formal reporting component to this program, however data is shared with partner agencies upon request and statistics are used in NPCA social media and the corporate NPCA Annual Report.

3.0 INTEGRATED WATERSHED MONITORING PROGRAM

3.1 Background: Integrated Watershed Monitoring

Integrated watershed monitoring is defined as a comprehensive and systematic approach to collecting, analyzing, and interpreting data related to the various components of a watershed. Integrated watershed monitoring programs aim to assess and understand the ecological, hydrological, and environmental conditions over time and space within a watershed to support effective management and conservation efforts. Watershed ecosystems and their components are linked, and implementing an integrated approach provides an understanding of these relationships. This is critical for the NPCA watershed as there are anthropogenic stressors threatening our ecosystems. The key components of integrated watershed monitoring include Water Quality Monitoring, Hydrometric Monitoring, Ecological Monitoring, Land Use and Land Cover Monitoring, Socioeconomic Data, Geospatial Data and Community Engagement. The integration of data from these various components provides a holistic understanding of the watershed's functions, allowing stakeholders to make informed decisions about resource management, environmental protection, and land use planning.

Integrated watershed monitoring programs are often long-term initiatives, as they aim to capture the dynamics and changes occurring within the watershed over time. The data collected through these programs contribute to sustainable watershed management, conservation of biodiversity, and the protection of valuable ecosystem services.

3.2 The Rationale for an NPCA Integrated Watershed Monitoring Program

The NPCA 10-year (2021-2031) Strategic Plan has identified an Integrated Watershed Monitoring Program (IWMP) as a critical priority to help achieve several strategic goals and actions related to Healthy and Climate Resilient Watersheds (Goals 1.1, 1.2, 1.3 and 1.4), Supporting Sustainable Growth (Goals 2.2 and 2.3), Connecting People to Nature (Goals 3.1 and 3.2), Partner of Choice (Goals 4.1 and 4.3), Organizational Excellence (Goal 5.2) and Financial Sustainability (Goal 6.2). The program supports NPCA's vision of "Nature for all" that envisions a healthy and vibrant environment with shared greenspace and clean water that sustains life for future generations.

The NPCA is well-positioned to transition and implement an IWMP as part of its core service delivery. The NPCA has conducted a watershed monitoring gap analysis (**Table 7**) to assess the strengths and weaknesses of an existing watershed monitoring program. This analysis was designed to identify gaps

or deficiencies in the current monitoring efforts to help improve the overall effectiveness of data collection and analysis within a watershed to address those data gaps.

Table 7: Key Identified Gaps in NPCA Monitoring	
	Monitoring Gaps
Hydrometric Monitoring	➢ Baseflow / Low-Flow Surveys ➢ Watershed Discharge Data ➢ Expanded Watershed Coverage of Stream Flow Network
Surface Water Monitoring	➢ Wet Weather or Event-Based Monitoring ➢ Winter Water Quality Monitoring ➢ Fisheries (Fish Communities and Fish Habitat) ➢ Stream Fluvial Geomorphology and Erosion Monitoring ➢ Coastal/Shoreline Ecosystem Monitoring
Groundwater Water Monitoring	➢ Wetland Hydrology-Groundwater-Surface Water Interaction
Terrestrial Monitoring Program	➢ Watershed Forest Community and Health Monitoring ➢ Watershed Wetland Community Monitoring ➢ Wildlife (Birds and Amphibians) ➢ Coastal/Shoreline Ecosystem Monitoring

In addition, the NPCA's existing monitoring programs will provide the baseline infrastructure to implement and build a new IWMP. This infrastructure includes existing monitoring program staff, equipment, reporting intervals, database management systems, GIS capacity, web-based tools, and recognition across the watershed. Opportunities to expand the IWMP will be further explored to provide additional internal and external services to meet the watershed resource management needs of the NPCA and our partners. The NPCA's current monitoring programs were designed to be highly flexible for expansion to incorporate additional monitoring components to identify and understand watershed stressors. This is demonstrated with expansion of monitoring components within the NPCA's Water Quality Monitoring Program from 2001 to 2023 (**Figure 5**).

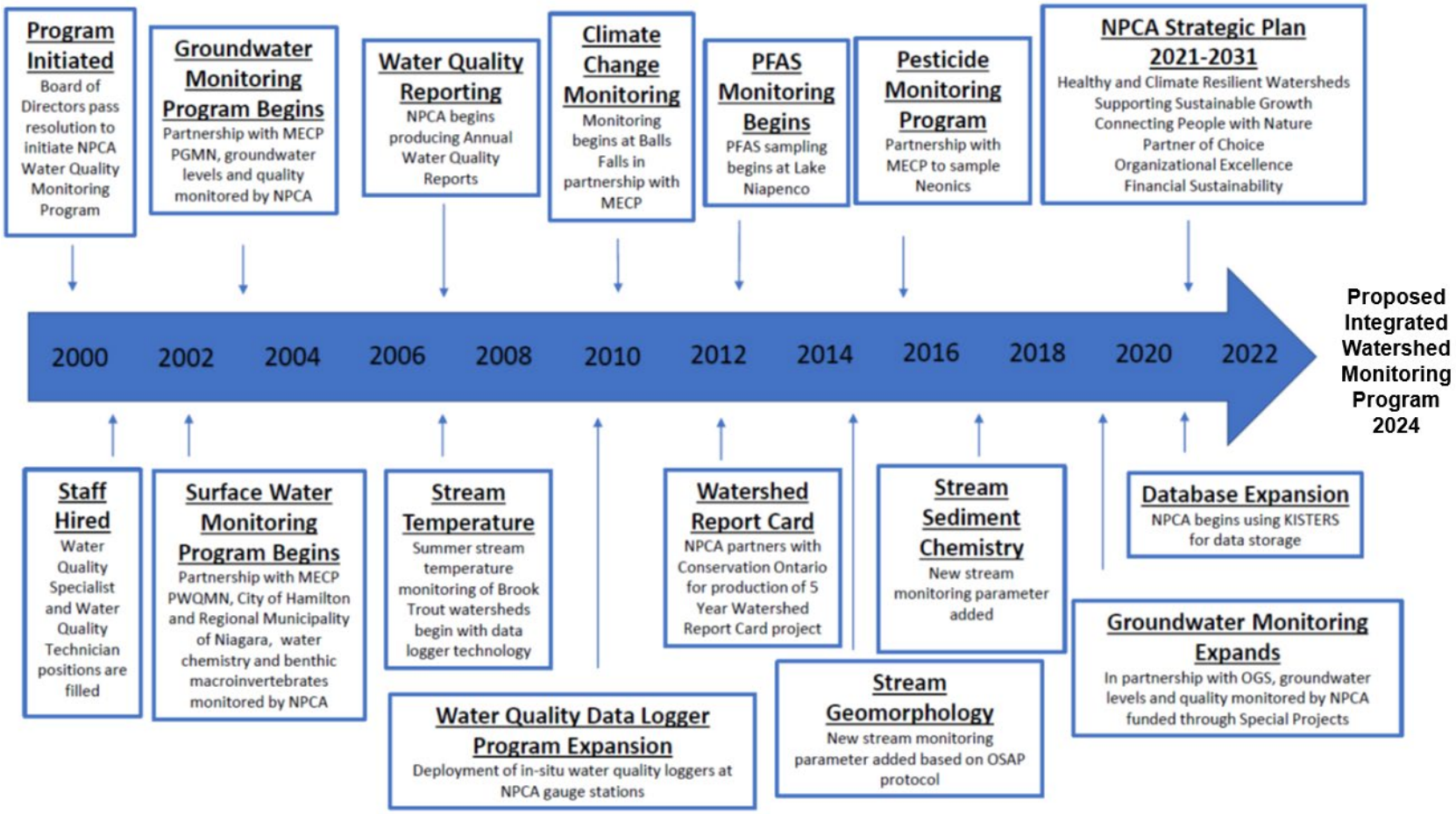


Figure 5. NPCA Water Quality Monitoring Program evolution

The NPCA's Integrated Watershed Monitoring Program (IWMP) will be designed to systematically collect and analyze data on various aspects of a watershed's environment, including its water quality, water quantity, land use, natural hazard risks, and ecological health. The rationale for the NPCA implementing such a program is grounded in several key considerations:

1) **Comprehensive Understanding**: The NPCA watersheds are complex and interconnected systems where various natural and human-induced factors can influence water quality, quantity, natural hazards, and overall health. An integrated monitoring program provides a comprehensive understanding of these interrelations, allowing for a more holistic view of watershed dynamics.
2) **Identifying Trends and Changes**: Long-term monitoring helps identify trends and changes within a watershed over time. This information is critical for distinguishing between natural variability and anthropogenic impacts, enabling timely and effective management responses to emerging issues.
3) **Early Detection of Issues**: Integrated monitoring allows for the early detection of potential problems such as pollution, habitat degradation, or changes in water flow patterns. Early identification provides an opportunity for proactive management interventions, helping to prevent or mitigate negative impacts.
4) **Effective Decision-Making**: Allow the NPCA to rely on accurate and up-to-date information to make informed decisions about land use, resource management, natural hazard management and environmental protection. An integrated monitoring program contributes to evidence-based decision-making.
5) **Sustainable Resource Management**: Watersheds are essential for providing various ecosystem services, including clean water, habitat for wildlife, and recreational opportunities. Monitoring helps ensure the sustainable management of these resources by providing information on water quality, biodiversity, and ecosystem health.
6) **Climate Change Adaptation**: As climate change continues to impact weather patterns and hydrological cycles, an integrated monitoring program is essential for assessing the effects on watersheds, including natural hazards. This information is crucial for developing adaptive strategies to address changing conditions and mitigate potential risks.
7) **Community Engagement and Education**: An integrated monitoring program fosters community engagement by involving the public, schools, and organizations in data collection and interpretation. This engagement enhances public awareness and understanding of watershed issues, leading to more informed and environmentally conscious communities.
8) **Regulatory Compliance**: There are regulations and standards which governing water quality and environmental protection in Ontario and Canada. An integrated monitoring program helps ensure compliance with these regulations by providing the necessary data for reporting and assessment.

9) **Research and Innovation**: Integrated watershed monitoring programs contribute valuable data for scientific research and innovation. The NPCA's data can be used researchers to study ecological processes, develop models, and advance our understanding of complex environmental systems and adaptive management approaches.
10) **Continuous Improvement**: Regular monitoring allows for the continuous improvement of adaptive management strategies. By assessing the effectiveness of implemented measures, the NPCA can adjust management plans and strategies based on real-world data and outcomes.

In summary, the rationale for an integrated watershed monitoring program revolves around the need for a comprehensive understanding of watershed dynamics, early detection of issues, informed decision-making, and the sustainable management of water resources, natural hazards and ecosystems.

3.3 Integrated Watershed Monitoring Program Advisory Group

The development of a comprehensive IWMP required a collaborative approach across divisions and departments of the NPCA. The NPCA formed an Internal Integrated Watershed Monitoring Program Advisory Group (**Table 8**) which met to scope the program, prioritize monitoring components, and assess NPCA resources to identify in-house technical experts.

