Toronto and Region Conservation Authority

Board of Directors Meeting
Agenda

September 24, 2021

9:30 A.M.

The meeting will be conducted via a video conference

Members of the public may view the livestream at the following link:

https://video.isilive.ca/trca/live.html

7.3. STANDING OFFER SUPPLY FOR PRINT SERVICES AND EQUIPMENT 289

Contract No. 10036290

8. SECTION III - ITEMS FOR THE INFORMATION OF THE BOARD

8.1. UPDATE ON MEMORANDUMS OF UNDERSTANDING AND SERVICE LEVEL AGREEMENTS WITH MUNICIPALITIES 291

8.2. UPDATE ON AWARD OF CONTRACTS 10035829 AND 10035830 – SUPPLY AND DELIVERY OF ARMOUR STONE TO ASHBRIDGES BAY TREATMENT PLANT LANDFORM PROJECT 300

8.3. DELEGATED AUTHORITY TO DISPOSE OF LAND TO METROLINX FOR FINCH AVENUE WEST LIGHT RAIL RAPID TRANSIT PROJECT 303

Status Update Regarding Delegated Authority Granted for Disposition of Toronto and Region Conservation Authority-owned Lands to Metrolinx for the Construction of Traction Power Substation (TPSS) Ductbanks for the Finch West Light Rail Transit (FWLRT) Project, City of Toronto, Humber River Watershed (CFN 65248)

8.4. PROCLAMATION OF THE ONTARIO NOT-FOR-PROFIT CORPORATIONS ACT 305

8.5. SUMMARY OF 2021 TRCA POLICY CONSULTATION SUBMISSIONS ON RECENT FEDERAL AND PROVINCIAL POLICY INITIATIVES 306

8.6. PARTNERS IN PROJECT GREEN EXECUTIVE MANAGEMENT COMMITTEE MINUTES

June 15, 2021 Meeting Minutes (Link)

8.7. REGIONAL WATERSHED ALLIANCE MINUTES

May 19, 2021 Meeting Minutes (Link)

9. MATERIAL FROM EXECUTIVE COMMITTEE MEETING HELD ON SEPTEMBER 10, 2021

Meeting Minutes Link

9.1. SECTION I - ITEMS FOR BOARD OF DIRECTORS ACTION

9.1.1. CITY OF TORONTO

Receipt of a request from the City of Toronto, for a permanent easement for the Martin Grove Road Watermain Replacement Project for lands located east of Martin Grove Road and north of Rathburn Road, municipally known as 305 Martin Grove Road, in the City of Toronto, required for the Martin Grove Road Watermain Replacement Project, Ravenscrest Park, Mimico Creek watershed (CFN 64472).
(*Executive Committee RES.#B78/21*)
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9.1.2. KINGCAL PROPERTIES AND MAINTENANCE INC.

Proposal from Kingcal Properties and Maintenance Inc. to enter a lease renewal of Toronto and Region Conservation Authority (TRCA) owned land to operate and maintain a property maintenance and management company located north of Rutherford Road and west of Pine Valley Drive, municipally known as 4948 Rutherford Road, in the City of Vaughan, Regional Municipality of York, Humber River watershed (CFN 39525)
(*Executive Committee RES.#B79/21*)
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9.2. SECTION II - ITEMS FOR EXECUTIVE ACTION (FOR THE INFORMATION OF THE BOARD)

9.2.1. REQUEST FOR TENDER FOR EROSION CONTROL WORKS AT 70 MAIN STREET SOUTH, CITY OF MARKHAM

Award of Request for Tender (RFT) No. 10036272 to retain a contractor to implement remedial erosion control works, including the supply of all labour, equipment and materials required for implementation. The project is located at 70 Main Street South, in the City of Markham.
(*Executive Committee RES.#B80/21*)
PDF Page 11/164

9.2.2. STANDING OFFER SUPPLY FOR INFORMATION TECHNOLOGY SOLUTIONS

Adoption of Kinetic Group Purchasing Organization (Kinetic GPO) contract for Information Technology infrastructure equipment, hardware products, and related services (Contract No. 10035438).
(*Executive Committee RES.#B81/21*)
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9.3. SECTION III - ITEMS FOR THE INFORMATION OF THE BOARD

9.3.1. 2021 SIX MONTH FINANCIAL REPORT

Receipt of Toronto and Region Conservation Authority's (TRCA) unaudited expenditures as of the end of the second quarter, June 30, 2021, for informational purposes.
(*Executive Committee RES.#B82/21*)
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9.3.2. 2021 COVID-19 SIX MONTH UPDATE

To provide an update to Toronto and Region Conservation Authority's (TRCA) Board of Directors regarding the financial impacts of COVID-19 in the first six months of 2021.
(*Executive Committee RES.#B83/21*)
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9.3.3. FUNDING AND GRANTS PROGRAM

In-Year Program Update to Toronto and Region Conservation Authority's (TRCA) Board of Directors on the Funding and Grants program and to highlight the success rate as of August 13, 2021.
(*Executive Committee RES.#B84/21*)
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9.3.4. 2021 RISK PROGRAM UPDATE

Update on Toronto and Region Conservation Authority's (TRCA) Risk Management Program.
(*Executive Committee RES.#B85/21*)
PDF Page 33/164

9.3.5. Q2 2021 COMMUNICATIONS SUMMARY

Information report regarding Toronto and Region Conservation Authority's (TRCA) corporate media communication activities during the second quarter of 2021 (April 1 – June 30).
(*Executive Committee RES.#B86/21*)
PDF Page 36/164

9.3.6. UPDATE ON APPROVED DELEGATED MAJOR PERMITS

TRCA staff are required to report back on any major permits issued through the approved delegated process during the months of July and August 2021.
(*Executive Committee RES.#B87/21*)
PDF Page 44/164

9.4. SECTION IV - ONTARIO REGULATION 166/06, AS AMENDED

Receipt of permits pursuant to Ontario Regulation 166/06, as amended, for applications under item 10.1, which were received at the September 10, 2021 Executive Committee Meeting.
(*Executive Committee RES.#B88/21*)
PDF Page 67/164

9.5. SEPTEMBER 10, 2021 EXECUTIVE COMMITTEE CLOSED SESSION ITEMS

(*Executive Committee RES.#B89/21*)
PDF Page 164/164

(*September 10, 2021 Closed Session Minutes will be circulated to Board Members separately*)

9.5.1. SUPPLEMENTARY COMPENSATION AND PAY EQUITY REVIEW

(*Executive Committee RES.#B89/21*)
PDF Page 164/164

(*September 10, 2021 Closed Session Minutes will be circulated to Board Members separately*)

10. CLOSED SESSION

11. NEW BUSINESS

NEXT MEETING OF THE BOARD OF DIRECTORS TO BE HELD ON OCTOBER 22, 2021 AT 9:30 A.M. VIA VIDEOCONFERENCE

John MacKenzie, Chief Executive Officer

/am

NIAGARA PENINSULA CONSERVATION AUTHORITY
250 Thorold Road West, 3rd Floor, Welland, Ontario L3C 3W2
Telephone 905.788.3135 | Facsimile 905.788.1121 | www.npca.ca

July 22, 2021

Kim Gavine
General Manager
Conservation Ontario
120 Bayview Parkway
Newmarket, ON
L3Y 3W3

SENT ELECTRONICALLY

Dear Ms. Gavine,

Please be advised that the Board of Directors of the Niagara Peninsula Conservation Authority (NPCA) adopted the following resolution at its meeting of July 16, 2021:

Resolution No. FA-147-2021
Moved by: Member Mal Woodhouse
Seconded by: Member Rick Brady

WHEREAS *globally, pollinator species, including bees and monarch butterflies are declining at a concerning rate due to anthropogenic activity such as habitat loss and degradation as well as pollution and climate change;*

WHEREAS *the dramatic global decline in the pollinator species population could seriously affect the pollination of human food crops around the world;*

WHEREAS *Health Canada's Pest Management Regulatory Agency (PMRA) has developed Best Management Practices (BMP's), resources, and guidelines to ensure agricultural practices across the country protect pollinators, and, is collaborating with the Provincial Ministry of Agriculture and Rural Affairs to advance these resources and BMP's;*

AND WHEREAS *the Niagara Peninsula Conservation Authority (NPCA) is committed to maintaining and enhancing pollinator habitat through its enhanced restoration and stewardship programs, community partnerships, as well as advising land development proponents through planning and development processes;*

NOW THEREFORE, BE IT RESOLVED*:*

1. ***THAT*** *the NPCA* ***REQUESTS*** *the support and collaboration of conservation authorities and (through the CAs) their partner municipalities across the Province of Ontario to include the provision of native pollinator habitat with specialized native plant species through future development and redevelopment projects.*

2. ***THAT*** *by copy of this motion, NPCA partner municipalities* ***BE REQUESTED*** *to advance the use of native pollinator plant species to promote pollinator habitat through projects on their own lands as well through planning and development processes.*

3. ***THAT*** *a copy of this resolution* ***BE CIRCULATED*** *to the Association of Municipalities of Ontario and the Federation of Canadian Municipalities for their consideration.*

4. ***AND FURTHER THAT*** *both the governments of Ontario and Canada* ***BE REQUESTED*** *to adopt a plan of action for properties within their control to protect pollinators and plant native pollinator species, and entrench this priority with the appropriate legislation with circulation of NPCA jurisdiction federal and provincial political representatives.*

CARRIED

Should you have any questions regarding the above issue, please feel free to contact CAO, Chandra Sharma at csharma@npca.ca or 905-788-3135.

Sincerely,

Grant Bivol

Grant Bivol
NPCA Clerk

Item 7.1

Section I – Items for Board of Directors Action

TO: Chair and Members of the Board of Directors
Friday, September 24, 2021 Meeting

FROM: Sameer Dhalla, Director, Development and Engineering Services

RE: **TRCA WETLAND WATER BALANCE MODELLING GUIDANCE DOCUMENT**

KEY ISSUE
Board approval of Toronto and Region Conservation Authority's (TRCA) Wetland Water Balance Modelling Guidance Document, a decision support tool developed to support the *Water Balance for Protection of Natural Features* of TRCA's Stormwater Management Criteria, and The Living City Policies for Planning and Development in the watersheds of TRCA.

RECOMMENDATION

WHEREAS wetlands play a crucial role as part of the "green infrastructure" of the Greater Toronto Area region by providing stormwater retention, flood attenuation, filtering of air and water pollutants, wildlife habitat and greenspace for communities to enjoy;

AND WHEREAS Toronto and Region Conservation Authority (TRCA) regulates wetlands and the interference with wetlands under Ontario Regulation 166/06;

AND WHEREAS TRCA staff review and assess submissions for development, infrastructure and site alteration affecting the hydrology of wetlands as part of planning, environmental assessment and permitting applications;

AND WHEREAS the development industry requested a technical guideline to provide guidance to proponents on how to model the hydrology of a wetland when impacts from a proposed development are anticipated to inform mitigation measures. The guidance document provides direction that helps to streamline the application review process by explicitly outlining the procedure for conducting a feature-based water balance modelling exercise for the protection of a wetland's hydrology;

AND WHEREAS in July of 2018, TRCA staff sought input into the development of the draft Modelling Guidance Document from partner municipalities, provincial agencies, the Building Industry and Land Development Association (BILD), consulting firms and neighbouring conservation authorities, and have now finalized the Modelling Guidance Document based on the input received;

THEREFORE, LET IT BE RESOLVED THAT the TRCA Wetland Water Balance Modelling Guidance be approved for use by proponents of development and infrastructure, consultants, and TRCA staff in the planning and development submission, review and approval process;

AND FURTHER THAT the Ministry of Northern Development, Mines, Natural Resources and Forestry, the Ministry of Transportation, the Ministry of Municipal Affairs, the Ministry of Environment, Conservation and Parks, the Ministry of the Environment and Climate Change, TRCA's member municipalities, Conservation Ontario and neighbouring conservation authorities be so advised.

BACKGROUND
At Authority Meeting #7/12, held on September 28, 2012, Resolution #A173/12 was approved, endorsing the TRCA Stormwater Management Criteria document (hereafter referred to as the SWM Criteria document). In accordance with provincial guidance and TRCA's The Living City Policies, applications under TRCA review are required to meet TRCA's criteria for water quantity, water quality, erosion and water balance. For proposals that impact a wetland's hydrology that has been designated for protection through the planning process, a wetland water balance analysis must be undertaken by the proponent. The water balance analysis helps to ensure the protection of wetlands and their ecological functions following development, and to increase the resilience of wetlands to other stressors, such as climate change. Wetland water balance analysis may also reduce municipal risks and liabilities associated with flooding of private property and municipal infrastructure, which are issues that may arise when wetland water balance is not properly considered. A water balance will not generally be required for linear infrastructure, such as roads and railways, where TRCA's regular permitting process would generally be sufficient to address potential impacts to natural features and associated mitigation options.

To help achieve the wetland water balance objectives, TRCA developed a series of technical guidance tools including TRCA's Wetland Water Balance Monitoring Protocol. The protocol was endorsed by Resolution #A143/16 at Authority Meeting #6/16, held on July 22, 2016, TRCA's Wetland Water Balance Risk Evaluation that was endorsed by Resolution #A210/17 at Authority Meeting #9/17, held on November 17, 2017, and TRCA's Wetland Water Balance Modelling Guidance Document (hereafter the Modelling Guidance Document) have been updated as presented in the attached documents.

Wetland Water Balance Modelling Guidance
The Modelling Guidance Document is a technical guideline that was requested by the development industry to outline the approach and procedure for conducting a feature-based water balance modelling exercise for the protection of wetland hydrology, as outlined in the Stormwater Management Criteria Document (SWM Document; TRCA, 2012). The purpose of the modelling exercise is to inform the need for, and the design of, mitigation measures to ensure a minimal difference between the post-development and pre-development water balance of a wetland. This Modelling Guidance Document provides an overview of wetland hydrology modelling, the strengths and weaknesses of various hydrological models, and the information that needs to be included in a feature-based water balance analysis report.

The Modelling Guidance Document is accompanied by a companion document, entitled Wetland Water Balance Modelling Case Studies (hereafter the Modelling Case Studies), that outlines set-up, calibration, and validation of wetland water balance models within five commonly used continuous hydrology models (HEC-HMS, HSPF, SWMM, MIKE-SHE, and VO5). This collection of modelling case studies is not intended to be a definitive guide to application of these models, but rather illustrates potential approaches within each model, and the advantages or drawbacks to application of the models to specific scenarios. The Modelling Guidance Document is intended to be a living document that TRCA staff will update periodically as new information and/or modelling approaches become available.

The Modelling Guidance Document benefits proponents by:

- Providing an overview of wetland hydrology modelling including the strengths and weaknesses of various hydrological models
- Clarifying the information that needs to be included in a feature-based water balance analysis report along with recommended report template and main section headings

- Providing consistency and transparency in decision-making along with a statistical tool that allows selection of acceptable mitigation measures:
- Efficiently using information as it largely requires the use of data and modeling approaches that is already being used as part of the planning process;
- Simplifying the review process by providing step-by-step guidance on risk determination.

RATIONALE
Conservation authorities (CAs) regulate wetlands under section 28 of the *Conservation Authorities Act* due to their importance for the hydrology and the ecology of watersheds. CAs also advocate for the protection of wetlands in their commenting roles under the planning and environmental assessment review processes. Protection of wetlands and their associated hydrological and ecological services is a key objective under provincial policy including the Provincial Policy Statement, the Oak Ridges Moraine Conservation Plan and the Greenbelt Plan.

The protection of wetlands on the landscape helps to fulfill TRCA's key objectives, and those of the Province and municipalities, for watershed resilience to climate change and land use change. Wetlands cover less than five percent of TRCA's jurisdiction yet provide a disproportionately large number of ecosystem services, including water storage, reduction of downstream flooding and erosion, provision of baseflow in streams, and provision of habitat for plants and animals (some of which only occur in wetlands).

The water balance of a wetland is an accounting of the various pathways by which water enters or leaves a wetland, such as rainfall, overland runoff or groundwater seepage. Land use change within the surface water catchment of a wetland may alter the water balance by changing the ratio of surface runoff (water output) to infiltration (water input) within the catchment, the proportion of water lost to evapotranspiration, or the area draining to a wetland through grading and stormwater management activities. Many of the ecosystem services provided by wetlands are dependent on the water balance and altering the water balance can result in loss of ecosystem services.

TRCA has documented several instances in which insufficient consideration of water balance for natural features has resulted in loss of ecosystem services and created nuisance flooding and erosion issues on private lots and back-up of water into municipal stormwater infrastructure. These are issues that are difficult and expensive to mitigate after development has occurred and/or infrastructure has been installed. Proactive mitigation during the planning phase is much more cost-effective but requires that the need for a water balance analysis be identified as early as possible in the planning and development process so that proponents and reviewers can scope the analysis into the application.

The determination of which wetlands will be protected on the landscape is external to any application of this Modelling Guidance Document and will be made as part of a planning or infrastructure review and approval process. The Wetland Water Balance Risk Evaluation (Risk Evaluation; TRCA, 2017) should be completed in advance of any application of this Modeling Document to determine the appropriate scope of analysis and type of model to be used. The Risk Evaluation identifies if a water balance analysis is necessary and, if so, the scope of study (monitoring and modeling) that is appropriate given the features of the application in question. If modelling is determined to be in scope, the Modeling Document and its companion document, the Modelling Case Studies, provides further guidance on suitable approaches and methods in modelling wetland hydrology, the strengths and weaknesses of commonly utilized continuous hydrology models, and the critical information that needs to be included in a feature-based water balance analysis report to identify the need for, and the design of, mitigation measures to ensure a minimal difference between the post-development and pre-development water balance of a wetland.