Table 8. Internal Integrated Watershed Monitoring Program Advisory Group

Committee Members	Expertise
Director, Watershed Strategies and Climate Change	Corporate Director
Manager Watershed Monitoring and Reporting	Program Administrator
Water Quality Specialist	Water Quality and Aquatic Ecology
Ecologist	Terrestrial Ecology
Manager Ecological Planning	Ecology Principles Applied through Planning and Permit Applications
Manager of Conservation Area Land Planning	Conservation Area Management Plans
Hydrogeology Specialist	Groundwater
Restoration Specialist	Restoration Ecology
Program Coordinator, Watershed Strategies and Climate Research	Climate Change Research and Innovation, and GIS Landscape Analysis
Senior Manager Integrated Watershed Strategies	Integrated Watershed Management

Flood Risk Management Officer	Water Quantity and Climate Data
Conservation Areas Programs & Services	Conservation Area Compliance Monitoring
Water Resources Engineer	Stormwater Management

Upon completion of the NPCA Integrated Watershed Monitoring Program (IWMP), the Advisory Group will transition to a Working Group that will ensure that this program meets the strategic goals and actions of NPCA 2021-2031 Strategic Plan and lays the groundwork for a long-term sustainable program. Working group members will collaborate on program implementation and maintenance, the analysis and synthesis of monitoring results, reporting requirements, review monitoring program requirements/priorities/plans, identify stakeholders and partners, assess staff and equipment resources, and identify potential funding sources. The Working Group will be an integral part of the adaptive management framework of the IWMP where the Working Group can learn to track the program's performance and impacts of actions and to inform refinement and new action.

In addition, as the IWMP becomes resourced and implemented, the NPCA will begin collaborating external stakeholders such as municipalities, other governmental agencies, academic institutions, and environmental groups to assess their monitoring needs for data and exchange of expertise. This will also be critical to shaping the Monitoring Areas of the NPCA's IWMP.3.4 Overview of NPCA's Integrated Watershed Monitoring Program

3.4 Overview of NPCA's Integrated Watershed Monitoring Program

The NPCA's Integrated Watershed Monitoring Program (IWMP) has the following high-level goal to achieve the strategic targets and actions of NPCA 2021-2031 Strategic Plan and build a long-term sustainable program. To support this program's goal, a conceptual model has been developed that identifies three key Watershed Monitoring Program Areas and four key Monitoring Support Systems necessary to achieve its goal.

> The goal of the NPCA Integrated Watershed Monitoring Program is to comprehensively assess the ecological health and resilience of the watershed through monitoring initiatives, to inform evidence-based conservation and management strategies for the NPCA watershed.

This conceptual model was developed in collaboration with the Internal Integrated Watershed Monitoring Program Advisory Group. The three Monitoring Program Areas are Long-Term Watershed Monitoring, Corporate Support Services, and Monitoring Service Provider. The four Monitoring Support Systems include Data Management, GIS, Communications and External Partnerships and External

Data. This model is shown in **Figure 6**. Further refined goals have been developed for the specific program areas.

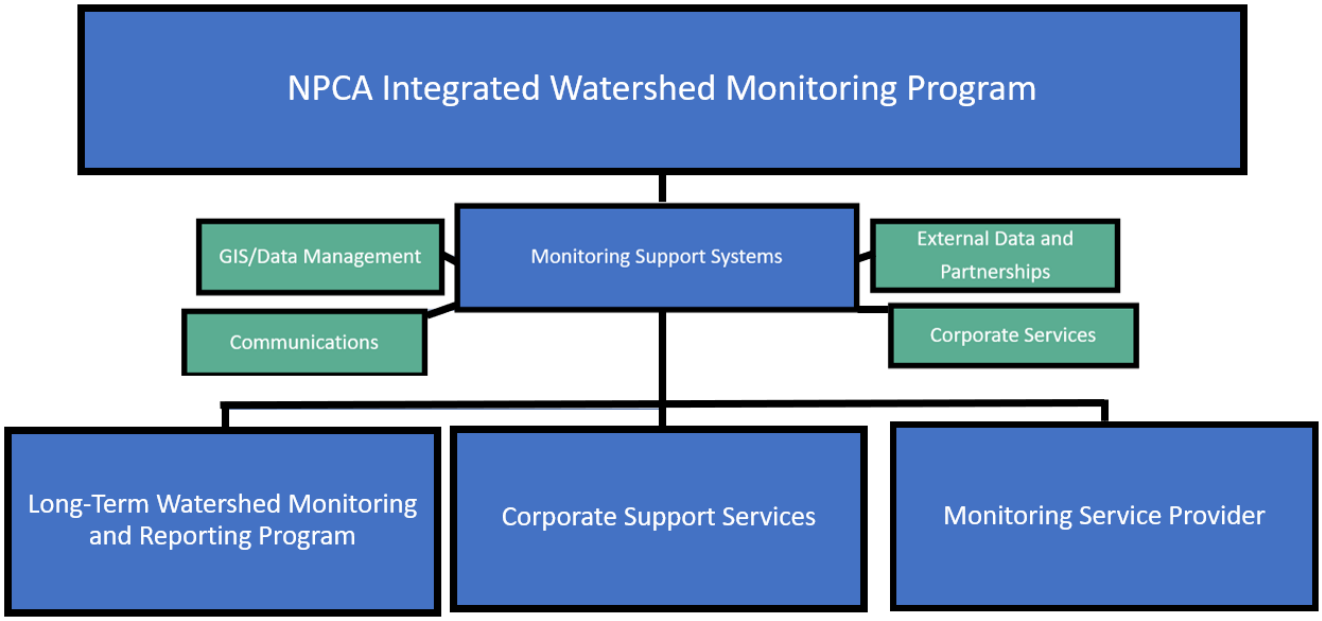


Figure 6. NPCA Integrated Watershed Monitoring Program Model

3.4.1 Monitoring Support Systems

Corporate Services, Geographic Information Systems (GIS) and Data Management, Communications, and external resources (partnerships and data) are crucial monitoring support systems for the NPCA IWMP. GIS provides spatial analysis and visualization capabilities, allowing the NPCA to map, monitor, and manage natural resources accurately. Communications systems facilitate the timely dissemination of information, ensuring that stakeholders are informed and responsive to environmental changes. Robust data management ensures the collection, storage, and analysis of vast amounts of environmental data across the agency, making it accessible and useful for decision-making. External partnerships enhance the reach and impact of the NPCA's IWMP by pooling data, resources, and knowledge from various organizations. Collectively, these elements enable a comprehensive approach support to the IWMP.

4.0 NPCA LONG-TERM MONITORING AND REPORTING PROGRAM

Long-Term Watershed Monitoring is a priority program for the NPCA's Integrated Watershed Monitoring Program. This program is identified as holding significant value for understanding and managing natural hazards and ecosystems with the NPCA watershed. In addition, this program will provide a foundation for scientific research, conservation initiatives, and informed decision-making. It will contribute to the NPCA's ability to sustainably manage and protect ecosystems, ensuring their resilience in the face of ongoing environmental changes. Here are several key aspects highlighting this program's importance:

1) **Baseline Data**: Long-term monitoring provides a baseline of watershed conditions, offering a reference point against which changes can be measured. This baseline is essential for distinguishing natural variability from anthropogenic influences.
2) **Detecting Trends and Changes**: Natural systems are dynamic and can undergo gradual or sudden changes. Long-term monitoring will the NPCA to detect trends and changes over time, providing insights into the factors driving ecological shifts.
3) **Ecosystem Health Assessment**: By continuously monitoring various ecological parameters, the NPCA will be able to assess the overall health of ecosystems. This includes tracking changes in biodiversity, ecosystem structure, and the abundance of key species, which are crucial indicators of ecosystem health.
4) **Early Warning for Disturbances**: Long-term monitoring can serve as an early warning system for ecological disturbances such as disease outbreaks, invasive species introductions, or habitat degradation. Rapid detection enables timely responses to mitigate negative impacts.
5) **Climate Change Impacts**: Long-term ecological monitoring plays a crucial role in understanding and documenting the impacts of climate change on natural hazards and ecosystems. Changes in temperature, precipitation, and other climate variables can be tracked, aiding in the assessment of adaptive responses and mitigation options.
6) **Conservation Planning and Management**: The data collected through long-term monitoring contributes to evidence-based conservation planning and management. This information helps identify priority areas for conservation, assess the effectiveness of conservation strategies, and guide adaptive management practices.
7) **Research and Scientific Understanding**: Long-term data sets are valuable for scientific research, enabling researchers to investigate natural processes within the watershed, test hypotheses, and develop and refine models. This contributes to a deeper understanding of the complex interactions within watersheds and ecosystems.
8) **Ecosystem Services Assessment**: Long-term monitoring helps quantify and assess the various ecosystem services provided by natural environments, such as water purification,

pollination, and carbon sequestration. This information is critical for making informed decisions about sustainable resource use.

9) **Policy Development and Decision-Making**: Policymakers rely on long-term watershed monitoring data to formulate environmental policies. Informed decision-making is essential for addressing emerging ecological challenges and ensuring the sustainable use of natural resources and management of natural hazards.
10) **Public Awareness and Education**: Long-term monitoring results can be communicated to the public, raising awareness about environmental issues, and fostering a sense of stewardship in the NPCA watershed. Education based on real-world watershed data enhances public understanding and support for conservation efforts.

The NPCA Long-Term Watershed Monitoring and Reporting Program will consist of five monitoring units. These include Surface Water Monitoring, Groundwater Monitoring, Terrestrial Monitoring, Hydrometric Monitoring and Watershed Landscape Analysis **Figure 7**. These units are further specialized and consist of a combination of the existing NPCA programs and new monitoring components that are integrated into a comprehensive network providing a holistic understanding of the NPCA natural resources.

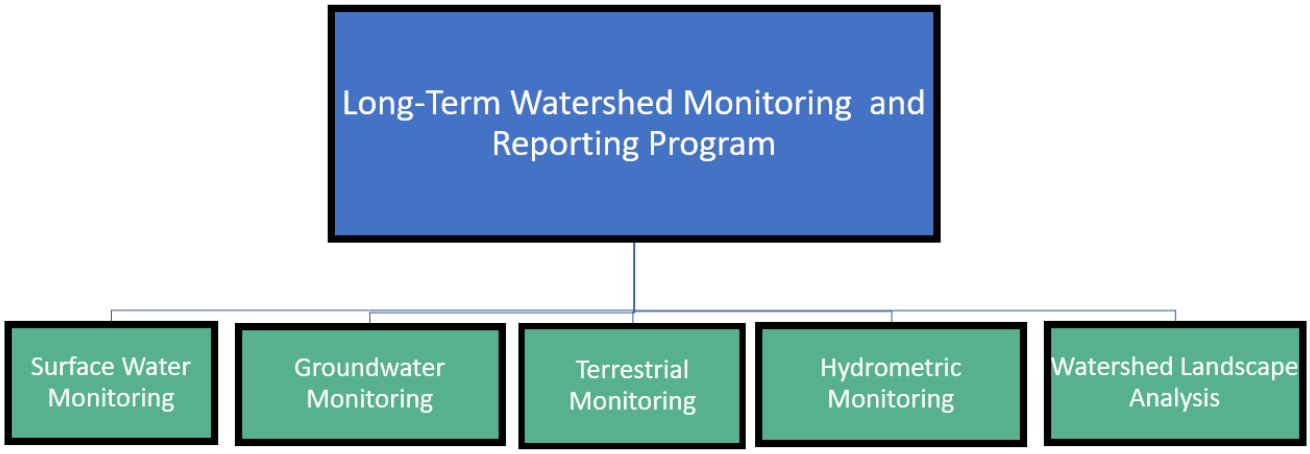


Figure 7. NPCA Long-Term Integrated Watershed Monitoring and Reporting Program.

4.1 Program Goal

The goals of the NPCA Long-Term Integrated Monitoring and Reporting Program are:

- To establish baseline conditions by understanding natural variability and ecological thresholds within the NPCA watershed
- To assess the temporal and spatial conditions of aquatic and terrestrial resources at various locations across the watershed compared to established baselines
- To identify potential stressors and emerging threats that could be addressed through other programs

4.1.1 Surface Water Monitoring

The NPCA's proposed Surface Water Monitoring Program will consist of five monitoring components which include the existing NPCA's water chemistry, stream benthic macroinvertebrates and stream temperature monitoring components and new NPCA monitoring initiatives such as fish communities and fluvial geomorphology **Figure 8**.

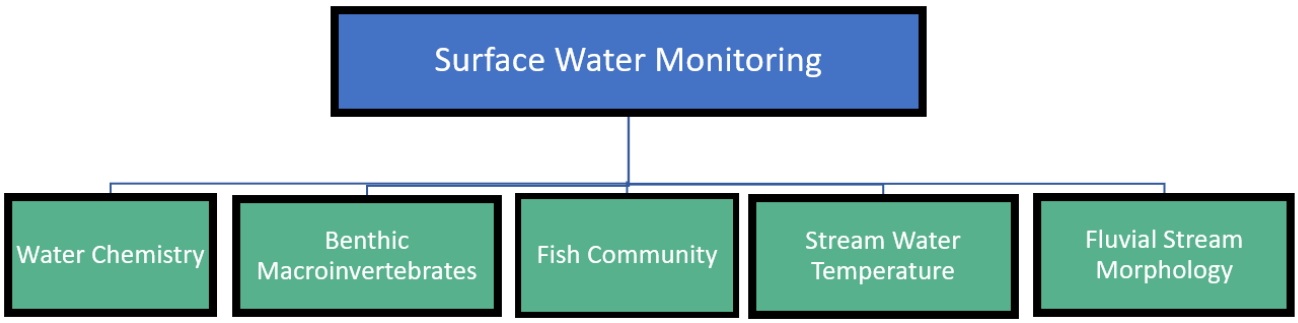


Figure 8. NPCA Long-Term Integrated Surface Water Monitoring Program.

Water Chemistry

The NPCA's Integrated Long-Term Watershed Monitoring Program surface water chemistry monitoring component will consist of the previous Ambient Watershed Surface Water Chemistry and Conservation Areas Surface Water Quality Monitoring Programs as well as the In-Situ Stream Monitoring Program. The sampling network, protocols and equipment maintenance methodologies will remain unchanged, ensuring consistency and reliability in the collected data. This continuation guarantees the program's ability to track long-term trends and assess the health of water bodies in the NPCA watershed. This will ensure the program can provide accurate and actionable assessments into surface water quality chemistry, facilitating informed decision-making and environmental management efforts. The Surface Water Chemistry monitoring component is summarized in **Table 9**.

Table 9: Water Chemistry Monitoring Components			
Total Number of Stations	**Sample**	**Frequency of Sampling**	**Sampling Protocol**
83	Grab Sample	8 Times Monthly (ice-free season)	Provincial Water Quality Monitoring Protocol
8	Grab Sample	2 Times (Jan-Mar)	
6	Continuous Deployed Water Quality Sensor and Logger	Winter PWQMN stations only	NPCA Protocol and YSI Inc.

Benthic Macroinvertebrates

The NPCA's Integrated Long-Term Watershed Monitoring Program benthic macroinvertebrate monitoring component will continue in its existing form, maintaining its essential role in assessing the health and ecological integrity of aquatic ecosystems. This established program utilizing the Ontario Benthos Biomonitoring Network Program (OBBN) protocol focuses on the systematic collection and analysis of benthic macroinvertebrate organisms. By continuing in its current framework, the program ensures consistency and reliability in monitoring these sensitive indicators of water quality. Benthic macroinvertebrates are highly responsive to changes in their environment, making them valuable indicators of stream health. The NPCA's continued use of the program's existing structure underscores its effectiveness in providing critical insights into water quality conditions, detecting environmental changes, and informing targeted conservation and restoration efforts. This approach ensures the program's continued contribution to maintaining the biodiversity and ecological balance of stream ecosystems. The Benthic Invertebrate monitoring component is summarized in **Table 10**.

Table 10: Benthic Invertebrate Monitoring Component		
Total Number of Stations	**Frequency of Sampling**	**Sampling Protocol**
65	Once- Spring Season 20-25 Stations each year 3 Year Rotation	OBBN

Fish Communities

The inclusion of a fish communities monitoring component into the NPCA's Integrated Long-Term Watershed Monitoring Program is imperative for a comprehensive understanding of aquatic ecosystems, as fish communities serve as ecological indicators of environmental health and providing critical insights into the overall balance and sustainability of aquatic environments. The monitoring of fish populations and their habitats offers a powerful tool through which the NPCA can assess the impacts of human activities, climate change, and pollution on aquatic ecosystems. In this context, the integration of fish-focused monitoring initiatives contributes significantly to the broader goals of environmental stewardship, resource management, and the preservation of biodiversity.

Fish communities is a new monitoring component for the NPCA and as resources become available, the implementation of this program will commence. To facilitate implementation, NPCA monitoring staff will be provided with training to ensure consistency and accuracy among field staff in data collection and species identification. NPCA staff have identified existing monitoring protocols (Stanfield 2017) used by Conservation Authorities in Ontario that can be utilized for this component. It is intended that regular field surveys will be conducted throughout the NPCA's monitoring network over specified time intervals to track changes in fish abundance, diversity, and distribution. The Fish Communities monitoring component is summarized in **Table 11**.

Table 11: Fish Community Monitoring Component

Total Number of Stations	Frequency of Sampling	Sampling Protocol
65	To be determined	Ontario Stream Assessment Protocol Section 3 Module 1

Fluvial Geomorphology

The inclusion of a fluvial geomorphology monitoring component into the NPCA's Integrated Long-Term Watershed Monitoring and Reporting Program will offer crucial insights into the dynamic interactions between water, sediment, and landforms within streams, which directly influence channel morphology, sediment transport, and habitat diversity ensuring additional understanding and managing of the NPCA's riverine ecosystems. The NPCA will have a comprehensive understanding of how natural and human-induced changes impact stream stability, hydrology, and ecological health over time. Assessing fluvial geomorphology provides valuable information for designing effective river restoration projects, mitigating erosion and sedimentation issues, and preserving aquatic habitats. Ultimately, including stream fluvial geomorphology enhances the monitoring program's ability to holistically evaluate the condition and resilience of stream ecosystems, leading to informed management decisions aimed at promoting their long-term sustainability.

Fluvial geomorphology is a new monitoring component, and upon resource availability, this program's implementation will begin. To streamline the process, NPCA monitoring personnel will undergo training to maintain consistency and accuracy in data collection methods. Drawing from existing monitoring protocols utilized by Conservation Authorities in Ontario, NPCA staff have identified protocols (MOE 2003, Stanfield 2017) that can be used for this program. The intention is to conduct routine field surveys across the NPCA's monitoring network at predetermined intervals to monitor fluctuations in fluvial geomorphological processes. The Fluvial Geomorphology monitoring component is summarized in **Table 12.**

Table 12: Fluvial Geomorphology Monitoring Component		
Total Number of Stations	**Frequency of Sampling**	**Sampling Protocol**
50	To be determined	Ontario Stream Assessment Protocol Section 4 Module 2 or Rapid Geomorphic Assessments (RGA)

Stream Water Temperature

The NPCA's stream water temperature program will continue in its current form maintaining its focus on the remaining identified and suspected coldwater watersheds. This program will continue to assess the health of coldwater habitats, identifying potential stressors such as climate change or anthropogenic disturbances, and informing targeted conservation and management strategies aimed at preserving the unique ecological characteristics of these watersheds. Continuity in the program ensures the consistent collection of data essential for understanding temperature fluctuations in coldwater streams and their impact on sensitive aquatic ecosystems. By retaining existing protocols, including regular sampling and advanced data analysis techniques the NPCA program can accurately monitor changes in stream temperature over time with precision. This ongoing effort is crucial for NPCA's partners, who can rely on the program's unchanged operation to provide reliable information crucial for safeguarding these valuable aquatic resources for future generations. The Stream Temperature monitoring component is summarized in **Table 13.**

Table 13: Stream Water Temperature Monitoring Component		
Total Number of Stations	**Frequency of Sampling**	**Sampling Protocol**
Minium of 9	Continuous hourly May to Nov Deployment	NPCA Protocol and Onset

4.1.2 Groundwater Water Monitoring

The NPCA's Integrated Long-Term Watershed Monitoring and Reporting Program will incorporate the existing Groundwater Monitoring in its current form. This program will maintain its systematic observation and assessment of groundwater chemistry and water levels of significant regional and local aquifers as shown in **Figure 9**.

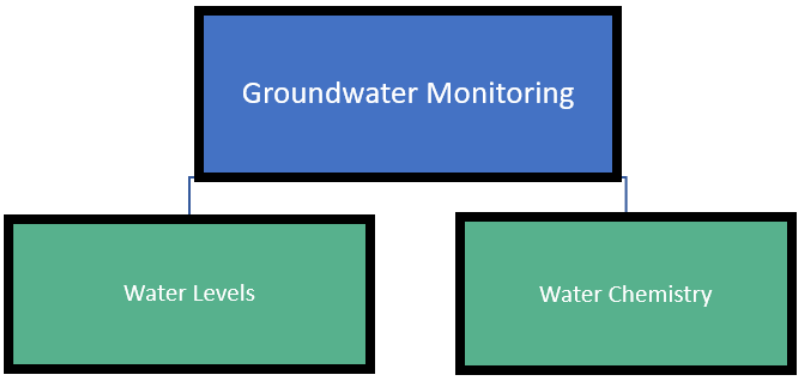


Figure 9. NPCA Groundwater Monitoring Components

The NPCA will continue to work with MECP as it pertains to the PGMN and its other partners to maintain, evaluate and adjust this program as required. This established program plays a crucial role in tracking the quality and quantity of groundwater resources, providing valuable data for informed decision-making. By continuing in its existing framework, the program ensures consistency and reliability in monitoring essential parameters such as chemical composition and water levels. This continuity is key for comprehensively understanding groundwater dynamics, detecting potential changes over time, and addressing emerging environmental concerns in the NPCA watershed. Utilizing the existing structure underscores its effectiveness in contributing to sustainable water management practices and the protection of vital groundwater resources. The Groundwater monitoring component is summarized in **Table 14**.