Stakeholder Consultation
TRCA staff established an External Stakeholder Committee (ESC) with representatives from municipalities, BILD, the consulting industry, Credit Valley Conservation, and other conservation authorities to collaborate on the development of the Modelling Guidance Document. The Modelling Guidance concept and intent to develop the guidance was presented to BILD in September 2016, then the draft document was presented to the ESC in February 2018. Then, drafts of the document were circulated twice for comment (summer 2018 and fall 2019) and revised based on feedback from internal staff, the ESC, and more broadly from external partners, which included all TRCA's partner municipalities, BILD, the consulting industry, relevant provincial agencies, and neighbouring conservation authorities.

External commentators were generally supportive of the intent, structure, and content of the draft version, and some had seen the draft previously through its use by TRCA Engineering staff; preliminary reports from staff are that the draft is helpful as a tool for consultants and staff in scoping water balance modelling exercises.

Furthermore, the Ministry of Northern Development, Mines, Natural Resources and Forestry recently released "Wetland Conservation Strategy for Ontario (2017-2030)" outlines the Province of Ontario's objective of ensuring no net loss of wetlands in southern Ontario by 2025, while the Ontario Flooding Strategy (2020) cites the development of policy tools and approaches to prevent new wetland loss. The Modelling Guidance Document can help achieve the above objectives.

Relationship to Building the Living City, the TRCA 2013-2022 Strategic Plan
This report supports the following strategies set forth in the TRCA 2013-2022 Strategic Plan:
Strategy 2 – Manage our regional water resources for current and future generations
Strategy 4 – Create complete communities that integrate nature and the built environment
Strategy 9 – Measure performance

FINANCIAL DETAILS
The development of the Modelling Guidance Document was supported by capital funding from the regional municipalities of York and Peel. TRCA staff secured external funding in the form of grants from the Great Lakes Protection Initiative (formerly the Great Lakes Sustainability Fund) and the Toronto and Region Remedial Action Plan. These grants, together with funding from the regions of York and Peel, also support continued wetland water balance monitoring in the jurisdiction being led by TRCA and Credit Valley Conservation.

DETAILS OF WORK TO BE DONE
The Modelling Guidance Document will be implemented through the Development and Engineering Services division in review of Planning Act applications, environmental assessments and master planning, and through TRCA's permitting process. TRCA planners, engineers, ecologists and hydrogeologists reviewing applications will continue to work with development proponents and consultants to streamline the review process while striving for the best possible outcome for environmental and growth management objectives. TRCA's Planning and Development Procedural Manual, Environmental Impact Study Guidelines, and Stormwater Management Criteria document will all be updated to reference the Modelling Guidance Document.

The Modelling Guidance Document will be posted on TRCA's website and will be reviewed biennially in conjunction with the Wetland Water Balance Monitoring document and Wetland Water Balance Risk Evaluation to reflect new science and understanding, and any minor updates to the SWM Criteria document. TRCA will communicate the approval of the Modelling Guidance Document to our municipal and conservation authority partners as well as other stakeholders.

Report prepared by:
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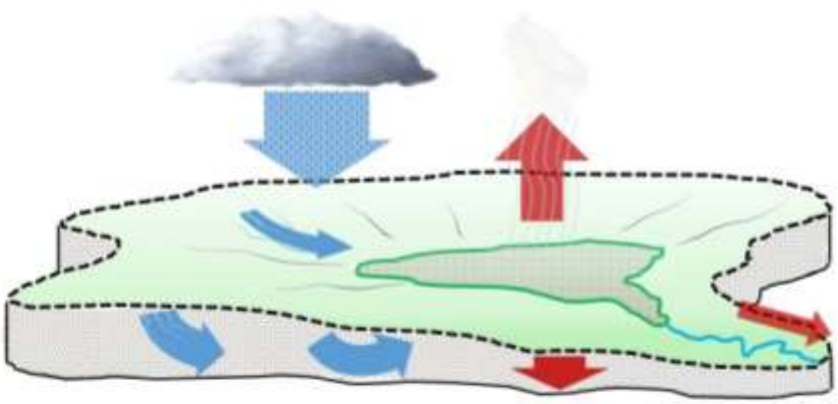
Emails: dilnesaw.chekol@trca.ca
Date: August 11, 2021
Attachments: 2

Attachment 1: Wetland Water Balance Modelling Guidance Document
Attachment 2: Wetland Water Balance Modelling Case Studies



WETLAND WATER BALANCE MODELLING GUIDANCE DOCUMENT

Toronto and Region Conservation Authority
August 2020

Acknowledgments

This document is made possible by generous funding and contributions provided by:

The Great Lakes Sustainability Fund
The Regional Municipality of Peel
The Regional Municipality of York
Toronto Remedial Action Plan
The Regional Municipality of Durham
The City of Toronto
Credit Valley Conservation

We gratefully acknowledge the contributions of the members of the Wetland Water Balance External Stakeholder Committee throughout the development of this document. The stakeholder committee included technical experts in stormwater engineering, ecology, hydrogeology, and planning with representation from both the public and private sectors.

Special thanks to Neil Taylor for help researching and compiling sections of this document.

For further information about this document, please contact:

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Please reference this document as:

Wetland Water Balance Modelling Guidance Document, Toronto and Region Conservation Authority, 2020

Table of Contents

Figures, Tables, and Equations

How to Read This Document

This *Wetland Water Balance Modelling Guidance Document* (hereafter *Modelling Document*) is intended to outline the approach and procedure for conducting a feature-based water balance modelling exercise for the protection of wetland hydrology, as outlined in the Stormwater Management Criteria Document (SWM Document; TRCA, 2012). The purpose of the modelling exercise is to inform the need for, and the design of, mitigation measures to ensure a minimal difference between the post-development and pre-development water balance of a wetland. This *Modelling Document* provides an overview of wetland hydrology modelling, the strengths and weaknesses of various hydrological models, and the information that needs to be included in a wetland feature-based water analysis report.

<u>The sections of this *Modelling Document* correspond to the template format for a feature-based water balance analysis report, which is also outlined in Appendix A of this document.</u> The intent is that the reader should refer to this document section by section to determine the information that is required in each corresponding section of the report (i.e. section 4 of the *Modelling Document*, outlining the development the conceptual model, corresponds to the information that should be included in the same section of the report).

Note that there is also a companion document to this *Modelling Document*, entitled *Wetland Water Balance Modelling Case Studies*, that outlines set-up, calibration, and validation of wetland water balance models within five commonly used continuous hydrology models (HEC-HMS, HSPF, SWMM, MIKE-SHE, and VO5). This collection of modelling case studies is not intended to be a definitive guide to application of these models, but rather illustrates potential approaches within each model, and the advantages or drawbacks to application of the models to specific scenarios. As model codes and modules change rapidly, other continuous hydrology models not listed in this document or the companion document may be acceptable; proponents are asked to verify alternative modelling approaches with TRCA staff prior to any submissions.

Finally, please note that this *Modelling Document* is intended to be a living document that TRCA staff intend to update periodically as new information and/or modelling approaches become available.

1 Introduction

This *Modelling Document* outlines the methods and procedures for conducting a feature-based water balance modelling exercise for the protection of wetland hydrology, as outlined in the Stormwater Management Criteria Document (*SWM Document*; TRCA, 2012) in *Appendix D: Water Balance for Protection of Natural Features.* The purpose of the modelling exercise is to inform the need for, and the design of, mitigation measures to ensure a minimal difference between the post-development and pre-development water balance of a wetland. Figure 1 below depicts an overview of the model development process, including critical steps for consultation with TRCA and/or the municipality.

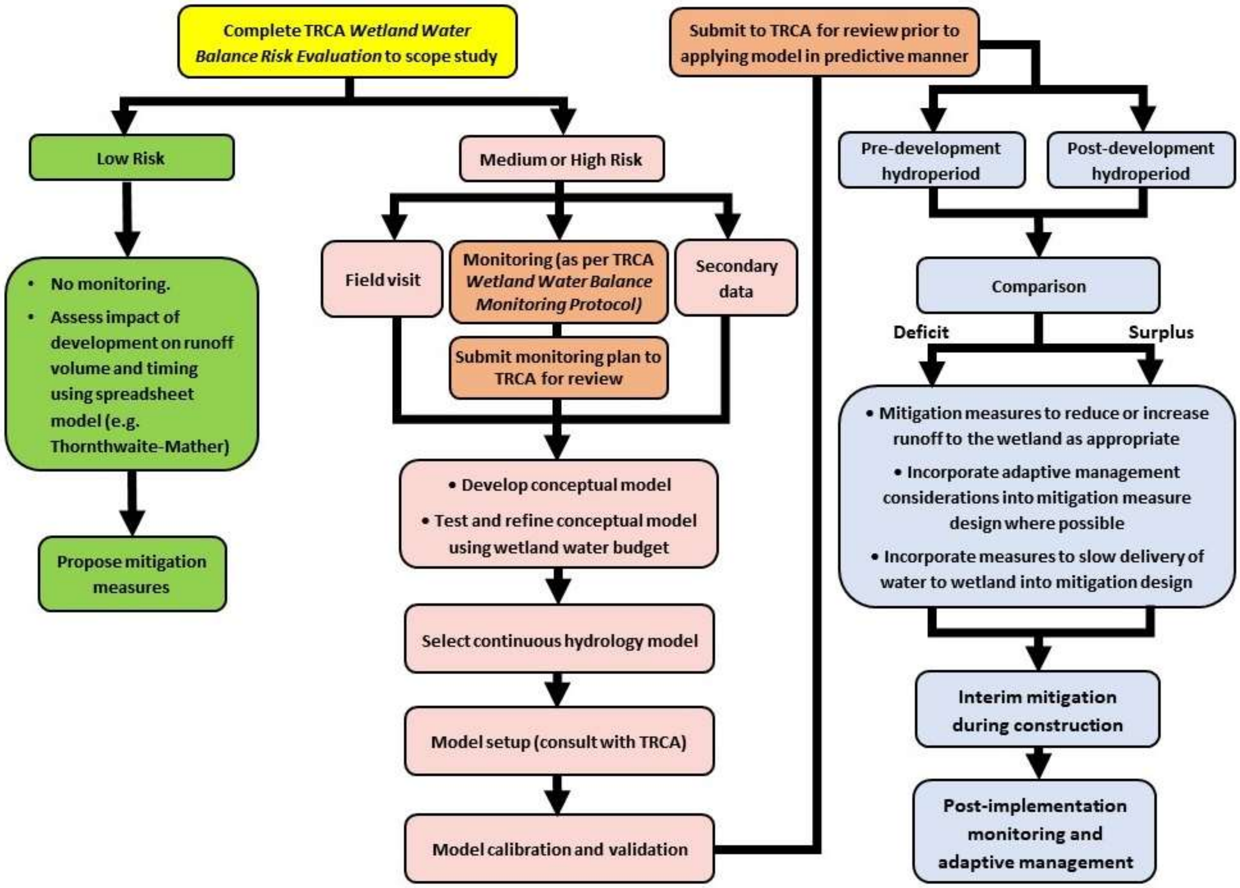


Figure 1: Steps for wetland modelling as part of a Feature-based Water Balance analysis

Proponents of development and infrastructure using this guidance document should refer to the *SWM Document* (TRCA, 2012) for guidance on the overall objectives of feature-based water balance analysis (also referred to as water balance for protection of natural features). The determination of which wetlands will be protected on the landscape is external to any application of this *Modelling Document* and will be made as part of a planning or infrastructure review and approval process. The *Wetland Water Balance Risk Evaluation* (*Risk Evaluation*; TRCA, 2017) should be completed in advance of any application of this guideline to determine the appropriate scope of analysis and type of model to be used. The Risk Evaluation considers the magnitude of potential hydrological change a proposal embodies relative to certain threshold values, as well as the sensitivity of the wetland in question in order to determine an appropriate scope of analysis. The *Modelling Document*, *Risk Evaluation*, and other tools supporting implementation of the *SWM Document* criteria are indicated in relation to the corresponding steps in the *SWM document* in Figure 2.

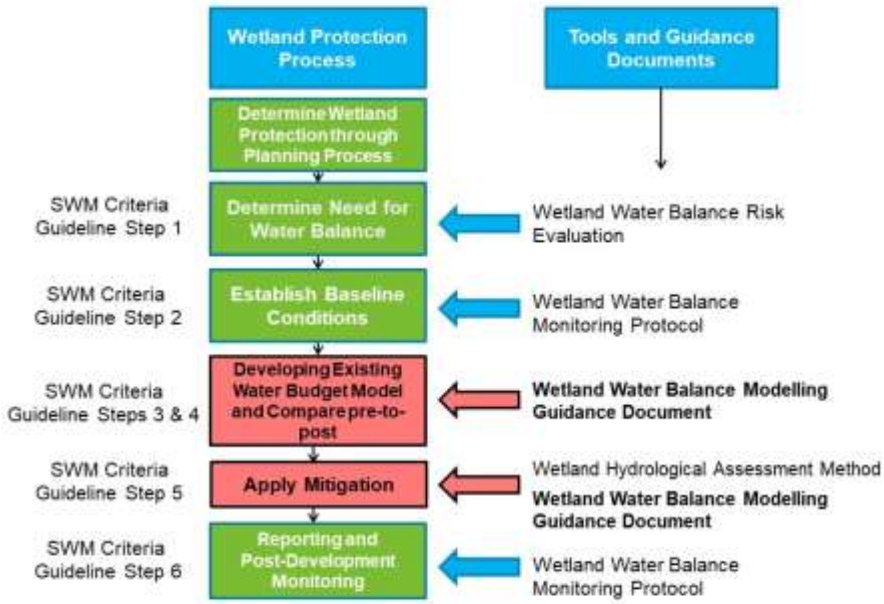


Figure 2: Wetland water balance tools and guidelines and their relation to steps in the SWM Document.

2 Understanding the Hydrological System

This section of the feature-based water balance (FBWB) report must include a discussion of the landscape and hydro(geo)logical contexts of the wetland(s) in question as they relate to the major hydrological processes operating within the wetland under natural (i.e. pre-development) conditions. This discussion should be informed by careful review of existing/secondary information, site surveys, and especially by wetland hydrology monitoring data collected on site.

The hydrology of a wetland directly determines many aspects of its physical, chemical, and ecological characteristics, and as such it is perhaps the most important variable influencing ecological function (Mitsch and Gosselink, 2007). Land development and infrastructure construction can affect the hydrology of a wetland in a number of ways, some of which may have a negative impact on the ecological function of a wetland. For example, water taking directly from a wetland or from an aquifer that discharges directly to a wetland has a clear potential to directly alter the wetland's water balance. Land use change within the surface water catchment of a wetland may alter the water balance by changing the ratio of surface runoff to infiltration within the catchment as well as the proportion of water lost to evapotranspiration. This is an issue particularly when there is a substantial increase in the proportion of impervious cover such as paved surfaces and roofs (Hicks and Larson, 1997; Reinelt and Taylor, 2001). Alteration to the size of the catchment area draining to a wetland due to land grading activities or stormwater management system design also has the potential to significantly change the water balance.

It is important to note that wetland hydrology encompasses much more than the average annual depth of water in a wetland. Aspects of wetland hydrology such as the proportion of total inflow derived from surface water or groundwater, the timing and duration of inflows, and the timing of water level drawdown over the growing season all contribute to the maintenance of a particular ecological function. For example, amphibian species may require water for breeding during spring but may also require habitat to be seasonally dry to prevent predatory fish from establishing in this habitat. Similarly, some obligate wetland plants will be outcompeted by facultative upland plants if a wetland dries out too early, leading to shifts in the ecological community. Significant differences in wetland ecology and associated ecosystem services can occur between relatively small differences in hydrological regime on the order of tens of centimeters (Baldwin *et al.*, 2001; Mitsch and Gosselink, 2007; Moor *et al.*, 2017).

The term *hydroperiod* is used to refer to the pattern of water level change within a wetland over time, both above and below ground, and is a measure of the net sum of interaction between the different water balance components (i.e. the change in storage). The *hydroperiod* is a key measure by which to track changes in the water balance over time, and is the primary focus of wetland hydrological monitoring, as outlined in the *Wetland Water Balance Monitoring Protocol* (TRCA, 2016).

Under increasing urbanization, ecosystem services provided by wetlands will be affected unless their hydroperiods are protected through implementation of water balance mitigation measures. The design of functioning wetland mitigation measures requires a proper understanding of the wetland hydrological system. A sound conceptual understanding of the wetland hydrological system is a prerequisite to assessment of the impact of any anthropogenic activities on the wetland hydrology. Also, lack of a proper conceptual understanding of how the wetland works will lead to selection of invalid models, which will then result in ineffective mitigation measures.