Table 14: **Groundwater Monitoring Component**		
Total Number of Stations	**Frequency of Sampling**	**Sampling Protocol**
46	Yearly Grab Sample Continuous Hourly Water Level Data Logger	Provincial Groundwater Monitoring Network Program (PGMN)

4.1.3 Terrestrial Monitoring

The NPCA's Integrated Long-Term Watershed Monitoring and Reporting Program is initiating the development of a new Terrestrial Monitoring Program. This initiative addresses a significant data gap in the NPCA's monitoring efforts and it recognizes the immense value of long-term terrestrial monitoring in providing insights into ecosystem dynamics and changes over extended periods. This program is crucial for resource management, as it helps assess the health of species and ecosystems, identify threats, and enable effective management within the NPCA watershed. The inclusion of long-term terrestrial monitoring is indispensable for informed decision-making, conservation efforts, and advancing the NPCA's understanding of the complex interactions within the watershed. It provides a foundational integrated framework for addressing environmental challenges and promoting sustainable practices. The NPCA's proposed Terrestrial Monitoring Program will consist of three monitoring components which include Forest Monitoring, Wetland Monitoring and Wildlife Monitoring **Figure 10**.

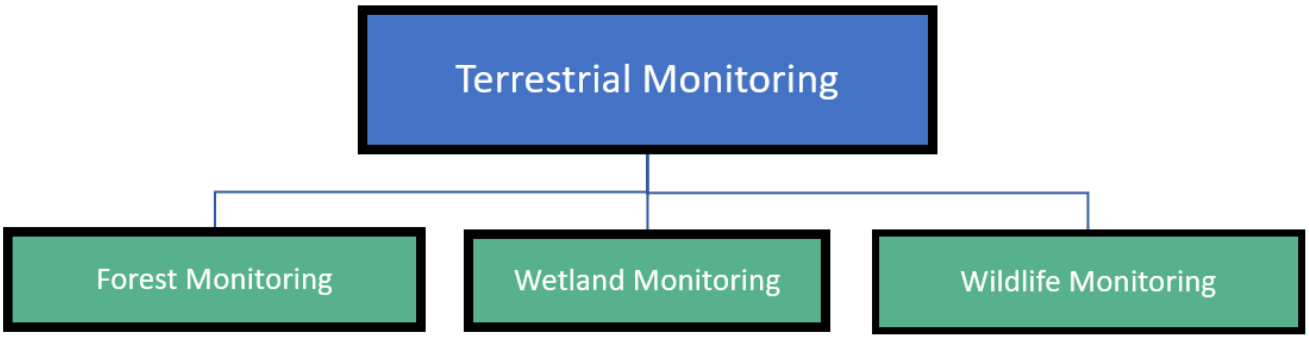


Figure 10. NPCA Terrestrial Monitoring Components

Forest Monitoring

The forest ecosystems in the NPCA watershed play a vital role in supporting rich biodiversity and offering a variety of ecosystem goods and services that are essential for human well-being, including carbon storage, nutrient cycling, and air purification. Healthy forests exhibit greater resilience against various disturbances, including the impacts of climate change. However, the health of forests can be compromised by a range of factors such as disease and invasive species. Moreover, alterations in land use patterns surrounding forests, stemming from urbanization, aggregate extraction, natural succession, and events like ice storms, can significantly impact forest health and the diverse organisms they harbor. Conversely, positive initiatives such as ecosystem restoration projects can contribute positively to forest health and resilience.

For the Forest Monitoring component, the NPCA proposes to use the Ecological Monitoring and Assessment Network (EMAN) monitoring protocols (Roberts-Pichette &Gillespie. 1999) also used by various Conservation Authorities. By implementing the same monitoring protocols as other agencies, a larger data set is available for comparison which could strengthen data analysis for certain applications.

The NPCA's proposed Forest Monitoring is shown in **Table 15**. The size and sample frequency of this program will be determined by NPCA resources through a watershed statistical analysis that is being completed in 2024.

Table 15: Forest Monitoring Component			
Indicator	**Total Number of Stations**	**Frequency of Sampling**	**Sampling Protocol**
Tree Health	To be determined		Ecological Monitoring and Assessment Network Program (EMAN)
Shrub and Tree Regeneration			
Ground Vegetation			

Wetland Monitoring

The NPCA wetlands ecosystems provide habitat for many species, both common and rare. Wetlands provide many valuable ecological services such as regulating water movement, controlling sedimentation and filtering pollutants such as fertilizers from the surrounding water and land. The NPCA recognizes it is critical to monitor wetland ecosystems, because potentially significant changes in hydrology, soils, species composition and structure can be detected, and therefore, allow issues to be identified and addressed.

The NPCA is proposing to use monitoring protocols developed by the Toronto and Region Conservation Authority (TRCA 2019) and Credit Valley Conservation (CVC) for the wetland monitoring component. These can include monitoring wetland hydrology and vegetative communities. By implementing the same monitoring protocols as other agencies, a larger data set is available for comparison which could strengthen data analysis for certain applications. The NPCA's proposed Wetland Monitoring is shown in **Table 16**. The size and sample frequency of this program will be determined by NPCA resources through a watershed statistical analysis that is being completed in 2024.

Table 16: Wetland Monitoring Component			
Indicator	**Total Number of Stations**	**Frequency of Sampling**	**Sampling Protocol**
Physical Environment	To be determined		Toronto and Region Conservation Authority (TRCA) and Credit Valley (CVC)
Tree Counts			
Shrub and Tree Regeneration			
Ground Vegetation			
Wetland Hydrology			

Wildlife Monitoring

The NPCA recognizes the need to implement long-term monitoring of bird and amphibian communities in forest and wetland ecosystems within the watershed. Birds and amphibians serve as vital indicators of ecosystem health due to their sensitivity to environmental changes. By tracking population trends, species diversity, and distribution patterns over extended periods, and its possible to gain valuable insights into the overall ecological dynamics of forest and wetland ecosystems. Long-term monitoring allows for detecting subtle shifts in community composition and identifying potential threats such as habitat degradation, pollution, and climate change. Furthermore, these monitoring efforts provide essential data for informing conservation strategies and management practices aimed at preserving critical habitats and safeguarding the intricate web of life supported by forest and wetland ecosystems. The NPCA intends to design a terrestrial monitoring network where regular field surveys will be conducted over specified time intervals to track changes in their abundance, diversity, and distribution. The NPCA's proposed Wildlife Monitoring Program is shown in **Table 17**. The size and sample frequency of this program will be determined by NPCA resources through a watershed statistical analysis that is being completed in 2024.

Table 17: Wildlife Monitoring Component			
Indicator	**Total Number of Stations**	**Frequency of Sampling**	**Sampling Protocol**
Forest and Wetland Birds	To be determined		Ontario Forest Bird Monitoring Program and Marsh Monitoring Program (BSC 2006a and 2006b)
Wetland Amphibians			
Forest Plethodontid			

4.1.4 Hydrometric Monitoring

The NPCA's Integrated Long-Term Watershed Monitoring Program's will incorporate the Hydrometric Monitoring program in its current form, maintaining its crucial role in extensively assessing surface water quantity and climate conditions (**Figure 11**). This program is dedicated to the comprehensive observation of hydrological parameters, providing invaluable data for understanding water dynamics and climate impacts. By continuing in its existing framework, the program ensures the ongoing collection of accurate and reliable information on stream water levels, flow rates, and meteorological factors. This continuity is essential for tracking changes over time, detecting trends, and informing effective water resource management strategies. The program's commitment to its existing structure facilitates the NPCA's understanding of hydrological patterns and their interconnectedness with climate variables, contributing to informed decision-making and sustainable environmental practices. The Hydrometric Monitoring component is summarized in **Table 18**.

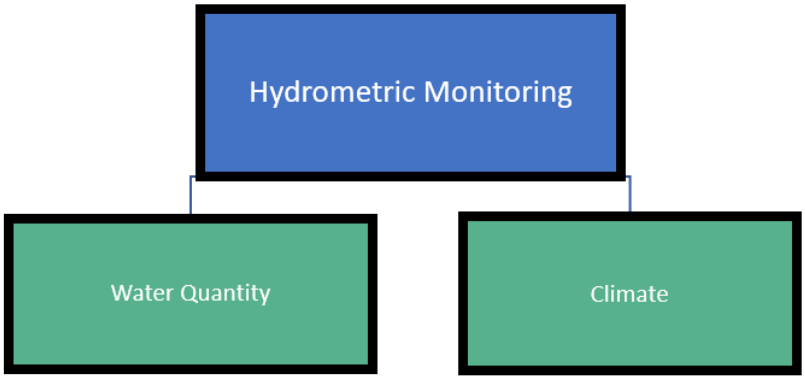


Figure 11. Hydrometric Monitoring Components

Table 18: Water Quantity and Climate Monitoring Components			
Total Number of Stations	**Sample**	**Frequency of Sampling**	**Sampling Protocol**
21	Water Level	Continuous 5 to 15 minutes readings	NPCA and Water Surveys Canada
7	Water Flow	Continuous 5 to 15 minutes readings	
7	Snow	10 sampling points per Site November to April	Ontario Snow Surveying Manual
11	Precipitation	Continuous 5 to 15 minutes readings	NPCA
7	Wind	Continuous 5 to 15 minutes readings	

In addition, the NPCA must provide programs and services to support the functions and responsibilities related to Flood Forecasting and Warning in its watershed jurisdiction as required under the *Conservation Authorities Act* and O. Reg. 686/21: Mandatory Programs and Services. The NPCA is responsible for forecasting where and when flooding is likely to occur and for issuing appropriate flood messages. The NPCA issues flood messages to municipal emergency management officials and the media if flooding is possible or imminent. The municipal officials then warn watershed residents and allow municipalities and other government agencies to implement emergency response plans and, if necessary, evacuate communities. The NPCA's Flood Forecasting and Flood Warning is directly supported by the NPCA's Hydrometric Monitoring Program that assesses surface water quantity and climate conditions within the watershed

4.1.5 Watershed Landscape Analysis

The Watershed Landscape Analysis unit of the Long-Term Integrated Watershed Monitoring Program is another tool that the NPCA will be continuing to use to characterize the human, aquatic and terrestrial features, conditions, processes, and interactions within a watershed. This program provides a systematic way to understand and organize ecosystem information. In so doing, watershed landscape analysis enhances the NPCA's ability to estimate direct, indirect, and cumulative effects of our management activities and guide the general type, location, and sequence of appropriate management activities within a watershed. The Watershed Landscape Analysis Program currently has two programs, and these are shown in **Table 19**.