The hydrology of wetlands can be very complex. Some wetlands discharge to groundwater, while others are recharged by groundwater. Some will retain water year round while others may be dry for part of the year. Depending on the type and condition of vegetation and the amount of open water, evapotranspiration rates will vary greatly. Antecedent conditions of soil moisture and amount of water already stored in the wetland will affect how much storage is available for runoff. Hydrological models are tools that aid in understanding the interaction of the different components of the water balance by providing a simplified representation of these interactions. Provided that this simplified representation is sufficiently complete, good models allow different land use and stormwater management scenarios to be explored in a way that would not be otherwise possible, thereby helping engineers and other professionals come up with designs that minimize the difference between the pre- and post-development wetland hydroperiod.

In evaluating the hydro(geo)logic and landscape context of the wetland, proponents should start by reviewing available studies and datasets that conservation authorities and different levels of government have initiated. For example, regional groundwater studies, watershed and sub-watershed studies, geological and land cover maps, are all helpful in providing the landscape context for the FBWB study.

Following a review of existing/secondary information, the next information sources should be field inspections to verify existing conditions on the ground. Field visits can help confirm if overland drainage patterns inferred from secondary information reflect site conditions, or if features such as culverts or tile drains may cause conditions on the ground to differ from expectations. Field-based hydrology monitoring data on wetland storage dynamics and channelized surface flow is crucial to developing a better understanding of the wetland hydrological system and can reveal a great deal about how the system functions.

In developing a better understanding of the wetland hydrological system through collected monitoring data and secondary sources, it may be helpful to consider the following questions:

1. What are the dominant water transfer mechanisms between the wetland and its surroundings?
2. How long does the wetland contain standing water?
3. Do the maximum depth and areal coverage of surface water change from year to year?
4. How quickly do water levels draw down during extended dry periods?
5. What is the wetland hydroperiod response to precipitation events?
6. Is the amount of surface water flowing into the wetland roughly equal to the amount flowing out?
7. What is the relationship between groundwater head and wetland water levels?
8. Is the hydraulic gradient in the wetland mostly upwards or downwards, and what is the hydraulic conductivity of the soil?
9. How do these observations relate to the observed distribution of wetland habitat?

The first step in attempting to answer these questions should be to construct simple time series plots of the wetland water levels and any data on nearby groundwater levels, surface water flows, etc., with all data displayed on the same plot. Trends should be visually analyzed at different time scales (hourly, daily, weekly, monthly) to identify periodicity and likely water sources and transfer mechanisms. Water sources and transfer mechanisms may vary throughout the year according to season.

3 Developing a Conceptual Model

This section of the FBWB report must include a conceptual diagram of the wetland showing all important hydrological sources, sinks, and transfer mechanisms, and the relationships between them. Any assumptions must be discussed and justified. For some wetlands, it will be necessary to have more than one conceptual diagram to describe its hydrology during different seasons or under different conditions.

After the practitioner has developed a conceptual understanding of the wetland hydrological system, a conceptual model should be developed to represent the important sources, sinks, and transfer mechanisms. A conceptual model should be in the form of a simplified diagram that provides a functional description of the hydrological system under pre-development conditions. The conceptual model needs to represent the main hydrological components and their interrelation and needs to be suitable for implementation in a mathematical model. Figure 3 below illustrates two examples of conceptual diagrams for wetlands with slightly different hydrological components.

Conceptual models should always be written down and using an annotated diagram showing water transfer mechanisms, such as precipitation, evaporation, evapotranspiration, surface flow (overland flow, channelized flow and lateral flow in the unsaturated zone), over-bank flow and groundwater discharge and recharge, along with the structure of the underlying geologic strata. If water transfer mechanisms operate differently at different times (e.g. seasonally, or during dry and wet conditions) then different diagrams should be utilized to show variations of the water transfer mechanisms occurring in the wetland at those different times.

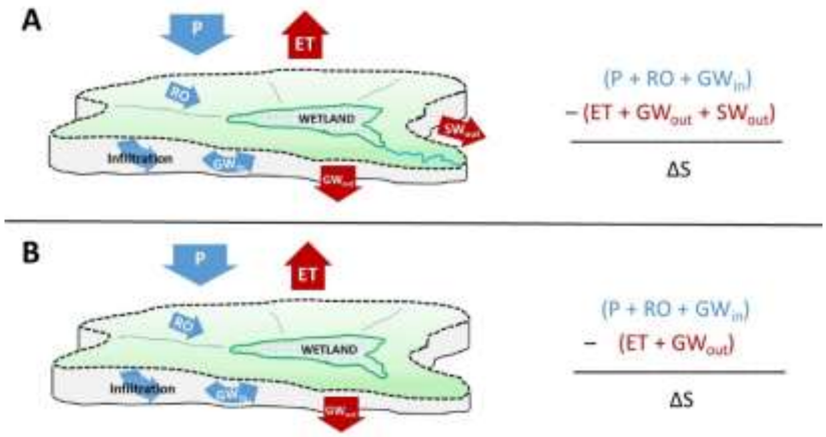


Figure 3: Conceptual diagram of a wetland with channelized surface outflows (A) and a wetland with no channelized surface outflows (B)

The FBWB report must discuss the conceptual model used to characterize the hydrology of the wetland under study. Conceptualization and characterization of the wetland will assist in selection of an appropriate hydrological model as it will help to define the significant water transfer mechanisms of the wetland hydrology and their interrelationships. The spatial boundary of the storage unit in the model representing the wetland and the temporal resolution requirements can be determined from the wetland characterization. Generally, the storage unit and its associated ratings curves (e.g. stage-storage curve) should be determined from the maximum observed water level. As the water transfer mechanisms in the wetland may vary seasonally, selection of the temporal resolution to be used in the computations must take into consideration the seasonal variability of the water transfer mechanisms of the wetlands. Conceptualization will also determine how lumped or detailed the modelled hydrological processes need to be. Any assumptions must be fully discussed and justified.

4 Testing and Refining the Conceptual Model Using a Water Budget Model

This section of the FBWB report must show the refinement of the conceptual model by quantifying rates of water transfer between model components via the transfer mechanisms previously identified in Section 3. A water budget model, as described below, should be used to determine if the components and transfer mechanisms identified in the conceptual model can adequately explain the observed wetland storage dynamics. If missing components or transfer mechanisms are identified, the water budget model should be refined as necessary. At this stage of the FBWB study, the model should be run using a monthly time-step.

The understanding of the wetland hydrological sources, sinks, and transfer mechanisms developed for the conceptual model next need to be tested, validated, and refined using a tool that allows quantification of water transfer rates through each transfer mechanism. A water budget model is a tool for quantifying the transfer of water in and out of the wetland via different pathways.

This model can be a spreadsheet-based tool that uses appropriate equations to calculate the transfer rates and corresponding storage dynamics, or it can be any modelling software that allows quantification of water transfer rates through different transfer pathways over a given time period. The water budget model outputs should be on at least a monthly basis to enable comparison with the observed responses of the wetland hydroperiod, and to test the appropriateness of the conceptual understanding of the wetland water balance.

4.1 Water Budget Model

The approach (i.e. spreadsheet calculations, modelling software) for the water budget model should be selected based on the understanding of the conceptual model. It may be found that the modelling approach may need to be revised as the qualitative understanding of the conceptual modelling is refined based on the difference between observed and simulated wetland storage dynamics.

To assess the transfer of water into and out of the wetland, the wetland should be viewed as a single open system. The system boundary should be drawn around the wetland by projecting the spatial wetland boundary vertically upwards and downwards to horizontal planes at the top and bottom of the system. The establishment of boundaries allows for a balance approach representing the movement of water into and out of the wetland system to be applied. The water balance of any bounded environmental system follows the principle of conservation of mass, and represents a budget of inputs, outputs, and storage of water in the system. The movement of water within the wetland system can be expressed using a water balance, an equation that accounts for water inflows to and outflows from the system. The wetland water balance equation is basically a routing procedure that sums the water inputs into and out of the wetland area, and the storage in the wetland. The wetland water balance can be described in the general form as follows:

$$\text{INFLOWS} - \text{OUTFLOWS} = \Delta\text{STORAGE} \qquad \text{Equation 1}$$

A more specific form of the water balance equation, which decomposes inflows and outflows into their constituent elements, is given in along with a conceptual diagram in Figure 4 below.

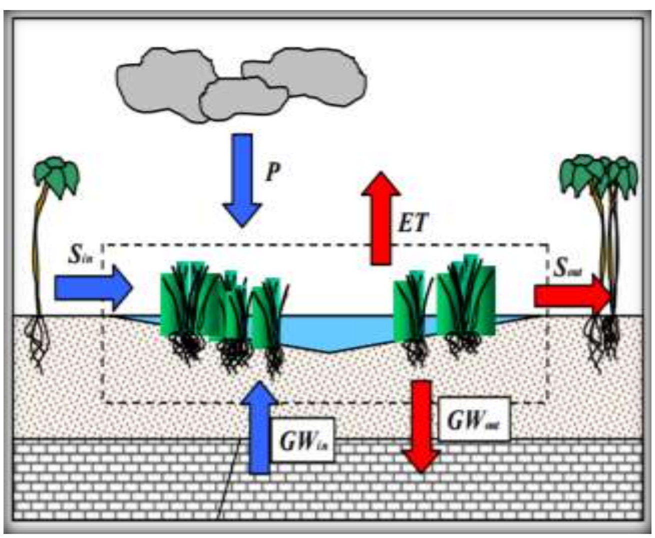


Figure 4: Conceptual representation of a wetland water balance

$$(P + S_{in} + GW_{in}) - (ET + S_{out} + GW_{out}) + \mu = \Delta S \qquad \text{Equation 2}$$

Where:

- P is precipitation in the form of rain or snow on the wetland catchment;
- S_{in} is the surface runoff into the wetland;
- S_{out} is the surface runoff out of the wetland;
- GW_{in} is the groundwater seepage into the wetland;
- GW_{out} is the groundwater seepage out of the wetland;
- ET is evapotranspiration from the wetland;
- μ is the residual; and
- ΔS is the change in water storage of the wetland.

In , the components on the left side represent the inputs (additions) and outputs (losses) to and from the wetland, while the right hand side represents the cumulative change in storage. An error term, μ, is added in order to account for some degree of measurement error. Each of the terms of the water budget can be expressed as depth of water per unit time (L/T) or as volume of water per unit time (L^3/T). The resultant equation quantifies the change in water storage over time as a function of water related inputs and outputs occurring in the wetland over the study period. Water balance analysis allows the conceptual understanding of the wetland hydrology to be refined by identifying gaps in understanding and missing inflows or outflows. A good strategy is to calculate the water balance for a single year representative of long-term average climate conditions, and then to calculate under years representative of relatively wet and relatively dry climatic conditions.

The water balance analysis should be undertaken for the wetland itself as a single hydrological unit. However, there are some complex wetlands which may be impossible to represent as one hydrological unit. For these complex wetlands it is appropriate to subdivide the wetland into two or more hydrologically distinct units, and the water budget should be calculated separately for each of the different hydrological units. Figure 5 below shows a wetland that has two features which are connected when the northern feature is filled and overtops the berm or the divide and flows into the southern feature. It should be noted that during more frequent events these two features may not be hydraulically connected on the surface. However, during major events they are hydraulically connected. In wetland systems such as this, it may be practical to divide the wetland into different hydrological storage units. For such complex wetland systems, calibration will likely be improved if monitoring data is available for each of the wetland hydrological storage units.

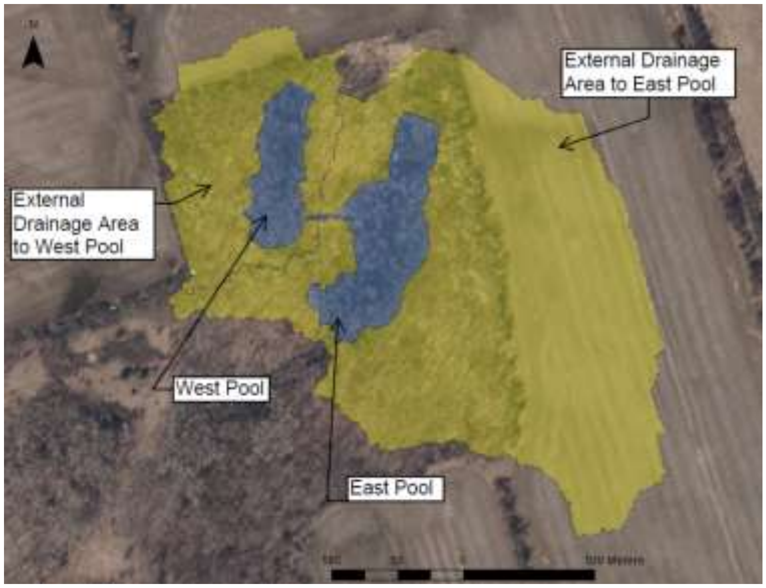


Figure 5: Example of wetland with two distinct hydrological units or pools

In the next sections, each of the water balance components will be discussed in terms of the common methods of estimation available. **For additional information, including governing equations for various water balance components and for potential data sources, the reader should refer to Appendix B**.

4.1.1 Precipitation

Precipitation, in the context of estimating a wetland water balance, refers to the quantity of direct precipitation received by the wetland and surrounding catchment area. Precipitation is most often estimated from the precipitation recorded by a network of gauges, such as those operated by provincial and federal agencies, conservation authorities, and municipalities. Interpolation of precipitation totals, on both an event and an annual basis, is preferable to estimates based on a single point of measurement, as spatial variability associated with precipitation can lead to substantial error and uncertainty. This may be a particular problem in cases where precipitation is a dominant input into the wetland system and a more precise precipitation estimate is needed. There are several methods available for estimating average precipitation from a network. The three most common methods for computing average precipitation within an area are the arithmetic mean, the Thiessen Polygon Method, and the Isohyetal method. There are abundant resources available to assist the proponent in applying each of these methods of calculation, and therefore they are not repeated here.

The steps used to quantify the precipitation component of a wetland water balance are outlined below in Figure 6.

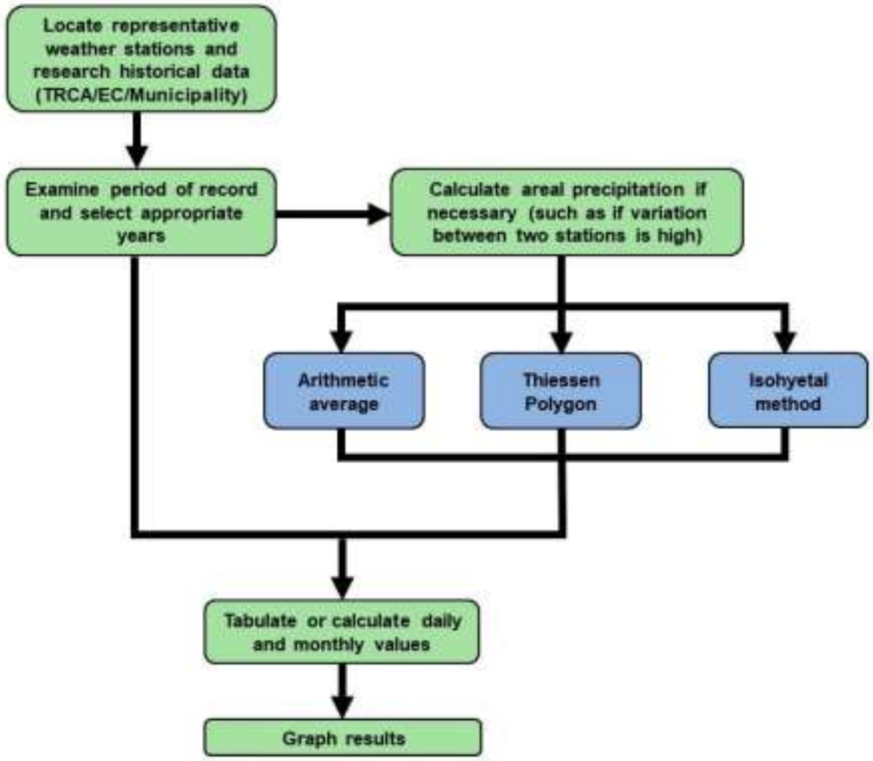


Figure 6: Flow chart for the calculation of the precipitation component of a wetland water budget.

4.1.2 Surface Flow

Surface flow into a wetland can be derived from channelized flow (streamflow), non-channelized flow, and seasonal or periodic inputs from lakes, ponds, and rivers during high water periods. Surface water outflows from wetlands that have precipitation as their dominant input are typically highest during the wet season. However, in wetlands which have major inputs of groundwater, surface water outflows may be more evenly distributed throughout the year. Presence of surface water within a wetland throughout the year depends on the temporal balance of inflows and outflows. Generally, in southern Ontario, runoff rates are highest during the spring due to the combination of abundant rainfall, saturated soils, low evapotranspiration rates, and snowmelt contributions. Runoff rates from May through October tend to be low as evapotranspiration is high and drier soils have greater capacity to infiltrate moderate- and low-intensity rainfall events. Runoff typically increases through fall as plants enter senescence and evapotranspiration decreases. Runoff rates are variable through winter depending on patterns of precipitation and air temperature.

The sections below outline methods that can be used to estimate non-channelized flow from the wetland catchment and channelized flow draining into the wetland.

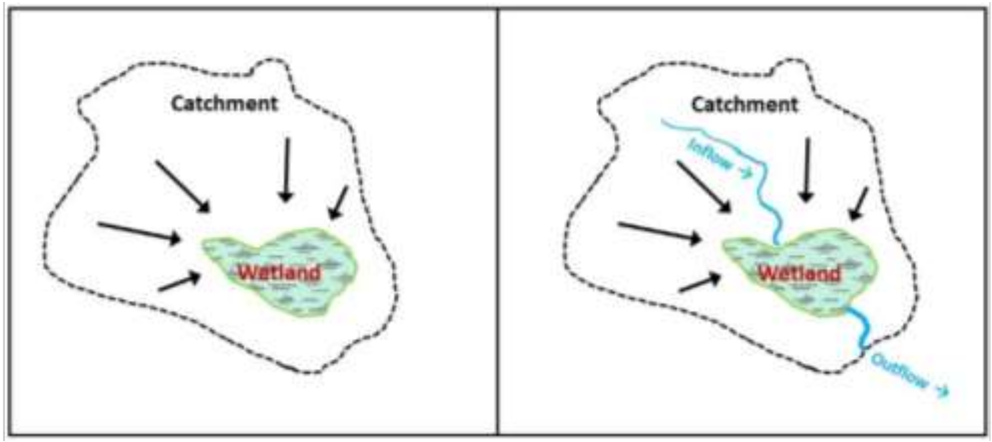


Figure 7: Wetland receiving non-channelized flow only (left) and wetland receiving both non-channelized and channelized flow (right)

Non- channelized Surface Flow

As field measurements of diffuse overland flow are quite challenging, generally a simple modelling approach is used to estimate the volume of overland flow generated by contributing catchment areas. The United States Department of Agriculture's Soil Conservation Service (SCS) developed the curve number (CN) method (SCS, 1972), a simple model to estimate surface runoff volumes generated by a catchment for a given precipitation event. The CN method is widely used and was developed initially for application in small- to medium-sized rural catchments across the United States. To apply the CN method, the contributing catchment area is first divided according to land-use types. An appropriate CN value for each land use type is determined from a lookup table (see Table B1, Appendix B) and a single CN value based on the weighted area of the individual CN values is used to determine the value of potential storage (*S*) in the CN equation (SCS, 1972).

For more information on the SCS curve number method, relevant equations, and CN lookup values, see section B1 in Appendix B.

Channelized Surface Flow

If the wetland receives surface water in the form of channelized flow, it may be possible to make direct measurements using weirs, flumes, and stage-gauging techniques. Accurate field-based streamflow measurements can provide valuable input data to inform wetland water balance analysis. By establishing the cross-sectional area of flow (A, m^2) associated with each stream or channel stage, the continuity equation can be used to calculate discharge (Q, m^3/s). The velocity component (V, m/s) of the continuity equation can be calculated using Manning's Formula (Manning, 1891). Appropriate values for Manning's roughness factor can be found in Table B2, Appendix B.

In circumstances in which direct discharge measurements using weirs and flumes cannot be made, or in which data is not available, hydrological models may be used to estimate channelized flows. Although models are simplified representations of natural hydrological systems, they are nonetheless valuable tools for quantifying different components of the water balance. Selection of the most appropriate model depends on the ultimate objective of the surface water study and the characteristics of the wetland catchment in question; see section 5.3 and section 5.4 for more information on selection criteria for continuous hydrology models.

The steps used to quantify the surface water portion of a wetland water budget are summarized in Figure 8. All non-channelized surface flow that enters the wetland from the surrounding catchment can be quantified using the runoff curve number or model another hydrological model with the capability to simulate surface runoff from the catchment area. Channelized flow can be estimated using the continuity equation in combination with measured stage-gauge data, or else by using a continuous hydrology model. Quantification of channelized flow using a hydrology model may minimize the need to collect data at a particular site for wetland water balance analysis, but field data may reduce some uncertainty introduced by the simplification of the wetland hydrological system in the model and the selection of model parameters. More information on field monitoring procedures and requirements can be found in the *Wetland Water Balance Monitoring Protocol* (TRCA, 2016).

The sum of channelized and non-channelized flow values constitutes the overall surface water input to the wetland system. An adequate assessment of surface water inputs is important for all wetlands, but for riverine and other surface-water-driven wetlands it is critical. Contributions of non-channelized and channelized flow must be quantified for all sites. Daily and monthly surface water flow values must be calculated for representative wet, dry, and average years. These values should be converted to units of depth per unit time and graphed alongside the other components of the water budget.

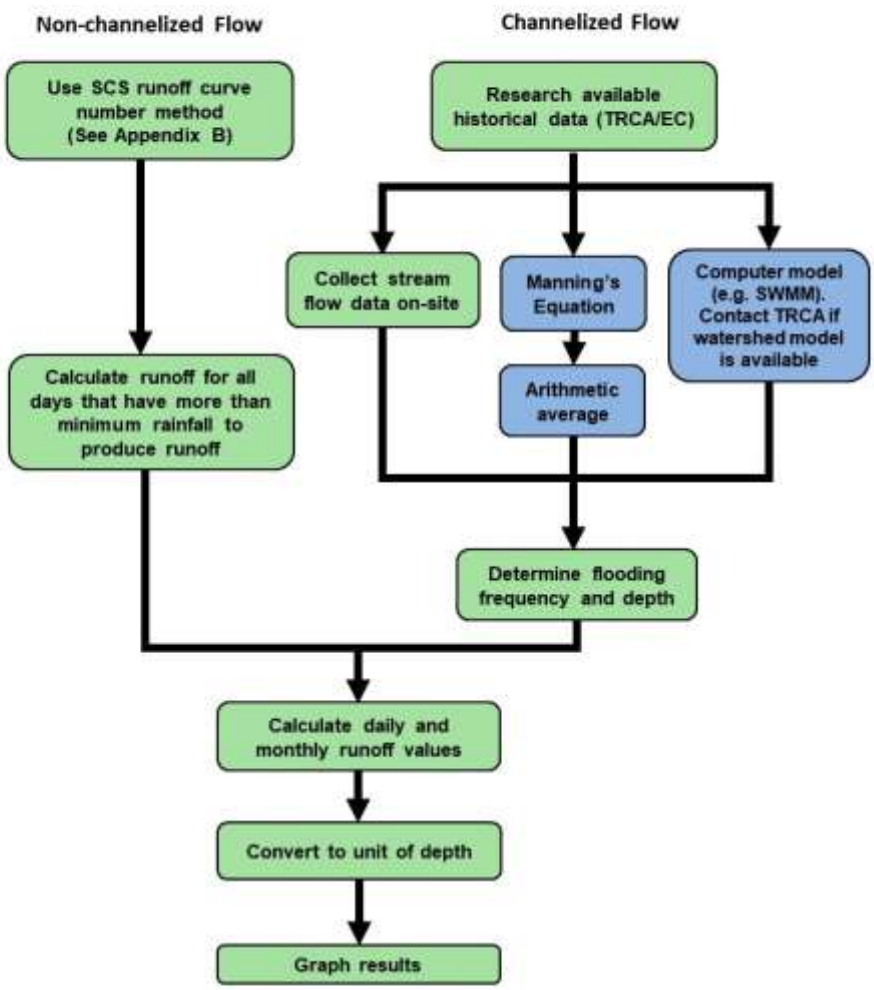


Figure 8: Steps used to quantify surface-flow

4.1.3 Evapotranspiration

Evapotranspiration refers to the loss of water to the atmosphere in the vapour phase from both evaporation (from surface water bodies and soil water) and transpiration (water passing through plants via transpiration). Evapotranspiration (ET) rates from a wetland are affected by several meteorological, physical, and biological variables, including solar radiation, surface temperature, wind speed, relative humidity, available soil moisture, and vegetation type and density. Evapotranspiration varies both seasonally and daily. The evapotranspiration rate is higher during periods when plants are actively growing and transpiring than during periods when they are dormant (Carter, 1996), and tends to be lower at night and on cool, cloudy days and higher on hot, sunny days.

Generally, empirical methods for estimating ET are used to calculate potential evapotranspiration (PET), which is subtracted from the available surface water or soil moisture in the wetland at a given time to calculate actual evapotranspiration (AET). PET rates assume that ET is not limited by water availability; if there is no water left for the atmosphere to extract from the wetland surface and soil, such as during exceptionally dry periods in summer or late fall, then no ET takes place, and AET is lower than PET. As a rule, AET will never exceed PET.

It should be noted that estimating evapotranspiration (ET) is one of the most challenging components of a wetland's water balance to calculate because of the complexity of monitoring this flux and its high variability in time and space. Evapotranspiration rates vary during different growth periods of vegetation communities. A variety of methods are available to estimate ET,

	Method					
Variable	Thorn-thwaite (1948)	Hargreaves *et al.* (1985)	Makkink (1957)	Turc (1961)	Priestley-Taylor (1972)	Penman-Monteith (1965)
Temperature	Required	Required	Required	Required	Required	Required
Humidity				Required		Required
Wind Speed						Required
Radiation		Required*	Required**	Required**	Required***	Required***
No. of daylight hours	Required					
Saturated Vapour pressure						Required
Ground Heat Flux					Required	Required
Resolution	Monthly	Daily	Daily or finer	Daily	Daily or finer	Daily or finer

*Daily radiation at top of atmosphere, as calculated using global solar constants according to latitude and Julian day
**Insolation, or incoming shortwave radiation (only)
***Net radiation, or incoming minus outgoing radiation

Table 1: Comparison of several ET estimation methods in terms of required parameters

including direct-measurement procedures and empirical formulas; however, it has always been a challenge to determine the accuracy and practicability of these methods. Generally, the Penman-Montieth method (Monteith, 1965) is considered the most accurate available empirical method, but requires a number of parameters that may be difficult and/or expensive to measure. For this reason, other estimation methods for ET, requiring a reduced set of input parameters, are more commonly used.

Table 1: Comparison of several ET estimation method below outlines the data requirements for a number of ET methods. More information on a number of empirical equations and their application is provided in Appendix B. The first step should be to establish what meteorological data are available within a reasonable vicinity of the study site, as the parameters available will dictate which methods may be applied. Alternatively, if no suitable data is available, proponents may wish either to collect direct measurement data, or to supplement existing station data with data collected on-site for use with empirical methods. Typically, Environment Canada stations have daily temperature and some have radiation data that can be used as input parameters to estimate ET; some conservation authorities and municipalities may have additional meteorological stations with data for relevant input parameters.

The steps used to quantify the ET portion of a wetland water budget are shown below in Figure 9.

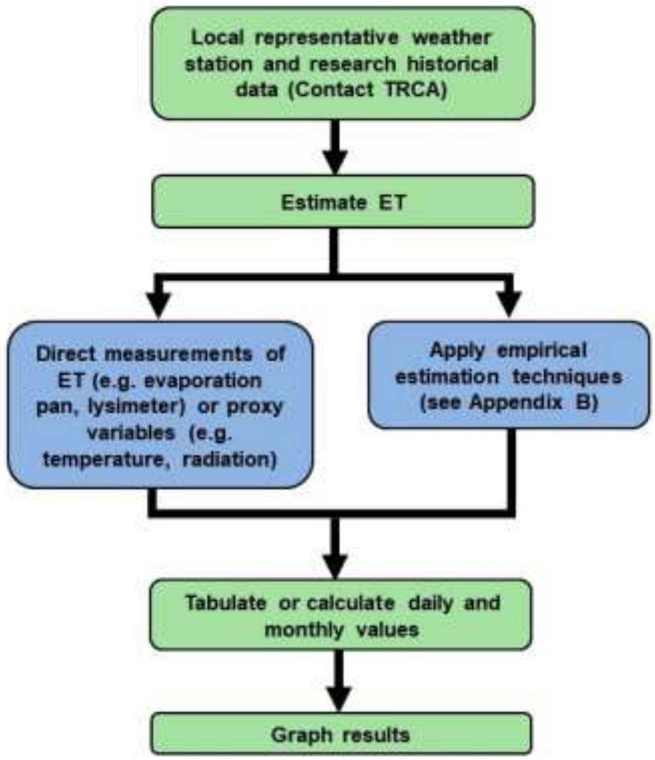


Figure 9: Steps used to quantify the ET component of a wetland water balance

4.1.4 Groundwater flow

Although accurate estimation of the groundwater component of the wetland water balance can be challenging due to the cost of subsurface investigations, estimates of the groundwater flux can be critical to the assessment of water budgets. TRCA advises applicants to begin by researching existing and historical groundwater information in the vicinity of the subject wetland. Regional groundwater datasets, such as that maintained by the Oak Ridges Moraine Groundwater Program, may be useful in this regard. Determining what is known about groundwater and the subsurface environment within the study area will help to determine the amount of data that needs to be collected on-site. Collection of on-site data is often essential to understanding groundwater exchange between the wetland and the surrounding area, as the hydrogeologic environment can vary dramatically over short distances. Collection of hydrological monitoring data, as per the TRCA *Wetland Water Balance Monitoring Protocol* (2016), can help to ascertain local conditions. Drive-point piezometers can be installed by hand within the wetland, including at multiple depth intervals to estimate vertical hydraulic gradients and hydraulic conductivity, and are a much cheaper alternative to drilled wells for investigating the local groundwater environment.

For some wetlands, it may be possible to find an analytical solution to Darcy's Law or various derived forms of Darcy's Law and thereby calculate flow across a series of two-dimensional planes or sections surrounding the wetland. However, for wetlands and aquifers with more complex geometries, or sites dominated by bedrock, an analytical solution using Darcy's Law may not be possible. Under these circumstances, a numerical groundwater flow model can be used to simulate groundwater flow. Numerical groundwater flow models are mathematical representation of an actual groundwater system that can be used to predict water levels as well as the direction and magnitude of flow. Models range from simple to very complex in terms of data-input requirements, calibration requirements, and data output. An internally drained wetland where the outflows from the wetland are only groundwater outflow and evapotranspiration will definitely require a complex numerical ground-water flow model to accurately estimate the groundwater flow exchange between the wetland and the surrounding areas. The applicant should consult with the local conservation authority to determine if there any existing calibrated numerical groundwater flow models.

For both the analytical and modeled solutions to estimating the groundwater component of the water balance, it is critical that wells are installed such that they can adequately characterize water table fluctuations and groundwater movement across the site. The hydraulic conductivity of local aquifers and aquitards must be determined from soil borings, wells, infiltrometers, permeameters, and/or aquifer tests. Daily and monthly groundwater flux rates should be tabulated and graphed for the monitored time period; multi-year data sets may be needed to adequately characterize groundwater interaction, particularly at sites where groundwater head is a dominant control on wetland water levels. Figure 10 outlines the steps used to quantify the groundwater component of a wetland water balance.

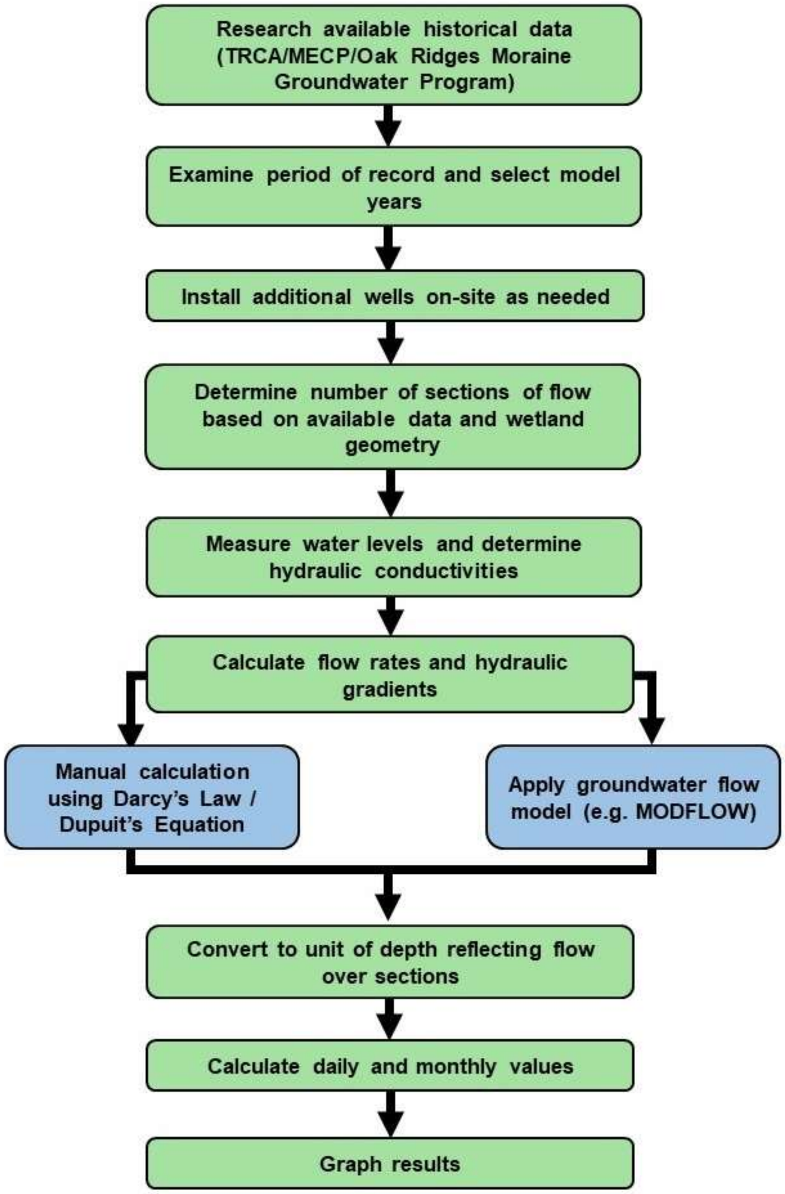


Figure 10: Steps used to quantify the groundwater component of a water balance

4.1.5 Change in Storage

Total storage in a wetland consists of the sum of surface water, soil moisture, and groundwater within the model-defined wetland boundary. The change in storage (ΔS) in a wetland over any period of time represents the difference between the inflows to and outflows from the feature; if the water balance calculation yields a negative ΔS value, more water is flowing out than in, and the opposite is true for a positive ΔS value. The change in storage is essentially equivalent to the *hydroperiod* of the wetland, or the rise and fall of water levels above and below ground within the wetland, as defined in the *Stormwater Management Criteria* (TRCA, 2012). The hydroperiod is the most important variable for monitoring to capture, as outlined in the *Wetland Water Balance Monitoring Protocol* (TRCA, 2016). Monitoring of the hydroperiod is generally most effective when instruments are installed such that the water levels within the lowest points of the wetland, and closest to the center, are captured.