Table 19: Watershed Landscape Analysis Programs		
Watershed Landscape Analysis Programs	**Program Description**	**Recommended Analysis Intervals**
Watershed Natural Areas Inventory (NAI) Program	• This program identifies, classifies, and maps natural heritage areas in the NPCA watershed jurisdiction. The resulting data provides a representation of the natural cover and features of the Niagara watershed using the Ecological Land Classification (ELC), a standard in Ontario to classify natural areas. The NPCA intends to conduct NAI inventories at determined intervals as a tool to assess changes in the watershed.	10 years
Watershed Natural Asset Assessment & Carbon Sequestration Program	• Baseline inventory of carbon sequestering forest, wetlands, and meadow • Natural assets analysis that provides the valuation of ecosystem services, such as flood attenuation, and stormwater regulation.	10 years

4.2 Data Management

Data management is a key part of the NPCA's long-term monitoring program. The long-term monitoring program collects from a wide range of sources depending on the program unit and these data include time series, discrete data, taxonomic and GIS datasets. By building upon the databases that NPCA currently utilizes (KISTERS, Microsoft Office, SQL server and internal data systems), and work with the NPCA's Information Technology (IT) and GIS divisions to establish a centralized database to store and manage all collected data. This will allow the NPCA to work towards implementing an efficient data management system that ensures data consistency, security, integrity, and accessibility.

4.2.1 NPCA Data Users

The NPCA long-term monitoring programs will and currently generate a large wealth of scientific data that has a diverse range of users spanning various sectors as shown in **Figure 12**. Here are some key user groups that frequently utilize the NPCA environmental monitoring data:

1) **Federal and Provincial Agencies**: Environmental protection agencies and regulatory bodies such as ECCC and the MECP use the NPCA's monitoring data as background watershed conditions.
2) **Public Health Unit**: Monitoring data related to water quality is vital for the NPCA's public health agencies partners to assess potential health risks associated with environmental factors such as E.coli monitoring of beaches and outlet tributaries. This information can inform public health policies and interventions.
3) **Research Institutions and Education**: Scientists and researchers in environmental science, ecology, climatology, and related fields use the NPCA's monitoring data to conduct studies, develop models, and advance the understanding of environmental processes. Academic institutions may also use this data for teaching and training purposes. In addition, local elementary and secondary schools use the NPCA's environmental monitoring data for educational purposes, exposing students to real-world environmental challenges and encouraging the development of environmental stewardship.
4) **Municipalities**: Municipal partners can use the NPCA's extensive long-term monitoring datasets as background watershed conditions to inform municipal water and wastewater infrastructure projects. Municipalities may also use monitoring data to assess the impact of urbanization on ecosystems, plan for sustainable development, and address issues related to pollution, waste management, and green spaces.
5) **Industry**: Various industries, especially those with potential environmental impacts, may use the NPCA's monitoring data to ensure compliance with environmental regulations and implement sustainable practices.
6) **Non-Governmental Organizations (NGOs)**: Environmental NGOs often use the NPCA's monitoring data to advocate for environmental conservation and raise awareness about specific issues. NGOs may also conduct their monitoring or collaborate with other organizations.
7) **Community Science**: The NPCA does engage with community science initiatives that contribute to environmental monitoring by collecting data within the watershed. This grassroots approach helps increase the spatial coverage of monitoring efforts and fosters public awareness and engagement.
8) **Emergency Responders**: The NPCA's environmental monitoring data, especially in real-time, can be crucial for emergency responders during events like natural disasters such as flooding, industrial accidents, or pollution incidents. This data aids in decision-making and emergency response coordination.

The NPCA acknowledgers that these data user groups collectively contribute to a comprehensive understanding of environmental conditions, help identify emerging trends and challenges, and play a crucial role in shaping policies and practices that promote environmental sustainability. It is key that the NPCA have effective communication and collaboration among these stakeholders to maximize the impact of the NPCA's environmental monitoring data.

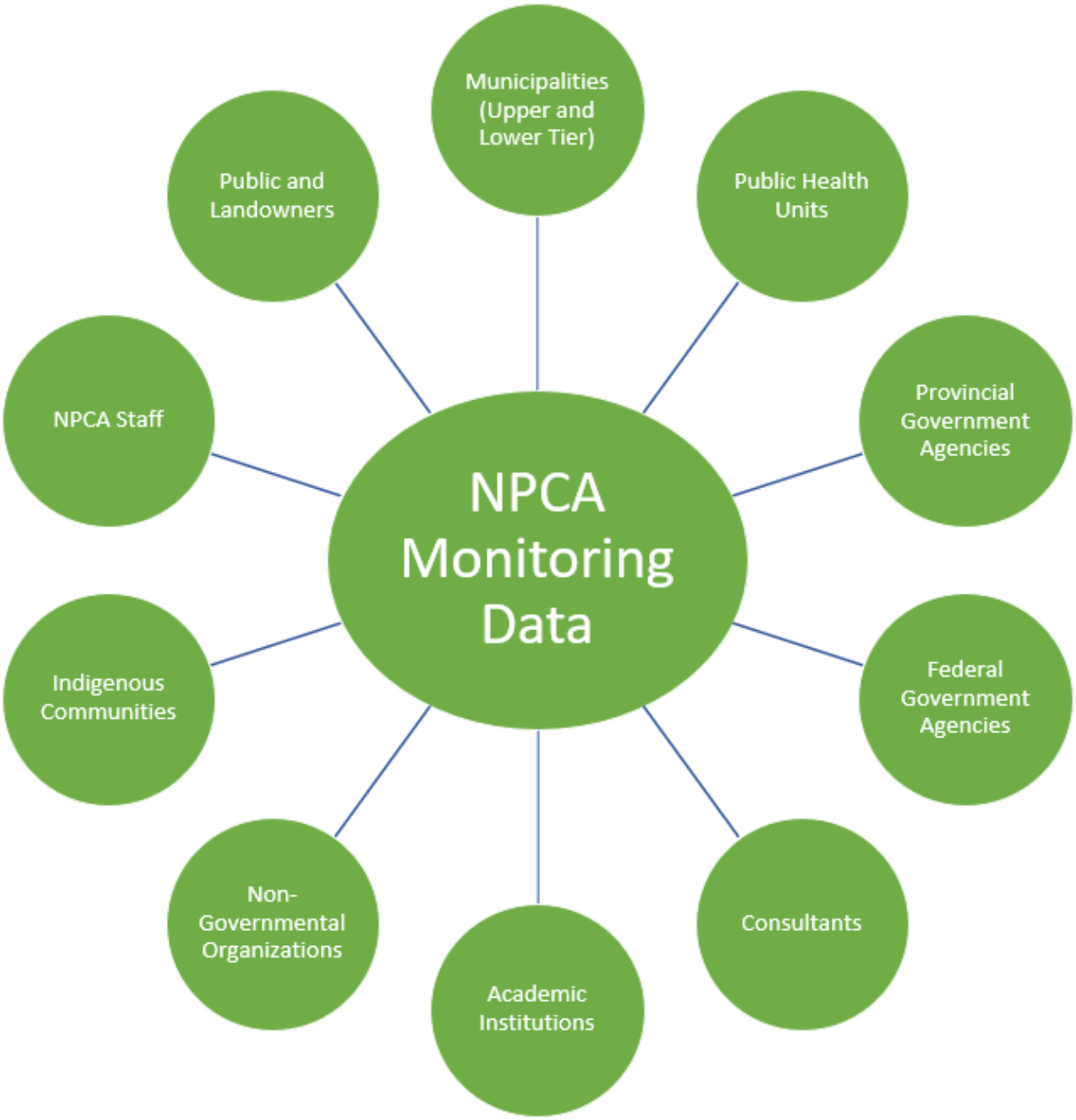


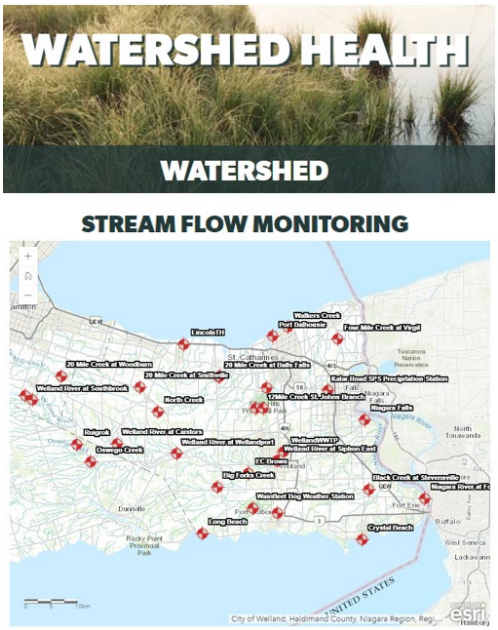
Figure 12. NPCA Data Sharing

4.3 Long-Term Monitoring Reporting

The reporting of results from the NPCA Long-Term Monitoring Program is essential for updating watershed partners and stakeholders, identifying emerging issues, informing management decisions and policy development, initiating actions, and advancing scientific knowledges. It is key that NPCA prioritize reporting and data sharing as it provides a valuable service to its stakeholders and funding agencies. In addition, the NPCA will determine the most effective method of communication to make watershed reporting accessible and informative for the target audience. Target audiences can range from scientific requests seeking raw data and detailed technical reports, to non-scientific audiences like Non-Governmental Organizations (NGOs), policymakers, and NPCA Board Members that may prefer synthesized reports with high-level messaging and graphical representations of key findings. Consequently, watershed reporting and disseminating data to a wide audience is a key priority for the IWMP program, and the NPCA will continue to use and develop the following reporting initiatives.

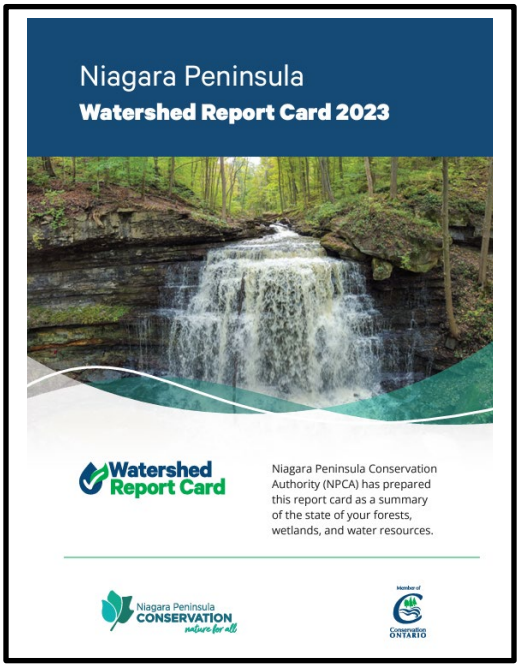
1) **Hydrometric Reporting**

The NPCA Hydrometric Monitoring Program will continue providing near real-time data stream flow, rainfall, and other meteorological information at locations across the watershed to the public by posting to NPCA website (https://npca.ca/watershed-health#flooding-stream-flow-monitoring).



2) Watershed Report Cards

The NPCA will continue with the Watershed Report Card project in partnership with Conservation Ontario. This is an important initiative that contributes to both local and broader watershed reporting across the province. Watershed report cards provide information on surface water, groundwater, forest, and wetland conditions within subwatersheds to promote an understanding of local health and emerging trends as a basis for setting environmental management priorities and inspiring local environmental action (Conservation Ontario 2011).



https://npca.ca/images/uploads/common/WRC_NPCA_2023_-_CO.pdf

3) Watershed Monitoring and Reporting Annual Reporting

The NPCA Integrated Watershed Monitoring Program will continue its annual reporting (NPCA 2024) and will expand its reporting to incorporate information, data, and monitoring results from the enhanced long-term monitoring program. This comprehensive approach will include detailed insights into water quality, terrestrial monitoring, and groundwater. By integrating these expanded datasets, the program aims to provide a more holistic view of watershed health, facilitating better-informed decision-making and more effective environmental management strategies.

4) Open Data Portals and Communications

The NPCA Integrated Watershed Monitoring Program will expand its use of ArcGIS to begin utilizing data visualization consisting of a dynamic dashboard, storyboard maps as well as data reporting that will be expanded on the NPCA's web services. These visually descriptive and user-friendly tools are intended to become the main communication instrument for the NPCA's Long-Term Monitoring Program results.

5.0 CORPORATE SUPPORT SERVICES

NPCA's Integrated Watershed Monitoring Program includes a Corporate Support Services Area that is comprised of several programs that will service the NPCA with crucial monitoring data to inform operational activities across multiple NPCA departments and divisions. Many components in this area have already been implemented previously, however their inclusion in this monitoring area better defines the scope of these programs at the NPCA and continues to allow for integration across NPCA monitoring areas. Therefore, internal monitoring components will be fully identified to facilitate improved collaboration and potentially allow for additional resources to meet program capacity. The type and number of Corporate Support Services that the NPCA implements is dynamic and driven by NPCA program and project needs.

5.1 Program Goal

- The goal of the NPCA Corporate Support Service area is to provide monitoring services and expert advice for NPCA's internal department programs and projects.

5.1.1 Environmental Permissions

The NPCA will continue to maintain the Environmental Permissions monitoring program as described in **Section 2.6**, which is a requirement of MECP and Public Health Units to support a variety of environmental permissions that are related to NPCA's Conservation Area services and infrastructure. These include MECP Environmental Certificate Approvals (ECAs), MECP Permit-to-Take-Water and Small Drinking Systems Public Health Directives. The Environmental Permissions monitoring programs are summarized in **Table 20** with corresponding Department leads and Department Integration for implementation.

Table 21: Summary of NPCA Environmental Permissions		
Environmental Permissions	**Department Lead(s)**	**Department Integration**
MECP Environmental Certificate Approvals ***Sewage Works-Balls Falls and Long Beach Conservation Areas***	Conservation Areas Department and Environmental Planning and Policy Division	Watershed Monitoring and Reporting Division
MECP Permit-to-Take-Water ***Binbrook and Virgil Conservation Areas***	Flood Risk Management Division	Conservation Areas Department
Public Health Directives **Small Drinking Water Systems** ***Binbrook and Virgil Conservation Areas***	Conservation Areas Department	Watershed Monitoring and Reporting Division

5.1.2 Conservation Areas Beach Monitoring Program

The NPCA will continue Conservation Areas Beach Monitoring Program as described in **Section 2.3.2**. Samples will continue to be collected at Long beach Conservation and Chippawa Creek Conservation Areas and analyzed for E. coli during the regular beach season. Data will continue to be posted on the NPCA webpage and be used to determine long-term trends in the water quality at NPCA swimming areas over time. This program will not be used to identify public health risks when swimming in natural water bodies. The Conservation Areas Department with continue as departmental lead with the program integration occurring where Watershed Monitoring and Reporting staff will be conducting the field program and potentially providing internal data analysis as requested. The Conservation Areas Beach Monitoring Program is summarized in **Table 21** with corresponding Department leads and department integration for implementation.

Table 21: Summary of NPCA Conservation Beach Monitoring Program			
Program	**Monitoring Component**	**Department Lead**	**Department Integration**
Conservation Areas Beach Monitoring- ***Long Beach Conservation Area*** ***Chippawa Creek Conservation Area***	*E. coli* sample collections Weekly (June to early September)	Conservation Areas Department	Watershed Monitoring and Reporting Division

5.1.3 Restoration Monitoring Program

The NPCA will continue to utilize the existing restoration monitoring program described in **Section 2.5**. This program will continue to allow NPCA staff to track restoration project progression after implementation and to guide decision-making by adaptive management. This program will continue to provide the Integrated Watershed Strategies and Restoration Division with data and analysis that will inform future restoration project plans and budgets within this program area. The Integrated Watershed Strategies and Restoration will continue as the lead, with the program integration occurring where Watershed Monitoring and Reporting staff provide long-term data analysis as requested. The Restoration Monitoring Program is summarized in **Table 22** with Department leads and Department Integration for implementation.

Table 22: Summary of NPCA Restoration Monitoring Program

Program	Monitoring Component	Department Lead	Department Integration
Restoration Project Monitoring Program	➢ Forest and Wetland Vegetative Communities	Integrated Watershed Strategies Department and Restoration Division	Watershed Monitoring and Reporting Division

5.1.4 Conservation Management Plans Program

The NPCA 10-year 2021-2031 Strategic Plan relies on Conservation Area Management Plans to achieve its goal of managing NPCA lands in part to increase biodiversity, habitat connectivity, and natural cover. Conservation Area Management plans are practical tools that outline the goals and strategies for natural areas. These plans provide a clear direction for managing the land towards these goals, guiding day-to-day decisions, and addressing complex challenges. Management plans involve input from various stakeholders to ensure that decisions are based on up-to-date science. The NPCA Corporate Support Services Monitoring area intends to support the preparation of NPCA Conservation Management Plans by providing environmental monitoring and inventory resources. These could include a range of environmental studies to establish baseline data to inform management plan decisions. **Table 23** summarizes a list of monitoring components that can be made available.

Table 23: Summary of NPCA Conservation Management Plans Program			
Program	**Monitoring Component**	**Department Lead**	**Department Integration**
Conservation Area Management Plan Program	➢ Hydrometric Surveys ➢ Groundwater Characterization ➢ Terrestrial Monitoring and Inventories ➢ Aquatic Monitoring and Inventories	Land Planning Division and Conservation Area	Watershed Monitoring and Reporting Division Conservation Areas Department Flood Risk Management Division

5.1.5 Conservation Lands Ecological Monitoring

The Conservation Lands Ecological Monitoring Program will continue in a modified format to allow the NPCA to conduct specialized ecological monitoring programs that fall outside the scope of NPCA's Long-Term Monitoring area. This program is flexible and can be expanded to include specialized monitoring components customized for a specific purpose within NPCA Conservation Areas and owned lands. This program will continue to provide the NPCA with data and analysis that will inform Conservation Area ecological management. The Conservation Lands Ecological Monitoring Program is summarized in **Table 24** with corresponding department integration for implementation.

Table 24: Summary of NPCA Conservation Lands Ecological Program			
Program	**Monitoring Component**	**Department Lead**	**Department Integration**
Conservation Lands Ecological Monitoring	➢ Hydrometric Surveys ➢ Groundwater Characterization ➢ Terrestrial Monitoring and Inventories ➢ Aquatic Monitoring and Inventories	Land Planning Division and Conservation Area	Watershed Monitoring and Reporting Division Conservation Areas Department Flood Risk Management Division

5.1.6 Climate Change

Recognizing the increased importance of climate change as a driver for watershed health and quality of life in the NPCA watershed, the NPCA's 2021-2031 Strategic Plan includes numerous climate-related actions across several strategic priorities. These actions will be implemented to guide the NPCA's

efforts to address local climate impacts through on-the-ground projects. Monitoring data will form the basis of climate-related projects and initiatives to retain and promote climate resiliency. This monitoring area will also demonstrate the NPCA's leadership with its watershed partners and the public. As the NPCA continues to develop and expand its climate change initiatives, the NPCA's IWMP Long-Term Monitoring Program Area will play a critical role in supporting these initiatives as noted in **Table 25**.

Table 25: Climate Change Monitoring Supporting Programs

Program	Monitoring Component	Department Lead	Department Integration
Climate Change	➢ Water Quantity ➢ Groundwater Quantity ➢ Surface Water Quality ➢ Surface Water Ecology ➢ Terrestrial Ecology	Land Planning Division and Conservation Area	Watershed Monitoring and Reporting Division Conservation Areas Department Flood Risk Management Division

5.1.7 Low Impact Development Monitoring

The NPCA has begun incorporating Low Impact Development (LID) projects into its own property infrastructure to address stormwater runoff that could result in erosion, sedimentation, and pollution. The NPCA's IWMP will a play pivotal role in supporting the environmental monitoring of the NPCA's LID projects by leveraging internal expertise and resources. The IWMP can oversee comprehensive monitoring programs that track the effectiveness of LID measures, such as permeable pavements, infiltration trenches, bioswales, and rain gardens, in reducing runoff and improving water quality. Depending on the LID project, data can be collected and analyzed on various environmental parameters, including water quality, water levels, and biodiversity, to assess the impact of LID projects. The LID Monitoring Program is summarized in **Table 26**. This program will help to ensure that LID strategies are effectively contributing to the resilience and health of local ecosystems by providing assessment data.

Table 26: LID Monitoring Supporting Programs

Program	Monitoring Component	Department Lead	Department Integration
LID Monitoring	➢ Water Quantity ➢ Groundwater Quantity ➢ Surface Water Quality ➢ Surface Water Ecology ➢ Terrestrial Ecology	Conservation Areas Department	Watershed Monitoring and Reporting Division Infrastructure Engineering and Asset Management Division

5.1.8 Community Science Monitoring

The NPCA Community Outreach and Engagement team will continue to implement the Community Science Monitoring program described in **Section 2.7.** This program partners with citizens and NGOs to actively participate in the protection and preservation of local ecosystems. This program can inform NPCA with developing training sessions and providing resources for members of our watershed community to collect data on various aspects of the environment, such as climate monitoring, water quality, wildlife populations, and habitat health. This approach can generate valuable scientific data and foster a sense of stewardship and connection to the watershed among participants. Depending on the type of community science monitoring projects, the IWMP is flexible to utilize supporting departments, and these are shown in **Table 27**.