For the standing water portion of a wetland's hydroperiod, ΔS (in units of depth) is equal to the change in water level (stage) multiplied by the area affected; these parameters are related via a stage-storage curve outlining the volume stored in the wetland at each stage. Various techniques with differing levels of accuracy can be used to develop a stage-storage curve, but are beyond the scope of this guideline. A stage gage can be used to help measure change in storage for the standing water portion of the hydroperiod, although important elements of the storage dynamics such as precipitation event response may be lost in the absence of a data logger.

For the below-ground surface portion of a wetland's hydroperiod, ΔS is equal to the change in measured water level multiplied by the specific yield of the sediment. Soils containing a high sand content tend to have a higher specific yield than soils with a higher proportion of silt and clay particles. Some residual storage water remains in the unsaturated zone above the water table when the water table elevation decreases; however, this quantity of storage may be negligible while the water table remains close to the ground surface. Some continuous hydrology models have the capacity to calculate the soil moisture component of ΔS.

Calculating ΔS from monitoring data using one or both of these data-based methods serves as a useful check against the value of ΔS calculated through the water balance approach. The difference between monitored and modeled ΔS can help to quantify the total error/uncertainty in the model, although it is less helpful in distinguishing between sources of error among individual components of the water balance.

4.1.6 Uncertainty/Errors

All water balance calculations have some inherent degree of uncertainty. This uncertainty results from both natural variability within the hydrological cycle and from errors in measurement and estimation. While uncertainty cannot be eliminated, application of appropriate methods can help to both reduce and quantify uncertainty. Calculating the water balance during representative wet, dry, and average climatological years can help to quantify some of the natural variability that may be expected at the site. A sensitivity analysis is a useful tool to help determine how the overall water balance is affected by changes to the magnitude of its individual components. By comparing the change in magnitude of the overall water balance resulting from changes to the magnitude of each individual parameter (e.g. magnitude of groundwater fluxes resulting under different hydraulic conductivity values), the practitioner can quantify the relative sensitivity of each parameter. Additional emphasis should be placed on parameters to which the water balance is especially sensitive in the refinement of the water balance model.

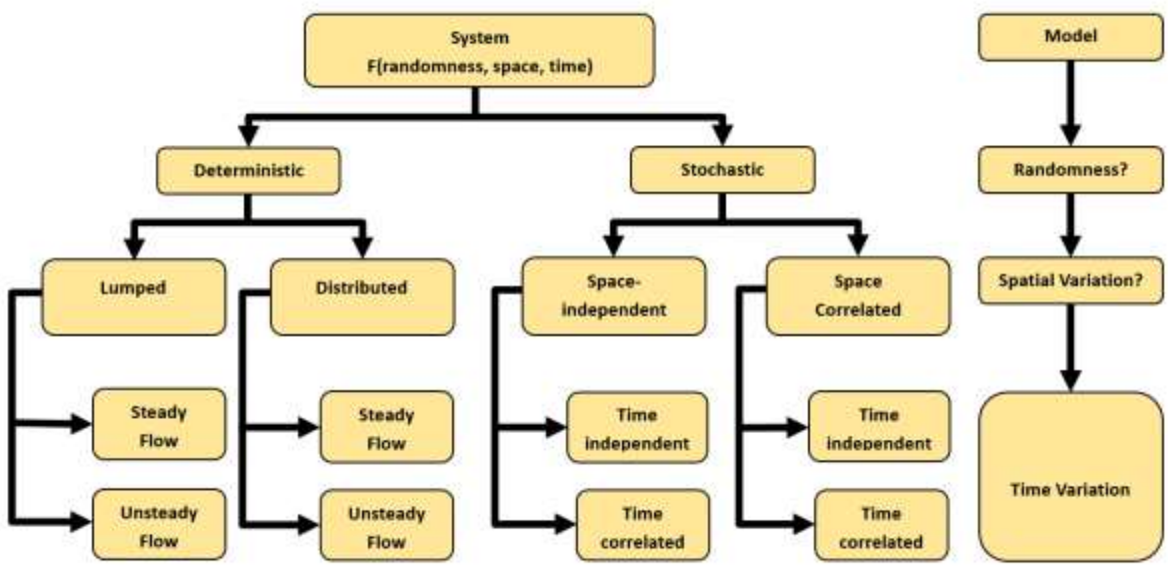
5 Continuous Hydrology Model Selection

This section of the FBWB report must describe the model set-up and the criteria that were used to select a continuous hydrology model as they relate to the objectives of the study. After model setup is complete, TRCA recommends that the applicant submit the model setup to TRCA to discuss before proceeding further to model calibration. This section should describe the procedure that was used to calibrate and validate the model using field monitoring data, including initial and final values of parameters, citing rationale and literature values, as appropriate. TRCA requires that the preliminary model calibration to existing conditions be documented and submitted for review and approval prior to proceeding to the application of the model in a predictive manner.

Continuous hydrology models are simplified representations of hydrological systems, and are the best tool available to practitioners for evaluating the current state of a system against many possible future states (e.g. different land use scenarios or different stormwater management techniques). Models can be broadly understood as a system of equations and logical statements that express relationships between variables and parameters (Clarke, 1973). Whereas parameters are generally assumed to be quantities that are constant in time and represent a fundamental property of the hydrological system (e.g. slope), variables may be measurable and generally assume different values at different times (e.g. storage in a pond) (Clarke, 1973).

Continuous hydrology models can be broadly classified into deterministic versus stochastic models (Chow *et al.* 1988; see Figure 11); deterministic simulation models do not have any random variables, and describe how a mass of water moves through a wetland catchment according to various physically-based hydrological processes. Stochastic models incorporate random variables described by probability distributions. All of the models referred to in this document are deterministic, including HEC-HMS, Hydrological Simulation Program – FORTRAN (HSPF), Precipitation-Runoff Modelling System (PRMS), EPA Storm Water Management Model (SWMM), PCSWMM, VH Otthymo Continuous, MIKE SHE and GSFLOW.

Figure 11: Classification of models, after Chow *et al.* (1988)



Another major distinction within the conceptual framework of Chow *et al.* (1988) is between lumped and distributed hydrological models. Lumped models ignore spatial variability of input variables and catchment parameters, instead subdividing the catchment(s) being represented into hydrologically homogenous units. By contrast, distributed models account for spatial variability of hydrological processes, input data, boundary conditions, and catchment characteristics, representing the catchment as a collection of cells of uniform size. Runoff volumes, determined from hydrological processes occurring within each cell, are routed to adjacent cells based on the direction of slope, down to the catchment outlet.

Hydrological models can be event-based or continuous in their simulation capacity. Event-based simulations represent the catchment hydrological response to an individual rainfall event in terms of runoff quantity, peak, timing, detention etc. In these simulations, which run on timescales of an hour to several days, infiltrating precipitation is omitted from the water balance calculation, "disappearing" into the soil with no further accounting for processes such as interflow or dynamic interaction with groundwater. This is due to the emphasis of these models on characterizing peak flow, to which the contribution of interflow and groundwater is generally believed to be negligible. Event simulation models similarly do not account for evapotranspiration or changes in soil moisture, for the same reason. Continuous models operate over extended periods of time (months to years) and determine fluxes of water via various processes including during periods with no precipitation or runoff. Continuous models also account for infiltrating water, generally routing it into soil moisture storage, groundwater flow, unsaturated flow, and evapotranspiration.

5.1 Why Continuous Simulation for Wetland Hydrology Modelling?

The water input to a wetland catchment reaches and then leaves the wetland on a variety of timescales, producing the seasonal patterns of fluctuations in hydroperiod that are the primary determinant of distinct wetland flora and fauna communities present at a site. Continuous simulation over a longer time period is needed to account for antecedent moisture conditions and the inter-event hydrology of the wetland catchment, and to explore how changes in land use and drainage may affect the hydroperiod of the wetland under the full range of natural conditions that could be expected at a given location. Continuous hydrology models offer a much more detailed representation of the wetland hydrological response under both natural (pre-development) and post-development scenarios, if the model is well conceptualized, calibrated, and validated. Simulation using these types of models therefore provides a more robust basis on which to make decisions about the potential impacts a proposal may have on a wetland and the potential measures to mitigate those impacts.

5.2 Criteria for Selection of Continuous Hydrology Models

Deciding on the right model to simulate wetland hydrology has always been a challenge due to the many factors that must be considered. Hydrological models vary widely in their capabilities, complexity, strengths and weaknesses, making selection of an appropriate model for a specific application difficult (Golmohammadi *et al.*, 2014). Many criteria for model selection will be project-dependent and user-dependent, and therefore somewhat subjective. For example, preferences concerning the graphical user interface (GUI), computer operation system, input-output management and structure, or add-on expansibility, are subject to individual modeler preference and experience.

The following are some of the project-dependent considerations that should be considered in selecting a continuous hydrology model. It might not be possible to be address all concerns in all four areas outlined below, and so selection criteria should be considered iteratively, recognizing that limitations in any of the four areas may restrict choices and thus require re-evaluation of the personnel involved, cost of the exercise, and so on.

A) Objectives of the overall modelling exercise

This consideration is at the very core of a successful modelling exercise. Key questions that need to be answered include:

- Is the broader context of the modelling clear?
- How are the results of the modelling going to be used?
- What specific outputs are needed?
- Where will the model be applied?
- What are the proposed actions that need to be represented in the model?
- Who will be interpreting the results and what decisions will they be making?

Answers to these questions will provide an outline of the basic capabilities required of the models under consideration. Defining the required model outputs defines what the model must be able to represent, and the appropriate scales of time and space for the model exercise. It is very important to consider the main hydrological processes operating in the wetland's pre-development condition, and that may be operating in the post-development condition, based on the best available information about the wetland and the proposed development at the start of the modelling exercise. Generally, the main hydrological processes that need to be considered for inclusion in a continuous wetland hydrology model include precipitation, interception, depression storage, infiltration, overland flow, lateral flow, base (subsurface) flow, stream flow, evapotranspiration, channel routing and reservoir routing.

Other key questions that may help to define model objectives and selection of an appropriate model include:

- Land use: can the model represent existing land use conditions?
- Intended use: is the intended use for planning purposes, engineering/design, or operational performance?
- Model complexity: is a less complex model sufficient?
- Modeler experience: what is the model-specific expertise of current staff? Is there budget to hire an expert?
- Green Infrastructure/LID: does the model has the capability of integrating green infrastructure/LID

When defining the modelling objectives, the modelers and decision-makers should also consider whether the model is required for regulatory compliance, and which models are accepted by the regulatory agency, by consulting with the conservation authority.

B) Availability of input data

The selection of an initial modelling platform based on the identified modelling objectives will define the general data needs. Data limitations are the single biggest constraint to model choice and confidence in results. Without reliable data, there is no reliable way to evaluate the relationship between the simulation results and the conditions in reality.

Some key questions regarding the availability of input data include:

- Are data at the right spatial and temporal resolution available?
- Is there a good understanding of the data accuracy?
- Are the input data collected at the right location, so as to be representative of conditions in the wetland?
- Can all the inputs required by the model be provided within the time and cost constraints of the project?

- How much work is needed to make the data usable in a model?
- If certain data are not available, can they easily be collected?

Failure to consider these questions will likely lead to model results in which there is little confidence.

C) Availability of modelling expertise

Different models require different levels and types of skill to apply and interpret. Important considerations with respect to appropriate expertise include: understanding of the physical processes and catchment behavior involved (e.g. surface water vs. groundwater processes); interpretive and technical understanding concerning models and algorithms; numerical and data manipulation skills; and communication skills (particularly if the modelling is part of a broader development design process). An honest assessment of the capabilities of the team early on will identify major gaps and may limit the type of model the modeler chooses. The overall confidence in a modelling exercise is in general highly dependent on the quality of the modelling team in addition to the model itself.

D) Availability of resources (time and money)

Modelling, data collection, and data manipulation are time consuming. Data are of little use without the expertise for interpretation, and expertise (both technical and non-technical) can be expensive. There will be constraints on total time and money available, possibly limiting the extent to which the original objectives can be met. There will invariably be a trade-off between resources and the extent to which all objectives can be met, and this trade-off needs to be discussed. The modelling team needs to be able to clearly articulate what is reasonable to expect given the available resources, and how an increase or decrease in resources would affect the scope and utility of the modelling exercise.

5.3 Review of Available Continuous Hydrology Models.

Surface hydrology models such as HEC-HMS, HSPF, PRMS, SWMM, Visual OttoHymo, and integrated hydrology models such as MIKE SHE and GSFLOW, have been successfully applied to simulating wetland hydrology and assessing the effect of land use changes on the wetland. A brief description of each of these continuous hydrology models is provided below. As mentioned previously, other continuous hydrology models not listed in this document or the associated case studies companion document may be acceptable, but proponents are asked to verify alternative modelling approaches with TRCA staff prior to any submissions.

HEC-HMS

The US Army Corps of Engineers (US-ACE) Hydrologic Engineering Center HEC-HMS (Hydrologic Modelling System) model is designed to simulate the complete hydrological processes of watershed systems. Hydrological analysis procedures such as event infiltration, unit hydrographs, and hydrological routing are included in HEC-HMS. The model also includes procedures necessary for continuous simulation including evapotranspiration, snowmelt, and soil moisture accounting. Advanced capabilities are also provided for gridded runoff simulation using the linear quasi-distributed runoff transform (ModClark). Supplemental analysis tools are provided for model optimization, forecasting streamflow, depth-area reduction, assessing model uncertainty, erosion and sediment transport, and water quality. HEC-HMS is comprised of a graphical user interface, integrated hydrological analysis components, data storage and management capabilities, and graphics and reporting facilities. Infiltration losses can be simulated for event modelling by initial and constant, SCS curve, gridded SCS curve number, and Green & Ampt methods. The five-layer soil moisture accounting model can be used for continuous modelling of complex infiltration and evapotranspiration environments. Excess precipitation can be transformed into surface runoff by unit hydrograph methods, Clark, ModClark, Snyder, and SCS technique. A variety of hydrological routing methods are included for simulating flow in open channels (lag method, Muskingum method, modified Puls method, kinematic wave or Muskingum-Cunge method). Most parameters for methods included in subbasin and reach elements can be estimated automatically using the optimization manager. Wetland in HEC-HMS can be represented in reservoir routing. HEC-HMS does not simulate groundwater movement explicitly. However, the groundwater recharge and discharge can be calculated externally and the calculated value can be included in the model as point sources.

HSPF

The US Environmental Protection Agency (US-EPA) HSPF (Hydrologic Simulation Program-Fortran) program has its origin in the Stanford Watershed Model developed by Crawford and Linsley (1966). Hydrocomp, Inc. developed its present form. HSPF is a comprehensive, conceptual, continuous watershed simulation model designed to simulate all water quantity and quality processes that occur in a watershed, including sediment transport and movement of contaminants (Bicknell et al., 1997). It can reproduce spatial variability by dividing the basin in hydrologically homogeneous land segments and simulating runoff for each land segment independently. A segment of land can be modeled as pervious or impervious. In pervious land segments HSPF models the movement of water along three paths: overland flow, interflow and groundwater flow. Snow accumulation and melt, evaporation, precipitation and other fluxes are also represented. Routing is done using a modified version of the kinematic wave equation. HSPF includes an internal database management system for input and output.

PRMS

The US Geological Survey (USGS) PRMS (Precipitation-Runoff Modelling System) model is a modular-design, deterministic modelling system developed to evaluate the impacts of various combinations of precipitation, climate, and land use on streamflow, sediment yields, and general basin hydrology (Leavesley et al., 1983). In PRMS a watershed can be divided into subunits based on basin characteristics (slope, aspect, elevation, vegetation type, soil type, land use, and precipitation distribution). Two levels of partitioning are available (USGS, 2000). The first divides the basin into homogeneous response units (HRU) based on the basin characteristics. The sum of the responses of all HRU's, weighted on a unit-area basis, produces the daily system response and streamflow for a basin. A second level of partitioning is available for storm hydrograph simulation. The watershed is conceptualized as a series of interconnected flow planes and channel segments. Surface runoff is routed over the flow planes into the channel segments; channel flow is routed through the watershed channel system. Output options include observed (if available) and predicted mean daily discharge, annual and monthly summaries of precipitation, interception, potential and actual evapotranspiration, and inflows and outflows of the ground water and subsurface reservoirs. Parameter-optimization and sensitivity analysis capabilities are provided to fit selected model parameters and evaluate their individual and joint effects on model output.

SWMM

The US-EPA Storm Water Management Model (SWMM) is a comprehensive dynamic hydrological simulation model for analysis of quantity and quality problems associated with urban runoff (CHI, 2003). Both single-event and continuous simulation can be performed on urban basins. Modeller can simulate all aspects of the urban hydrological and quality cycles, including rainfall, snowmelt, surface and subsurface runoff, flow routing through drainage network, storage and treatment. Flow routing can be performed in the Runoff, Transport and Extran blocks, in increasing order of sophistication. Extran block solves complete dynamic flow routing equations for accurate simulation of backwater, looped connections, surcharging, and pressure flow. The hydrological simulation in the Runoff block uses the Horton or Green & Ampt equations where the data requirements include area, imperviousness, slope, roughness, width (a shape factor), depression storage, and infiltration values for either the Horton or Green & Ampt equations for up to 100 subbasins. The program is driven by precipitation for up to ten gages (distributed spatially), and evaporation. Basic SWMM output consists of hydrographs and pollutographs at any desired location in the drainage system. The model performs best in urbanized areas with impervious drainage. The model lacks GUI, but various vendors have developed user-friendly GUIs (OSU-CE, 2003): (PCSWMM – a menu-driven interface developed by Computational Hydraulics International, XP-SWMM or Visual SWMM by XP Software, the Danish Hydraulic Institute GUI for the Runoff and Extran Blocks, MIKE-SWMM).

Visual OttoHymo

Visual OTTHYMO (VO) is a hydrological modelling software which primarily uses the HYMO model engine developed by J.R. Williams in 1973. This engine was further developed at the University of Ottawa, where it was named OTTHYMO 83. The first graphical interface was developed by the founder of Civica in 1998 (Visual OTTHYMO 1.0). VO is currently being developed by Civica Infrastructure, and additional features and commands continue to be added. The continuous version of VO (5.0) was released in 2017 with the ability to simulate snow melt, infiltration, evapotranspiration and groundwater infiltration. Continuous VO uses the same commands as the single event simulation (with some additional parameters required for continuous modelling). The wetland command is a new feature added to VO 5.0 in 2018. This command is designed to model all the hydrological processes in a wetland including inflow, evaporation, seepage and outflow. The interface for the wetland command is similar to that used in continuous VO, however a groundwater component has been added to the wetland. Groundwater seepage into and out of the wetland are calculated using Darcy's equation and the difference in elevation between the ground water and either the stored water or, if the wetland is dry, the bottom of the wetland.

MIKE SHE

MIKE SHE is a commercial engineering software package developed at the Danish Hydraulic Institute (DHI). MIKESHE, integrated, physically based, fully distributed, modular, dynamic modelling system, the DHI version of the original SHI (Systeme Hydrologique Europeen) program developed through a joint project of CEH Wallingford, Danish Hydraulics Institute and SOGREAH (France). The model is applicable on spatial scales ranging from single soil profiles (for infiltration studies) to regional watershed studies. MIKESHE includes all of the processes in the land phase of the hydrological cycle: precipitation (rain or snow), evapotranspiration, interception, overland sheet flow, channel flow, unsaturated sub-surface flow and saturated groundwater flow. Evapotranspiration is calculated using the Kristensen and Jensen method. MIKESHE's overland-flow component includes a 2D finite difference diffusive wave approach using the same 2D mesh as the groundwater component. MIKESHE includes a traditional 2D or 3D finite-difference groundwater model. There are three options in MIKESHE for calculating vertical flow in the unsaturated zone: the full Richards equation, a simplified gravity flow procedure, and a simple two-layer water balance method for shallow water tables (DHI, 2000b).

GSFLOW

GSFLOW is the USGS modelling system that integrates the surface and groundwater components of the hydrological cycle. GSFLOW is based on two USGS models namely PRMS and MODFLOW. With GSFLOW, the user has the option to run the codes together in a fully fashion or to run each of the models independently. Within GSFLOW, both codes are fully coupled and capable of providing the feedbacks from surface water to groundwater resources vice versa. It is essential to include such feedbacks within GSFLOW for they affect the timing and rates of evapotranspiration, surface runoff, soil-zone flow, and groundwater interactions (Markstrom et al., 2008). GSFLOW is capable modelling system with potential applications to a variety of research questions, such as (i) how surface water processes affect recharge and water table responses, (ii) how climate change is likely to impact groundwater and surface water, and (iii) surface and groundwater effects on the behavior of springs, wetlands, and ecological systems (Markstrom et al., 2008).

Model Features	SWMM	HEC-HMS	HSPF	VH Ottohymo	PRMS
Model Type	Lumped-parameter	Lumped-parameter	Lumped-parameter	Lumped-parameter	Lumped-parameter
Simulation Type	Single-event/continuous	Single-event	Continuous	Single-event/continuous	Continuous
Watershed subdivision unit	Subbasins	Subbasins	subbasins	NasHyds/StandHyds	Hydrologic Response Units
Precipitation	Single/multiple hyetographs	single hyetograph	multiple hyetographs	Multiple hyetographs	Multiple hyetographs
Snow Melt	Snow accumulation Snow redistribution by areal depletion and removal operations Snow melt via heat budget accounting	Yes	Yes	Yes	Yes
Evapotranspiration	Yes (Modified Hargreaves using temperature, or timeseries input)	No	Yes	Yes	Yes
Infiltration	Green-Ampt Infiltration Curve Number infiltration Horton Infiltration	SCS curve number Initial and uniform loss Exponential loss rate Holtan loss rate Green-Ampt loss rate	Empirical equation based on soil type and available storage	SCS curve number	Green-Ampt during storm mode
Rainfall Excess to Runoff	Physically based, nonlinear reservoir model Kinematic Wave	SCS unit hydrograph Clark unit hydrograph Snyder unit hydrograph Kinematic wave	Manning's equation based on the depth of surface detention of excess precipitation	Nash unit hydrograph Standard unit hydrograph	Kinematic wave

Model Features	SWMM	HEC-HMS	HSPF	VH Ottohymo	PRMS
Reservoir storage and routing	Excess volume Under Steady and Kinematic Wave flow routing. In Dynamic Wave routing, the excess volume is assumed to pond over the node with a constant surface area.	Modified-Puls routing Level pool routing	Outflow can be volume or time dependent or user-specified	Modified-Puls routing	Modified-Puls routing Linear-storage routing
Subsurface Soil Water Flow	Computing the water fluxes during given time step using infiltration, evapotranspiration, percolation, seepage, lateral groundwater interflow	Baseflow quantity can be specified	Yes	No	Yes
Channel Routing	Steady flow routing Kinematic wave routing Dynamic wave routing	Muskingum Weighted Inflow Kinematic Wave Muskingum-Cunge Modified Puls Normal Depth Working R and D	Kinematic wave	Variable Storage Coefficient Muskingum-Cunge	Kinematic wave
Reservoir Routing	Steady flow routing Kinematic wave routing Dynamic wave routing	Storage-outflow, Elevation-storage-outflow, elevation area-outflow	Surface area-volume and wind speed	Modified-Puls routing	Puls Linear routing
GIS interface	Interface with GRASS	WMS, Geo-STORM, GISIWAM	no specific interface	Interface with ArcGIS	In development as a component of MMS

Table 2: Comparison of surface hydrological model capabilities

Model Features	MIKE SHE	GSFLOW
Model Type	Lumped-parameter	Lumped-parameter
Simulation Type	Single-event	Continuous
Watershed subdivision unit	Sub-basins	Hydrologic Response Units
Precipitation	Single hyetograph	Multiple hyetographs
Snow Melt	Yes	Yes
Evapotranspiration	Kristensen & Jensen method	Yes
Infiltration	SCS curve number; Initial and uniform loss; Exponential loss rate; Holtan loss rate; Green-Ampt loss rate	Green-Ampt (during storm mode)
Rainfall Excess to Runoff	SCS unit hydrograph Clark unit hydrograph Snyder unit hydrograph Kinematic wave	Kinematic wave
Reservoir storage and routing	Modified-Puls routing Level pool routing	Modified-Puls routing Linear-storage routing
Subsurface Soil Water Flow	Baseflow quantity can be specified	Yes
Channel Routing	Muskingum Weighted Inflow Kinematic Wave Muskingum-Cunge Modified Puls Normal Depth Working R and D	Kinematic wave
GIS interface	WMS, Geo-STORM, GISIWAM	In development as a component of MMS

Table 3: Comparison of integrated hydrological model capabilities

5.4 Model Setup

After going through the steps listed above for scoping the project and selecting an appropriate continuous hydrology model based on the study parameters, model setup can begin. Model setup describes the process of preparing the input data in the correct format, creating the model input files, and undertaking initial simulations. Setup is greatly dependent upon the availability of good quality data and field observations to characterize the study area. Hydrological data must be cleaned from random and systematic errors, otherwise a model may be erroneously rejected, or its calibration otherwise compromised so as to reduce the utility of the model.

In the model setup, there are some differences in the steps required to parameterize hydrological processes in different models. The preparation of inputs for some lumped catchment models is not complex, however data preparation for distributed, physically-based models is typically more complex. That being said, many parameters can be estimated for catchment properties, and therefore during model setup and parameterization, respective model manuals should be consulted and referenced.

Typically, the following input data will be needed for modelling the relevant hydrological processes in most continuous hydrology models:

- High resolution Digital Elevation Model (DEM)
- Land use / land cover
- Soil type and other basin physiographic data (e.g. depression storage coefficients)
- Precipitation and temperature data
- Channel and reservoir hydraulic data
- Stage-storage and stage-discharge data
- Actual or potential evapotranspiration data, or sufficient input data for one of the empirical estimation equations.

The FBWB report must discuss the rationale for model setup, and include a description of the input data preparation and model input files. The report must describe sources of data that are used in the estimation of the parameters for the model and the assumptions that are used in the process. To the greatest extent possible, model parameters should be derived from site-specific observations. The topographic features onsite should be represented at the finest resolution possible and can be derived from digital elevation models or site surveys. Infiltration and recharge parameters, soil zone parameters, and hydraulic conductivities should ideally be obtained from onsite soils analysis or borehole drilling. Land cover mapping should be revised for consistency with the existing site conditions, if required.

As the FBWB methodology outlined in this report requires continuous hydrology modelling, long-term climate data inputs should be prepared for the model simulations. TRCA's *SWM Document* (2012) suggests using climate data from as close as possible to the target site to determine the target (i.e. pre-development baseline) long-term hydroperiod and assessing and mitigating the impact of development. At a minimum, the period from 1991 to 2008, considered to be representative, should be used. This is considered to be a representative period containing wet, average, and dry years. TRCA staff can provide a forcing dataset for the representative period upon request. Model output should be set to daily resolution, which will be used to create weekly, monthly, and annual summaries.

After model setup is complete, TRCA recommends that the applicant submit the model setup to TRCA and discuss with TRCA before proceeding further to model calibration.

5.5 Model Calibration

Watershed models contain many parameters; these parameters are classified into two groups: physical and process parameters*.* A physical parameter represents physically measurable properties of the catchment (e.g. areas of the catchment, fraction of impervious area and surface area of water bodies, surface slope etc.). Process parameters represents properties of the catchment which are not directly measurable e.g. average or effective depth of surface soil moisture storage, the effective lateral inflow rate, the coefficient of non-linearity controlling the rate of percolation to the groundwater. (Sorooshian, and Gupta 1995). Hence in order to utilize any predictive catchment model for estimating the effectiveness of future potential management practices one needs to select values for the model parameters so that the model closely simulates the behavior of the study site. The process by which the parameters are selected is called model calibration. There are two parts to this process: parameter specification and parameter estimation.

Assigning of initial estimates parameters of the model using prior knowledge about the catchment properties and behaviors is called parameter specification. For “physical” parameters, estimates are made using measurements obtained from maps in the field. The parameters are then typically fixed at these measured values and not adjusted further unless determined to be in error. For “process parameters”, estimates of the range (minimum and maximum values) of possible values for these parameters are determined based on judgment and understanding of the hydrology of the catchment. The process of parameter estimation described below then reduces this uncertainty in the parameter estimates.

Parameter estimation is various techniques designed to reduce the uncertainty in the estimates of the process parameters. A typical approach is to first select an initial estimate for the parameters, somewhere inside the ranges previously specified. The parameter values are then adjusted to more closely match the model behavior to that of the catchment. The process of adjustment can be done “manually” or using computer-based “automatic” methods.

As it is mentioned above, the objective of a calibration procedure is the estimation of values for those parameters, which cannot be assessed directly from field data. According to Refsgaard and Storm (1996), three types of calibration procedures can be differentiated:

1. Trial-and-error, manual parameter adjustment;

2. Automatic, numerical parameter optimization;

3. A combination of (1) and (2).

Refsgaard and Storm (1996) argued that the first method is the most common, and especially recommended for the application of more complicated models in which a good graphical representation is a prerequisite. Alternatively, an automatic calibration involves the use of a numerical algorithm, which finds the optimum of a given numerical objective function. This is carried out by applying the model to numerous combinations and permutations of parameter levels, in order to find the best parameter set in terms of satisfying the criterion of accuracy. The combination means that the manual method is placed at the beginning of the procedure in order to delineate rough orders of magnitude, which is followed by the automatic calibration for fine adjustment. The reverse procedure is also possible, whereby the automatic method is used as a kind of sensitivity analysis to find the most important parameters, which are afterwards manually calibrated.

Gan (1988) has recommended that a combination of manual and automatic procedure be adopted for the model calibration. Manual calibration alone is very tedious, time consuming, and requires the experience of the modeler. Because of the time-consuming nature of the manual model calibration, there have been a number of researches towards development of automated calibration methods. Automatic calibration on the other hand relies heavily on the optimization algorithm and the specified objective function.

Model outputs should be calibrated to fall within a percentage of average measured values and then model performance statistics (r^2 and E_{NS}) were evaluated. If measured and simulated means met the calibration criteria and daily, weekly and monthly r^2 and E_{NS} did not, and then additional checking was performed to ensure that rainfall variability and evapotranspiration seasonal variability were properly simulated over time. If all parameters were pushed to the limit of their ranges for a model output (i.e., flow or water level) and the calibration criteria were still not met, then calibration should be stopped for that output and the modeler should do further investigation on the input parameters.

5.6 Validation

In order to utilize any predictive catchment model for estimating the effectiveness of future potential management practices the model must be first calibrated to measured data and should then be tested (without further parameter adjustment) against an independent set of measured data. This testing of a model on an independent data set is commonly referred to as model validation. Model calibration determines the best, or at least a reasonable, parameter set while validation ensures that the calibrated parameters set performs reasonably well under an independent data set. Provided the model predictive capability is demonstrated as being reasonable in both the calibration and validation phase, the model can be used with some confidence for future predictions under somewhat different management scenarios.

5.7 Model Performance Assessment

In order to assess the ability of the calibrated model in mimicking the hydrological processes within the wetland catchment, model performance assessment measures must be applied. Model performance assessment can usually be done by comparing both simulated and observed hydrographs graphically and using statistical measures.

5.7.1 Graphical Comparison of Observed and Calibrated Hydrographs

Graphical display of calibrated and observed flows is very important because the traditional method of evaluating model performance by statistical measures has limitations. Statistical indices are not effective in communicating qualitative information such as trends, types of errors and distribution patterns. In fact, one should not depend on only single statistical measures of model performance. These are sometimes misleading because of the high possibility of compensation of errors from season to season or over years in long-term calibration. In both calibration and validation processes both observed and simulated hydrographs must be compared graphically. Figure 12 and Figure 13 below demonstrate graphical comparisons.