Table 27: Community Science Monitoring Supporting Program

Program	Monitoring Component	Department Lead	Department Integration
Community Science Monitoring	➢ Water Quantity ➢ Groundwater Quantity ➢ Surface Water Quality ➢ Surface Water Ecology ➢ Terrestrial Ecology	Watershed Strategies and Climate Change Department Climate Change and Special Projects Division	Watershed Monitoring and Reporting Division Flood Risk Management Division

5.1.9 Special Projects

The NPCA IWMP is structured to incorporate internal monitoring special projects that emerge outside of defined programs. The flexibility of the IWMP allows the program to address specific environmental concerns or emerging issues by leveraging internal resources and expertise. By integrating these special internal monitoring projects, the IWMP enhances NPCA's ability to deliver precise, actionable insights and support adaptive management strategies, ensuring the sustainable management of watershed resources.

6.0 MONITORING SERVICE PROVIDER

The IWMP includes a Monitoring Service Provider Area with the intent of highlighting the NPCA's potential as an environmental monitoring service provider to its watershed partners such as municipalities, provincial and federals agencies as well as private companies. The NPCA has a dedicated team of experts specializing in hydrometric, groundwater, surface water, and terrestrial monitoring programs. Utilizing state-of-the-art technologies, monitoring protocols, and data analyses, the NPCA is equipped to offer small-scale monitoring services. Through strategic communication with partners and planning, NPCA's monitoring, and inventory services can be expanded with additional resources (equipment and training) and staff to enhance data collection, analysis, and reporting capabilities for larger-scale projects.

6.1 Program Goal

- The goal of the NPCA Monitoring Service Provider Area is to provide environmental monitoring services to external partners within the NPCA watershed.

6.2 Monitoring Provider Services Project Intake Process

The NPCA currently has three Service Provider monitoring services, and these are summarized in **Table 28**.

Table 28: Existing Monitoring Provider Services	
Current Monitoring Services Provided	**Program Details**
Municipal Environmental Monitoring	*Glanbrook Landfill Biomonitoring Program* The City of Hamilton contracts the NPCA biennially to monitor benthic macroinvertebrates upstream and downstream of the Glanbrook Landfill to assess any landfill impacts to the adjacent watercourses. NPCA generates a separate report to the City of Hamilton for their exclusive information and use.
Municipal Environmental Monitoring	*Regional Water Quality Monitoring* The NPCA receives funding to monitor ambient water quality of streams and rivers throughout the Niagara Region's municipal jurisdiction. The data collected through this program is shared with the municipality and the NPCA generates an annual report summarizing water quality exceedances and overall trends.
Private Environmental Monitoring Services	*Hamilton Airport Biomonitoring Program* The Hamilton International Airport (HIA) contracts the NPCA to monitor macroinvertebrates to determine if stormwater runoff and de-icing fluids are impacting surface water quality in two headwater tributaries of the Welland River. NPCA generates a separate report to the HIA for their exclusive information and use.

In addition to the current service provider programs, it has been anticipated that the NPCA watershed partners, such as the municipalities, may wish to utilize the NPCA's environmental monitoring services for a variety of areas and these include.

1) Secondary Plans-Subwatershed Studies: Characterization and Pre and Post Construction Monitoring
2) Consolidated Linear Infrastructure Environmental Compliance Approval (CLI-ECA) Applications for Stormwater Management Systems: Performance Monitoring
3) Municipal Greening Targets: Environmental Inventories
4) Low Impact Development: Performance Monitoring

5) Long-Term Environmental Monitoring in Growth Areas: Environmental Inventories

The NPCA has formed a project intake team which has designed an intake process for Monitoring Service Provider projects which involves several systematic steps to ensure potential projects are well-defined, feasible, and aligns with the NPCA's organization goals and regulatory requirements. The detailed steps required for the IWMP's Monitoring Service Provider Project Intake Process are as follows in **Table 29**:

Table 29: Monitoring Service Provider Project Intake Process

Intake Process Step	Program Details
1. Initial Consultation	• Stakeholder Engagement: Engage with stakeholders to understand their needs, concerns, and objectives. • Define Objectives: Clearly define the goals of the monitoring project (e.g., water quality assessments, ecological inventories, water quantity). • Data Requirements: Identify the types of data required (e.g., physical, chemical, biological parameters). • Regulatory Compliance: Review relevant environmental regulations and guidelines to ensure compliance.
2. Project Proposal Development	• Scope Definition: Outline the scope of the project, including geographic boundaries, time frame, and specific parameters to be monitored. • Methodology: Develop a detailed methodology for data collection, analysis, and reporting. • Budget Estimation: Estimate the budget required, including equipment, personnel, and other resources. • Risk Assessment: Identify potential risks and challenges to completing the project and propose mitigation strategies.
3. Feasibility Study	• Technical Feasibility: Assess the technical feasibility of the project, including the availability of necessary equipment and technology. • Operational Feasibility: Evaluate the operational feasibility, considering logistical aspects and the availability of skilled personnel. • Financial Feasibility: Ensure that the project is financially viable within the budget constraints.
4. Project Approval and Funding	• Proposal Submission: Submit the project proposal. • Review and Feedback: Address any feedback or queries from the reviewing authority. • Funding Approval: Secure funding and ensure financial resources are allocated appropriately.

By utilizing the Monitoring Service Provider Project Intake Process the NPCA can ensure that environmental monitoring projects are thoroughly planned, effectively executed, and yield reliable data and reporting for clients.

7.0 Integrated Watershed Monitoring Program Implementation

The NPCA is optimally positioned to implement the IWMP as a key part of its strategic core service delivery by leveraging its existing monitoring efforts to transition to the integrated approach. The NPCA's current resources include established monitoring programs, trained monitoring staff, advanced equipment, regular reporting intervals, robust database management systems, GIS capabilities, and sophisticated web-based tools. Additionally, the NPCA's programs are already well-recognized across the watershed. Designed with flexibility, the NPCA's current monitoring programs can expand with strategic incremental investments, allowing for the integration of additional monitoring components to effectively identify and understand watershed stressors.

The NPCA's IWMP will utilize the robust Long-Term Monitoring Programs as its foundation for expanded monitoring. These anchor programs benefit from stable funding, supportive partners, and mandated roles, ensuring a reliable and consistent framework. The NPCA's extensive experience and proven track record in running these programs make it the ideal basis for developing a comprehensive, integrated monitoring system. By building on these established programs, the NPCA can support various internal and external monitoring initiatives.

7.1 Financial Considerations

The *Conservation Authorities Act* and O. Reg. 686/21: Mandatory Programs and Services, sets out mandatory and non-mandatory programs and services for Conservation Authorities to provide for its jurisdictional area and these are funded in different ways **Table 30**.

Table 30: Conservation Authorities Program and Service Categories

CA Act	Description
Category 1	Mandatory programs and services as identified in Ontario Regulation 686/21 that can be funded through a municipal levy.
Category 2	Municipal programs and services provided at the municipality's request. These programs can be funded through government and other agency grants and/or municipal funding under a memorandum of understanding (MOU) or agreement with the municipality.
Category 3	Other programs and services that an Authority (Board) determines are advisable. These programs can be funded through self-generated revenue, user fees, government and other agency grants, donations, etc. Any use of municipal funding will require an agreement and would be subject to cost apportioning.

The NPCA's IWMP incorporates several programs and services designated as Category 1 that are essential for compliance with regulatory requirements and for the effective management and protection of watershed resources. These components include:

- Flood Forecasting and Hydrometric Monitoring
- Provincial Surface Water Quality Monitoring Program (PWQMN)
- Provincial Groundwater Monitoring Network (PGMN)
- Monitoring and Environmental Inventory Activities on NPCA-owned Lands to inform the management of lands

The NPCA's IWMP also incorporates several programs and services that fall under Category 2 or 3 non-mandatory program or service classifications as per the Conservation Authorities Act. These include:

- Expanded Surface Water Quality Monitoring
- Expanded Groundwater Quality Monitoring

- Stream Benthic Macroinvertebrates Monitoring
- Fish Communities Monitoring
- Watershed Landscape Analysis
- Restoration Monitoring
- Community Science Monitoring

These non-mandatory services are partially funded through service-level agreements with municipal partners or external funding sources. In accordance with the transition requirements under the Conservation Authorities Act, the NPCA has entered into Service Level Agreements with the watershed participating municipalities of Niagara Region, City of Hamilton and Haldimand County, for non-mandatory Category 2 and 3 program services, and costs associated with the programs and services are to be reviewed on an annual basis as part of the NPCA's annual budget approval process. Lower-tier municipalities in Niagara Region, which are not levied for NPCA programs and services, can also enter into agreements of services for a fee-for-service basis when a local municipality wishes to engage NPCA to provide services, such as monitoring, data analysis and reporting. Additionally, staff are proactively seeking external funding opportunities such as:

- Partnerships: working with a mix of existing and new partners to fund and complete projects that meet our shared goals.
- Grants: external funding sources, such as Federal and Provincial grant programs will be targeted to help support projects in all program areas.
- Niagara Peninsula Conservation Foundation (NPCF): collaborating with the NPCF to increase funding for IWMP initiatives through donations and giving programs.
- Fee-for-service: leveraging the NPCA's skills and expertise to increase self-generated revenue.

A Watershed-based Resource Management Strategy, to be developed by the end of 2024, as required under the Conservation Authorities Act and O. Reg. 686/21: Mandatory Programs and Services, will assist NPCA with evolving and enhancing its programs and services to address or manage local watershed triggers, issues, or risks. The Watershed-based Resource Management Strategy will include identifying Category 2 and 3 programs and services such as the IWMP, with cost estimates, that are recommended to support the delivery of mandatory programs and services. Conventional funding approaches to implement the IWMP will be combined with opportunities to seek external grants and innovative approaches to leverage various sources of funding. Future costs will be determined by the program's scope, staffing requirements and uptake and interest by partners and funders.

7.2 Standard Operating Procedures

The NPCA considers Standard Operating Procedures (SOPs) important for the effective implementation of the Integrated Watershed Monitoring Program. SOPs ensure consistency, reliability, and accuracy in data collection and analysis. By providing detailed, standardized guidelines for every aspect of the monitoring process, SOPs minimize variability and human error, thereby enhancing the credibility and comparability of the results over time and across different locations. SOPs facilitate training and competency for NPCA staff, ensuring that all personnel perform monitoring tasks uniformly, regardless of their experience level. Additionally, SOPs are essential for regulatory compliance, as they document that proper methodologies are followed, which is critical for meeting legal and environmental standards. The NPCA is currently developing and formalizing SOPs for its various monitoring programs.

7.3 Training

Proper training of IWMP staff is crucial for the program's success and effectiveness across all monitoring areas. The NPCA will survey the technical level of IWMP staff and identify training gaps to ensure that staff are well-versed in monitoring protocols, enabling consistent and standardized data collection across different sites. Additionally, thorough training on the use and maintenance of monitoring equipment is vital for obtaining accurate and reliable data. By investing in the proper training of staff, the program can ensure high-quality data collection and analysis, leading to better-informed decision-making and more effective watershed management.