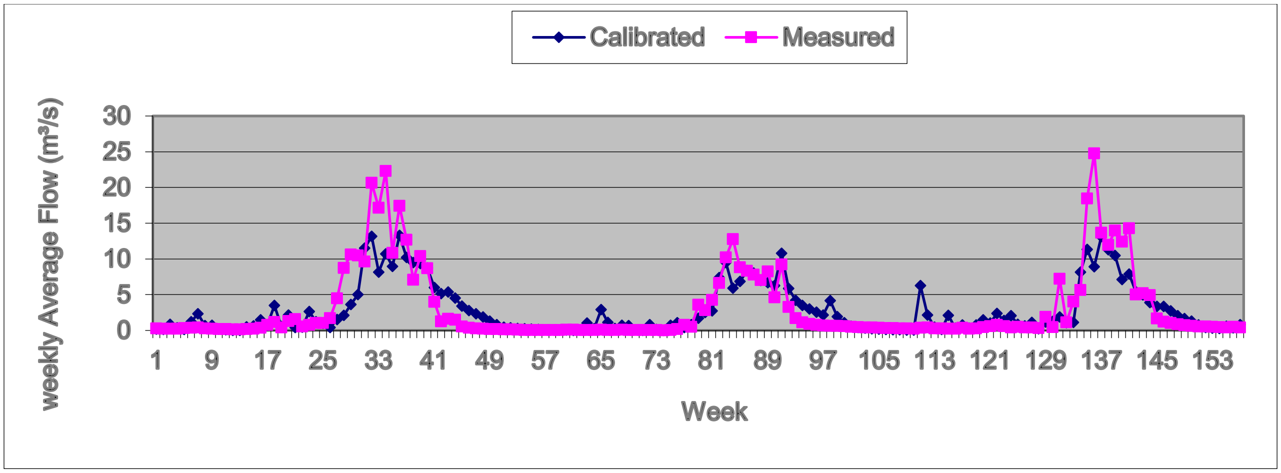


Figure 12: Observed vs. calibrated weekly flow

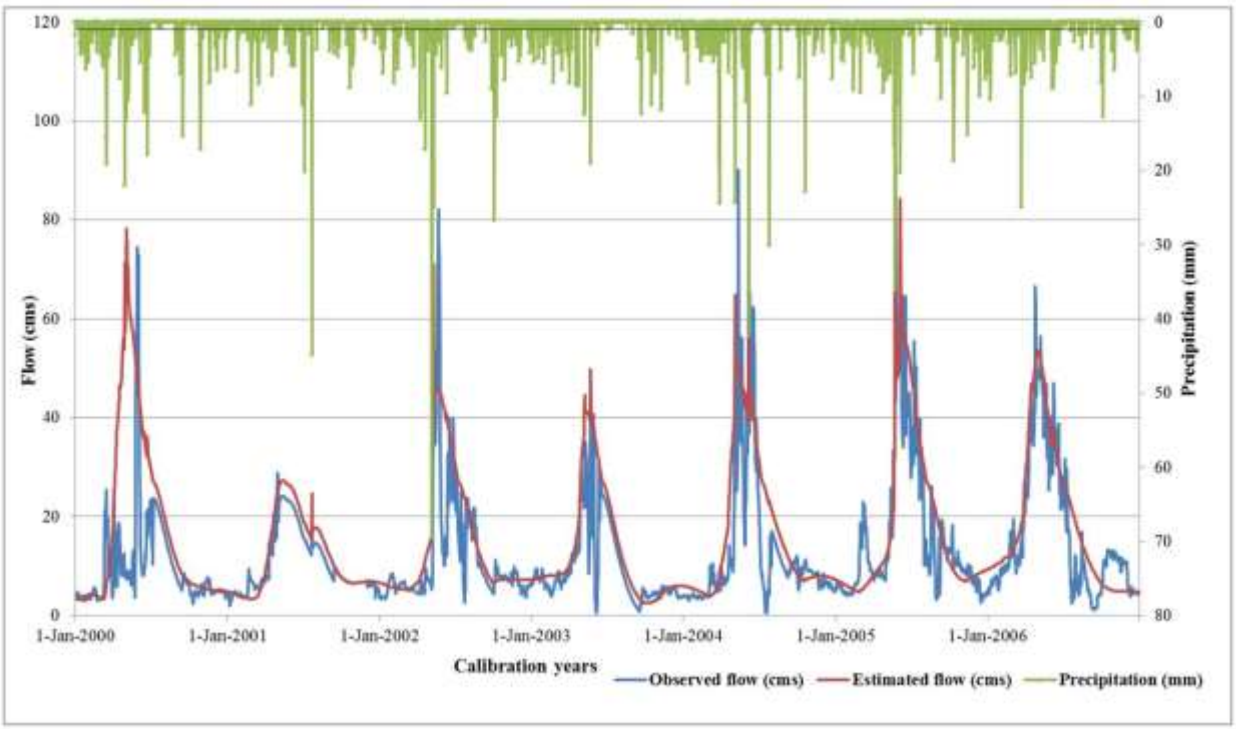


Figure 13: Observed vs calibrated daily flow and rainfall

5.7.2 Statistical Measures

Three methods for goodness-of-fit measures of model predictions can be utilized during the calibration and validation periods, these three numerical model performance measures are the percent difference (D), coefficient of determination (r^2 coefficient) and the Nash-Suttcliffe simulation efficiency (E_{NS}) (Nash and Sutcliffe 1970).

Percent Difference (D)

The percent difference measures the average tendency of the modeled values to be higher or smaller than the measured values for a given quantity over a specified period (usually the entire calibration or validation period in the study). (Gupta et al., 1999). The percent difference for a quantity (D) over a specified period with total days is calculated from measured and simulated values of the quantity in each model time step as:

$$D = 100 \cdot \left[\frac{\left(\sum_{i=1}^{n} q_{si} - \sum_{i=1}^{n} q_{oi} \right)}{\sum_{i=1}^{n} q_{oi}} \right] \qquad \text{Equation 3}$$

Where:

- q_{si} *is the simulated values of the quantity in each model time step*
- q_{oi} *is the measured values of the quantity in each model time step*

A value close to 0% is optimal value of D which means the model is simulating accurately. Positive values of D show that the model underestimates whereas negative values show that the model overestimates. . (Legates and McCabe, 1999)

Coefficient of Determination (r^2 coefficient)

The r^2 coefficient is a measure of how well trends in the measured data are reproduced by the simulated results over a specified time period and for a specified time step. The range of values for r^2 is 1.0 (best) to 0.0. The r^2 coefficient measures the fraction of the variation in the measured data that is replicated in the simulated model results. A value of 0.0 for r^2 means that none of the variance in the measured data is replicated by the model predictions. On the other hand, a value of 1.0 indicates that all of the variance in the measured data is replicated by the model predictions.

The r^2 coefficient for n time steps is calculated as:

$$r^2 = \frac{\left[\sum_{i=1}^{n} (q_{si} - \bar{q}_s)(q_{oi} - \bar{q}_o) \right]^2}{\sum_{i=1}^{n} (q_{si} - \bar{q}_s)^2 \sum_{i=1}^{n} (q_{oi} - \bar{q}_o)^2} \qquad \text{Equation 4}$$

Where:

- q_{si} *is the simulated values of the quantity in each model time step*
- q_{oi} *is the measured values of the quantity in each model time step*
- $\bar{q}_s$ *is the average simulated value of the quantity in each model time step*
- $\bar{q}_o$ *is the average measured value of the quantity in each model time step*

Nash-Sutcliffe Simulation Efficiency (E_{NS})

The E_{NS} simulation efficiency is a normalized statistic that demonstrates the relative magnitude of the residual variance compared to the variance of the measured data (Nash and Sutcliffe 1970).

The E_{NS} simulation efficiency for n time steps is calculated as:

$$E_{NS} = 1 - \frac{\sum_{i=1}^{n}(q_{oi} - q_{si})^2}{\sum_{i=1}^{n}(q_{oi} - \bar{q}_o)^2} \qquad \text{Equation 5}$$

Where:

- *q_{si} is the simulated values of the quantity in each model time step (in this case, daily, weekly and monthly)*
- q_{oi} is the measured values of the quantity in each model time step (in this case, daily, weekly and monthly)

The statistical index of modelling efficiency (E_{NS}) values range from 1.0(best) to negative infinity. E_{NS} measures how well the simulated results predict the measured data relative to simply predicting the quantity of interest by using the average of the measured data over the period of comparison. E_{NS} is a more stringent test of performance than r^2 and is never larger than r^2. A value of 0.0 for E_{NS} means that the model predictions are just as accurate as using the measured data average to predict the measured data. E_{NS} values range negative infinite and positive 1. When the E_{NS} values are less than 0.0 indicate the measured data average is a better predictor of the measured data than the model predictions while a value greater than 0.0 indicates the model is a better predictor of the measured data than the measured data average. E_{NS} values equalis to 1 is the optimal value. Servat and Dezetter (1991), the ASCE (1993), and by Legates and McCabe (1999) recommended this model performance evaluation technique. The E_{NS} simulation efficiency shows how well a graph of observed versus simulated values fits a 1:1 line

Figure 14 shows an example scatter diagram that demonstrates r^2 coefficient and E_{NS} simulation efficiency measures.

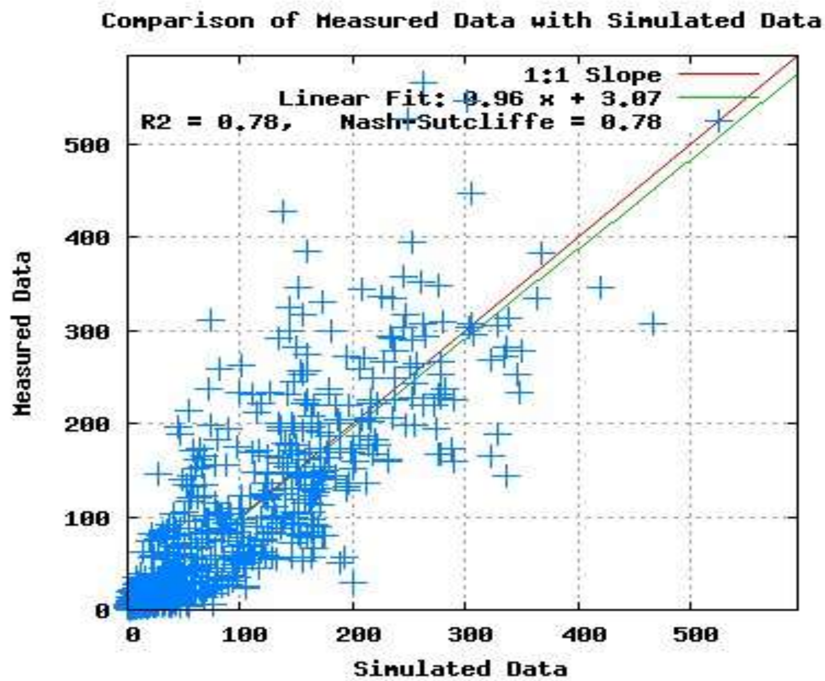


Figure 14: Scatter diagram of simulated vs. measured flow

The established continuous hydrologic model needs to be calibrated with measured data. The parameters in the hydrology model should be adjusted until the model performance statistics fall within D<15%, r^2 >0.75 and ENS >0.65 for daily values. The time step in the continuous hydrologic analysis needs to be daily values and the daily values can be used to generate weekly results.

TRCA requires that the preliminary model calibration to existing conditions be documented and submitted for review and approval prior to proceeding to the application of the model in a predictive manner.

6 Establishing Target Hydroperiod Using Existing Condition

This section of the FBWB report must establish the target hydroperiod by running the calibrated pre-development model using a long-term dataset as described in this section of the guidance document. The calibrated model should be approved by TRCA staff to ensure satisfactory performance prior to being applied in a predictive manner. Results should be presented for each year both graphically and in tabular format as outlined in Section 8.

The *Stormwater Management Criteria Document* (TRCA, 2012) states that the overall objective of FBWB analysis is to “manage the water balance with the intent to maintain the quantity (i.e. volume, timing, and spatial distribution) of surface water and groundwater contributions that ensures the pre-development hydroperiod (seasonal pattern of water level fluctuation) of the wetland is protected" (p.27). The proposed development must not cause significant changes to the hydroperiod that negatively impact the ecological and hydrological functions of the feature, as discussed in Section 8.

To produce the target hydroperiod, the calibrated model (reviewed and approved by TRCA staff) should be run under pre-development baseline conditions using a forcing dataset consisting of precipitation and temperature covering a period of 1991 to 2008. This is considered to be a representative period containing wet, average, and dry years. TRCA staff can provide a forcing dataset for the representative period upon request. Model output should be set to daily resolution, which will be used to create weekly, monthly, and annual summaries.

Following the pre-development model run, the average storage depth for each Julian day (e.g. February 19 = Day 50) during the modelled pre-development period should be calculated and used to create upper and lower boundaries for the 95 percent confidence interval boundaries.

7 Post-development Unmitigated Hydroperiod

This section of the FBWB report must provide the results from running the model using the same forcing data under post-development conditions without stormwater management mitigation practices. The representation of the developed areas of the wetland catchment in the model should be discussed and changes to the parameters of hydrologic response units outlined. The model output should be presented for each year both graphically and in tabular format as outlined in Section 8.

After establishing the target hydroperiod, the calibrated continuous hydrological model needs to be reconfigured to reflect the post-development land use and land cover condition. The configuration and parameterization of sub-catchments should be based on the best available knowledge about the development form and servicing requirements at the time of the analysis. The parameters assigned to the post-development sub-catchments and any changes to the configuration of the model should be reported in this section.

A graphical representation of the pre- to post-development comparison is shown below in Figures 15 and 16. In Figure 15, the proposed development has greatly increased the runoff volume going to the wetland while infiltration is simultaneously reduced, resulting in a significant increase in the wetland storage volume. Figure 16 shows an alternative example where the proposed development diverts most of the runoff volume away from the wetland while also reducing infiltration, resulting in a significant decrease in wetland storage volume.

To produce the post-development unmitigated hydroperiod, the calibrated pre-development model approved by TRCA staff should be run in post-development mode using the same 1991 to 2008 forcing dataset. Model output should be set to daily resolution, which will be used to create weekly, monthly, and annual summaries.

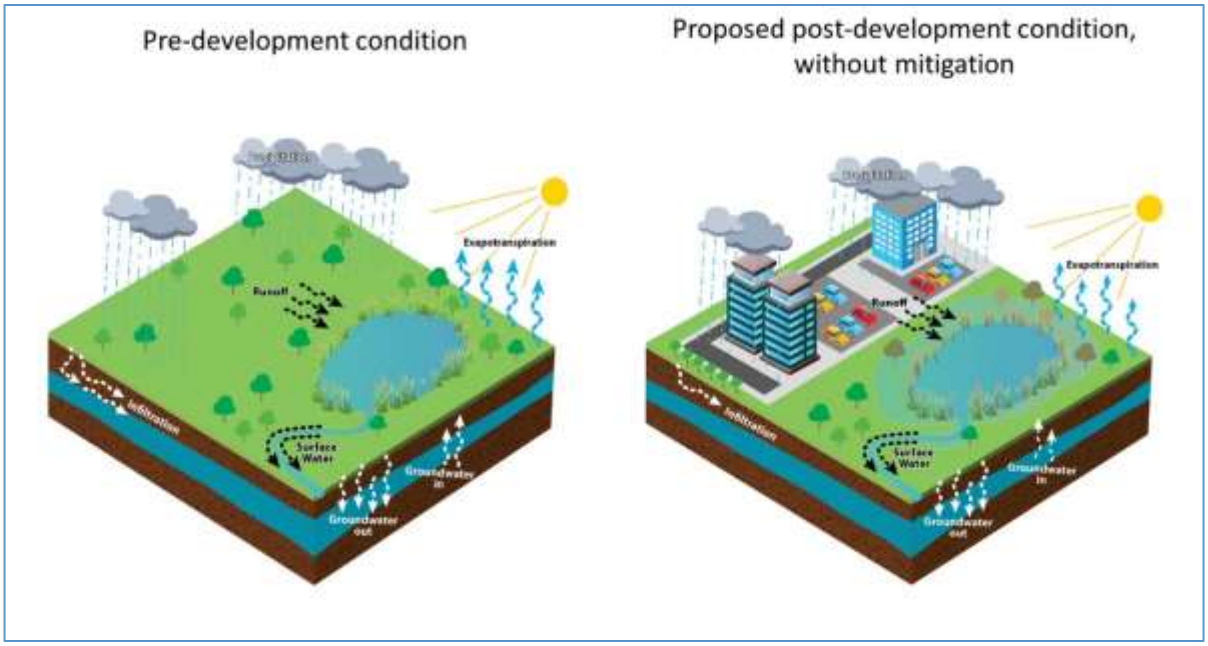


Figure 15: Development increased runoff volume to the wetland and reduced infiltration

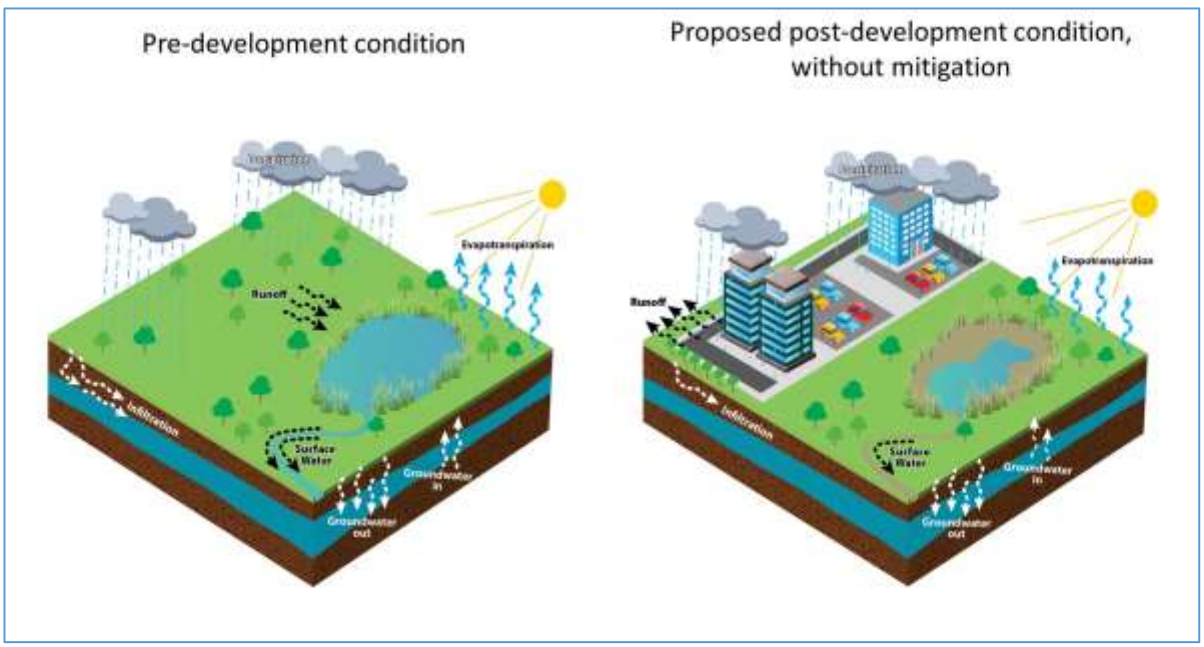


Figure 16: Development decreased runoff volume to the wetland and reduced infiltration

8 Comparison of the Pre-development Target Hydroperiod with the Unmitigated Post-development Hydroperiod

This section of the FBWB report should compare the simulated target hydroperiod with the post-development unmitigated hydroperiod, both graphically and in tabular format, for each model simulation year. A discussion of the potential ecological significance of differences detected between the target and post-development hydroperiod should also be included.