7.4 Indigenous Knowledge

Incorporating indigenous knowledge into NPCA's IWMP environmental monitoring programs holds significant importance, as it enriches scientific understanding with centuries-old wisdom and local expertise. Indigenous communities possess invaluable insights into their ecosystems, including intricate knowledge of biodiversity, natural resource management, and the subtle signs of environmental change. Integrating this knowledge not only enhances the accuracy and effectiveness of monitoring efforts but also fosters cultural preservation and respect for traditional ways of life. By embracing indigenous perspectives, environmental monitoring programs can cultivate holistic approaches that prioritize sustainability, resilience, and the harmonious coexistence of humanity with the natural world. This collaborative approach bridges the gap between scientific methodologies and indigenous wisdom, promoting more inclusive and equitable conservation strategies that benefit both the environment and indigenous communities.

The NPCA seeks to engage with local indigenous communities and individuals through our Public Advisory Committee (PAC) and other opportunities guided by our Indigenous Engagement Guidelines that are being developed, to support the development of a more holistic approach in watershed monitoring that incorporates aspects of Indigenous Traditional Knowledge and an awareness of the watershed spirit, in addition to western science and management objectives.

8.0 RECOMMENDATIONS AND CONCLUSION

8.1 Recommendations

To achieve the NPCA 2021-2031 Strategic Plan Goal 1.1 – Support evidence-based decision-making for climate-resilient watersheds and shoreline, and the objectives of the new IWMP, the following recommendations have been developed to ensure the NPCA's readiness for implementing the program. Each recommendation is accompanied by actions to be implemented by 2031.

Recommendation 1

That the NPCA prioritize and enhance the Long-Term Watershed Monitoring program within the Integrated Watershed Monitoring Program, as it is essential for understanding and managing ecosystems, supporting scientific research, conservation initiatives, and inform decision-making to ensure ecosystem resilience against ongoing environmental changes.

Action 1.1: Continue to focus long-term monitoring efforts on provincially mandated programs such as Hydrometric, Surface Water, Groundwater, and monitoring on NPCA properties and utilize these programs as a foundation for expanded monitoring.

Action 1.2: Where applicable, integrate long-term monitoring efforts and stations between the Monitoring Program Areas.

Action 1.3: Ensure IWMP monitoring data remains up to date, addresses data gaps, is transferable and relevant to the NPCA's partners such as municipalities, governmental agencies, academia, and the public.

Recommendation 2:

That NPCA will continue to regularly report results of its environmental monitoring programs in an understandable and accessible format to support decision-making by the NPCA and its partners to enhance watershed health and community awareness.

Action 2.1: Produce watershed health reports at relevant intervals that summarize key watershed findings.

Action 2.2: Provide regular updates on key findings to all internal departments, watershed municipalities, Board of Directors, and other key watershed management partners.

Action. 2.3 Transition towards 'open data' to establish a platform for sharing data with making most data collected through the IWMP accessible to partners and the public through NPCA web resources.

Recommendation 3

That NPCA ensures the IWMP has a robust Corporate Support Services Monitoring Area to incorporate internal monitoring components through collaboration, optimize resource allocation, and better define the scope and capacity of crucial monitoring programs and projects across multiple departments and divisions.

Action 3.1: Maintain a comprehensive inventory of internal monitoring requirements across NPCA's departments and divisions.

Action 3.2: Develop standardized protocols and guidelines for integrating internal monitoring components into the IWMP.

Action 3.3: Continue to utilize the IWMP Working Group to ensure collaboration and coordination of monitoring efforts across NPCA's departments and divisions.

Recommendation 4

That NPCA will continue to increase the capacity of its monitoring and inventory services within the IWMP to enable NPCA to become a comprehensive environmental monitoring provider for watershed partners, including municipalities, provincial and federal agencies, and private companies.

Action 4.1: NPCA will establish and strengthen partnerships with municipalities, provincial and federal agencies, and private companies to collaborate on monitoring projects and share resources and expertise.

Action 4.2: NPCA will develop and implement training programs for staff to enhance their skills in a variety of monitoring protocols/technologies and data analysis techniques to increase NPCA's monitoring services' capacity.

Action 4.3: NPCA will invest in monitoring equipment, software and database management to improve data accuracy, collection efficiency, and reporting capabilities.

Recommendation 5

That NPCA will continue to collaborate with municipal and community partners, agriculture, academia, and indigenous communities moving forward.

Action 5.1: NPCA will work towards building partnership agreements with municipal and community organizations, agricultural bodies, and indigenous communities as appropriate to outline roles, responsibilities, and shared goals within IWMP.

Action 5.2: The NPCA will organize regular meetings and workshops with municipal and community partners, agricultural representatives, academic institutions, and indigenous communities to share insights, discuss challenges, and coordinate monitoring efforts.

Action 5.3: NPCA will explore collaborative research projects with academic institutions and indigenous communities to leverage diverse expertise and traditional knowledge in monitoring and managing watershed health.

Recommendation 6

The NPCA will continue to explore efficiencies and innovations to continuously improve the IWMP.

Action 6.1: The NPCA will establish a schedule for regular reviews and assessments of the IWMP to identify areas for improvement, incorporate innovative practices, and ensure the program remains at the forefront of environmental monitoring.

Action 6.2: NPCA will develop a centralized data management system within the IWMP to streamline the collection, analysis, and sharing of monitoring data, ensuring timely and effective decision-making.

Action 6.3: The NPCA will investigate advanced monitoring technologies and automated data collection systems, to enhance the efficiency and accuracy of environmental monitoring.

The IWMP Working Group will prioritize the implementation of the Recommendations and Actions through a program workplan supported by a long-term budget plan guided by the Watershed-based Resource Management Strategy. NPCA staff will continue to report to the NPCA Board of Directors the progress and successes of the new IWMP to support healthy and climate resilient watersheds.

8.2 Conclusion

In conclusion, the NPCA's Integrated Watershed Monitoring Program is a comprehensive and systematic approach essential for understanding and managing the watershed's ecological, hydrological, and environmental conditions. For the NPCA, this approach is crucial due to the anthropogenic stressors threatening our watershed. By integrating monitoring components such as water quality, hydrometric, ecological, land use and cover monitoring, geospatial data, and community science, the program provides a holistic understanding of watershed functions. This enables informed decision-making for resource management, environmental protection, natural hazard management, and land use planning. The NPCA's 10-year Strategic Plan (2021-2031) has identified an IWMP as a critical priority to achieve strategic goals related to healthy and climate-resilient watersheds, sustainable growth, connecting people to nature, partnership excellence, organizational excellence, and financial sustainability. With existing infrastructure and a completed gap analysis highlighting areas for improvement, the NPCA is well-positioned to implement and expand this program as part of its core service delivery. This will not only enhance the effectiveness of data collection and analysis but also support the NPCA's vision of a healthy and vibrant environment, ensuring the sustainability of valuable ecosystem services for future generations.

9.0 REFERENCES

Bird Studies Canada (BSC). 2006a. Marsh Monitoring Program Guide to Amphibian Monitoring.

Bird Studies Canada (BSC). 2006b. Marsh Monitoring Program Guide to Bird Monitoring.

Canadian Council of Ministers of the Environment (CCME). 2001. Canadian Water Quality Index.

Canadian Council of Minister of the Environment (CCME). 2003. Canadian Water Quality Guidelines for the Protection of Aquatic Life. Canadian Environmental Quality Guidelines.

Conservation Ontario. 2022. Guide to Developing 2023 Conservation Authority Watershed Report Cards. Newmarket.

de Solla, S., A. De Silva and R Letcher. 2012. Highly elevated levels of perflurooctane sulfonate and other perfluorinated acids found in biota and surface water downstream of an international airport, Hamilton, Ontario, Canada. Environment International 39:19-26.

Griffiths, R.W. 1999. BioMAP: Bioassessment of Water Quality. The Centre for Environmental Training, Niagara College: Niagara-on-the-Lake, Ontario.

Hilsenhoff, W.L. 1987. An Improved Biotic Index of Organic Stream Pollution. Michigan Entomology Society. 20(11):9-13.

Jones, C., K. Somers, B. Craig, and T. B. Reynoldson. 2005. Ontario Benthos Biomonitoring Network Protocol Manual: Version 1.0. Ontario Ministry of Environment: Dorset, Ontario.

Ministry of Environment Conservation and Parks. 2020. The Provincial Water Quality Monitoring Network (PWQMN) A Comprehensive Guide. Government of Ontario, Toronto.

Ministry of Environment Conservation and Parks. 2018. Provincial Groundwater Monitoring Network Sampling Protocol. A Guide to the Collection and Submission of Groundwater Samples for Analysis. MECP Environmental Monitoring and Reporting Branch. Government of Ontario, Toronto.

Niagara Peninsula Conservation Authority. 2024. NPCA Water Quality Monitoring Program: 2023 Report. Niagara Peninsula Conservation Authority. Welland. Ontario.

Ontario Ministry of the Environment (OMOE), 1994. Water Management, Policies, Guidelines and Provincial Water Quality Objectives. Government of Ontario: Toronto.

Ontario Ministry of the Environment (OMOE). 2003. Technical Support Document for Ontario Drinking Water Standards, Objectives, and Guidelines. Government of Ontario, Toronto.

Ontario Ministry of the Environment (MOE). 2003. Stormwater Management Planning and Design Manual. Queen's Printer. Ottawa, Ontario. March 2003. http://www.ontario.ca/document/stormwater-management-planning-and-design-manual

Ontario. Ministry of Health. Recreational water protocol, 2019. Toronto, ON: Queen's Printer for Ontario; 2019
https://www.health.gov.on.ca/en/pro/programs/publichealth/oph_standards/docs/protocols_guidelines/Recreational_Water%20Protocol_2019_en.pdf

Ontario Ministry of Natural Resources. 1985 Ontario Snow Surveying Manual. Government of Ontario: Toronto.

Roberts-Pichette, P. and L. Gillespie. 1999. Terrestrial Vegetation Biodiversity Monitoring Protocols. EMAN Occasional Paper Series Report No 9. EMAN Coordinating Office. Burlington, Canada.

Stanfield, L. 2017. Ontario Stream Assessment Protocol. Version 10.0, Fish and Wildlife Branch. Ontario Ministry of Natural Resources. Peterborough, Ontario. 546 pp.

Toronto and Region Conservation Authority (TRCA). 2016. Wetland Vegetation Monitoring Protocol - Terrestrial Long-term Fixed Plot Monitoring Program – Regional Watershed Monitoring and Reporting.

Niagara Peninsula Conservation Authority

3350 Merrittville Hwy #9
Thorold, ON L2V 4Y6
www.npca.ca

Appendix 2: Niagara Peninsula Conservation Authority Enhanced Integrated Watershed Monitoring Program Conceptual Model