For each simulation year, create a hydrograph showing the modelled pre-development and post-development unmitigated wetland storage levels. The average storage depth for each Julian day (e.g. February 19 = Day 50) during the modelled pre-development period should be calculated and used to create upper- and lower-95 percent confidence interval boundaries, to be plotted on each hydrograph alongside modelled wetland storage. The confidence intervals will be the same for each year. An example of this for one year of data is shown below in Figure 17**.**

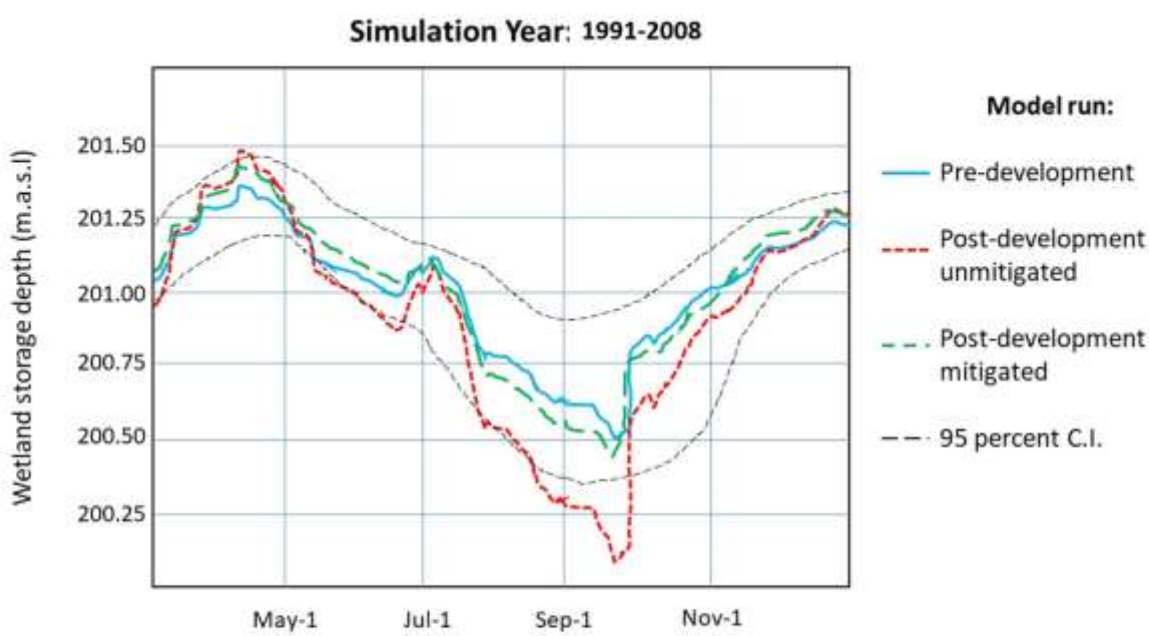


Figure 17: Hypothetical hydrograph for one simulation year comparing pre- and post-development

For tabular presentation of results, the storage depth and the inflow and outflow volumes to and from the wetland storage unit should be reported for each year. Inflow and outflow volumes should be further subdivided into their major constituents (e.g. output broken down into overland flow, ET, and infiltration). Each of these values should be summed over weekly, monthly, and annual intervals within the table, with differences between the pre- and post-development scenario calculated at each time interval as percentage of pre-development volume.

The report should include an assessment of the potential impact of changes on the wetland flora and fauna communities. An ecologist will provide an analysis of the model outputs to determine whether the risk to the wetland's ecological and hydrological functions can be considered acceptable. This assessment should be placed in the context of the model performance and uncertainty under different conditions and times of year.

TRCA staff recognizes that in most cases it will not be possible to achieve a post-development hydroperiod that matches exactly the pre-development hydroperiod. Instead the proponent should focus on minimizing the difference in hydroperiod timing and magnitude in order to minimize negative impacts to the wetland. TRCA is conducting research to support more robust decision making around levels of ecological risk, based on the natural range of observed variation within and among different wetland communities. However, it will continue to be necessary to consult with planning ecologists and other technical review staff to determine the scope of required mitigation.

9 Prepare Mitigation Measures

This section of the FBWB report should outline the design of mitigation measures, where required, and evaluate their performance by running the model using the same forcing data under mitigated post-development conditions. Performance evaluation should be measured against the target hydroperiod using the same graphical and tabular comparison as was used for the previous section. The event-based performance of any proposed stormwater management infrastructure involved in a mitigation solution also needs to be demonstrated.

The modeler should work collaboratively with an ecologist to understand the sensitivity of the wetland and to develop appropriate mitigation measures, where required, to ensure maintenance of the pre-development wetland hydroperiod. Once proposed measures have been identified, the modeler should modify the parameters and structure of the post-development unmitigated model to reflect the proposed changes to the development design, and re-run the model using the same long-term forcing dataset. Note that use of "mitigation measures" does not refer exclusively to stormwater management infrastructure, but rather could include solutions such as increased natural buffer widths or incorporation of more permeable surfaces like parklands within the development area of the wetland catchment.

A detailed description of proposed mitigation measures such as clean roof drainage collector systems directed to bioswales, infiltration galleries, third pipe systems, etc. should be included in the FBWB report. The locations and extents of the proposed mitigation measures and any stormwater management facilities should be clearly indicated in relation to the wetland on a map, including a description of how water will be conveyed to the wetland. Note that clean runoff from greenspace and roof areas is preferred to feed wetlands as necessary, as runoff from roads or paved surfaces as sources of supplemental water should only be considered as a last resort owing to the accumulation of sediment, salt, and hydrocarbons in stormwater runoff from roads and walkways.

Uncertainty in prediction is an issue in hydrological modelling due to uncertainty in input data, errors in measured data used for calibration, model structure uncertainty, and numerical error such as truncation error or roundoff error. There are different methods to estimate uncertainty in hydrological modelling analysis. Assessment of uncertainties of the prediction of the wetland hydrology model can be onerous exercise. However, uncertainty of impact prediction in the design of mitigation measures can be accounted for by expanding proposed mitigation measure by a given factor. In TRCA jurisdiction, it is recommended that a Factor of Safety by implemented for wetland mitigation measures by increasing the catchment area for the measures by 30%.

For development scenarios in which it is necessary to supply additional water to the wetland to maintain the water balance, the mitigation measures should be designed to collect runoff from an area that is 30 percent larger than the calculated area required wherever possible. For example, if a roof drain collector system is being used to supply additional runoff volume to the wetland, and calculations suggest that a total of 1 ha of roof runoff is necessary to replace the volume of water lost, the system should be designed to collect runoff from 1.3 ha of roof area. Additionally, adjustable orifices should be incorporated into the conveyance system, such that the orifice can be reduced or enlarged if monitoring and adaptive management identifies a surplus or a deficit of runoff reaching the wetland, and any excess runoff volume is conveyed via an overflow to the main storm sewer system. The requirement of 30 percent additional contributing area is meant to address the fact that it is much more difficult to add extra contributing roof area to a drain collector system than it is to re-route already connected contributing roof area to a different outlet (e.g. a stormwater management pond). The 30 percent additional contributing area recognizes the inherent uncertainty of modelling input data, output data, and mitigation system performance. The use of an adjustable orifice and overflow system allows for a mitigation system that is both adaptive and that functions in a completely passive manner, once it has been demonstrated to successfully maintain the wetland water balance.

The timing of release of runoff into the wetland resulting from the proposed mitigation design should be evaluated to ensure that there are no concerns around peak flow and localized erosion impacts. To confirm the timing of runoff entering the wetland, provide five (5) hydrograph of distinct storm events of precipitation volumes 15 mm or greater, showing existing and proposed timing of the hydrologic input. A table for each hydrograph should be provided demonstrating the time to the peak inflow rate, the peak inflow rate, and total time of hydrologic input demonstrating the proposed timing matches the existing condition as closely as possible. Further, an additional five (5) hydrographs of distinct storm events should be provided to verify the design, showing the same level of information and comparison. While it will not be possible to precisely match the pre-development timing of inflows to the wetland in the post-development condition, measures to slow the delivery of runoff to the wetland will help reduce the risk of ecological degradation owing to sudden changes in water level and to associated erosion and sediment control impacts.

The model output from the post-development mitigated scenario should be compared for each year against the target hydroperiod and post-development unmitigated hydroperiod using the exact same graphical and tabular presentation formats outlined in Section 8. The difference between the proposed post-development mitigation scenario and the target pre-development should be scenario calculated at each time interval as percentage of pre-development volume, as in Section 8.

Finally, this section should include a discussion about the potential residual negative impacts to the wetland ecological processes resulting from altered hydroperiod, after all mitigation measures have been incorporated. An ecologist should ensure that the mitigated hydroperiod is consistent with the wetland community.

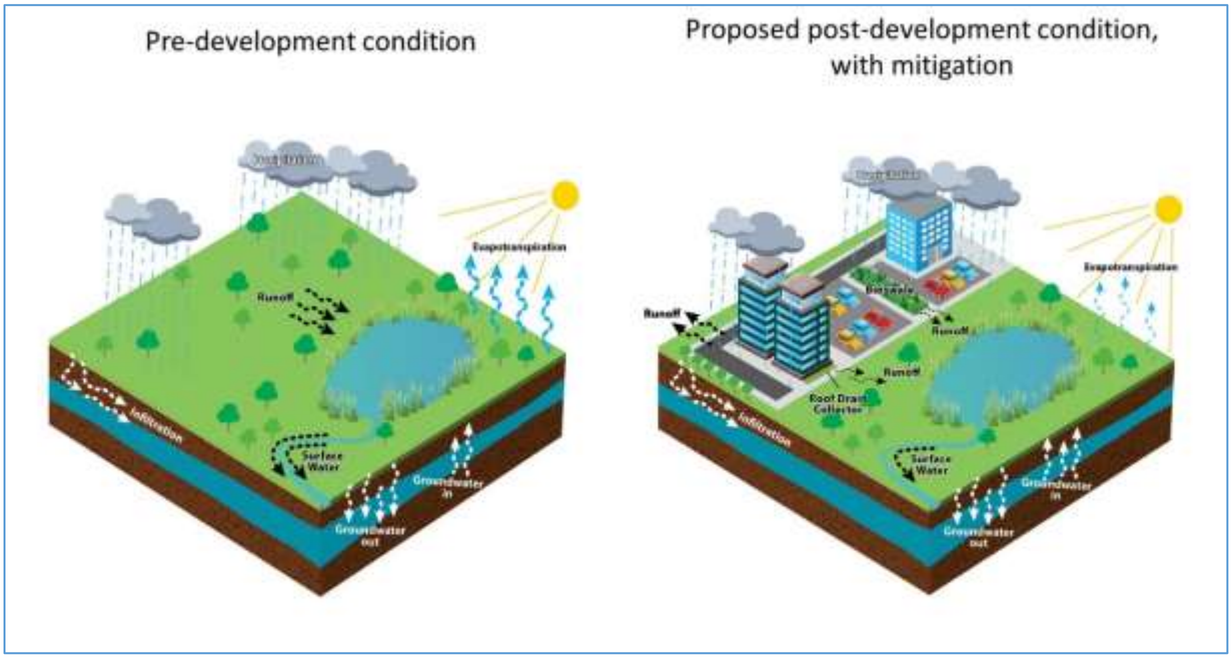


Figure 18: Development incorporated mitigation measures to maintain the pre-development hydroperiod in the post-development condition

10 Interim Mitigation Plan during Construction of the Project

This section of the FBWB report should outline an interim mitigation plan to protect the wetland during the construction phase, where a plan has been deemed necessary through consultation with the conservation authority. The mitigation plan should outline triggers for action and define the corresponding actions to take.

An interim mitigation plan may be required for developments where there is a risk of negative effects to the wetland resulting from the delay between alterations to the wetland catchment (typically during earthworks) and the implementation of mitigation measures (typically during building construction). The need for a mitigation plan will be determined in consultation with TRCA and municipal staff. A mitigation plan should outline active management measures for supplementing the water balance during construction and define triggers for when action is required (e.g. low and high water level thresholds for a specified duration and/or time of year, as deemed appropriate by ecologists). Such measures may be necessary to protect the ecological and hydrological functions of the wetland from multi-year disturbances which degrade the wetland to a point where these functions cannot be restored. In the case where supplemental water is needed to augment the interim water balance, clean sources of water are preferred (e.g. roof runoff, runoff from greenspace, or unchlorinated water from a water truck). Interim mitigation plans may include, for example, phasing soil stripping or grading activities within the wetland catchment, or having an interim grading plan that is designed to compensate for an anticipated surplus or deficit of water during the construction phase.

11 Monitoring and Adaptive Management Plan

This section of the FBWB report should outline the post-implementation monitoring plan where this has been identified as a requirement. The plan should outline the triggers for action and the associated adaptive management options, should post-implementation monitoring identify an excess or deficit in wetland water storage.

For proposals that have been determined to be medium or high risk as per the TRCA *Wetland Water Balance Risk Evaluation* (TRCA, 2017), post-implementation water balance monitoring is required to characterize the new wetland hydrology following construction and to understand any changes to the wetland's ecological function. The TRCA Wetland Water Balance Monitoring Protocol (TRCA, 2016) should be consulted for more detailed guidance. The hydrological monitoring instrumentation should remain in place post-development for a period agreed upon with the agencies, and continuous hydrological data should be collected during these years. The first year of post-development data collection may begin at 80-85% build-out as long as all mitigation measures designed to protect wetland hydrology have been implemented. As the purpose of post-development monitoring is to capture the passive operation of the mitigation system, this phase of the monitoring may not begin until these measures have been fully implemented.

In the FBWB report, the proponent should clearly outline the methods that will be used to evaluate the effectiveness of the mitigation measures in maintaining the pre-development wetland hydroperiod. For example, the modelled long-term hydroperiod can be used as a basis for comparison by plotting the monitored post-development water levels by Julian day-of-year (i.e. day 1-365) against the statistical distribution of long-term annual water levels over the same period. TRCA can provide tools and scripts upon request that can be used to facilitate these analyses and other numerical and graphical comparisons between different scenarios; two such tools are currently available in beta form.

An adaptive management plan should outline potential mitigation actions, should post-implementation monitoring identify an excess or a deficit in wetland water storage. The specifics of the adaptive management plan will necessarily depend strongly on local conditions and constraints, but may include, for example, designs that incorporate adjustable orifices, flow splitters, and similar devices that allow for the post-development area contributing runoff volume to be adjusted to some degree. The benefit of such designs is that they can operate passively without requiring active intervention, once a suitable post-development hydrological regime has been settled on. The feature-based water balance analysis report should identify opportunities to incorporate such designs so that the opportunity to integrate them into servicing and infrastructure is not missed. Consult with the conservation authority regarding appropriate adaptive management plan objectives and hydroperiod targets.

12 Conclusions and Recommendations

This final section of the FBWB report should summarize the original objectives of the modelling exercise and the main outcomes for each objective. The results of the comparison between the pre-development hydroperiod and the post-development hydroperiod should also be summarized. Finally, the design recommendations and supporting rationale with regard to any water balance mitigation measures that have been determined to be necessary through consultation with TRCA staff should be summarized.

Sources Cited

American Society of Civil Engineers. (ASCE). 1993. Criteria for evaluation of watershed models. Journal of Irrigation and Drainage Eng., 119, pp. 429-442

Allen, R.G., Pereira, L.S., Raes, D., Smith, M. 1998. Crop evapotranspiration —guidelines for computing crop water requirements. FAO Irrigation and drainage paper 56. Food and Agriculture Organization, Rome.

Bicknell, B.R., J.C. Imhoff, J.L. Kittle, Jr., A.S. Donigian, Jr. and R.C. Johanson. 1997. Hydrological Simulation Program—Fortran, User's manual for version 11. EPA/600/R-97/ 080. U.S. Environmental Protection Agency, National Exposure Research Laboratory. Athens, GA

Carter, V. 1996. Wetland hydrology, water quality, and associated functions, in National water summary on wetland resources: U.S. Geological Survey Water Supply Paper 2425, accessed December 22nd, 2017, at http://water.usgs.gov/nwsum/WSP2425/hydrology.html

CHI (Computational Hydraulics International). 2003. SWMM Pages. URL: http://www.computationalhydraulics.com/swmm.html

Chow, V. T., Maidment, D. R., and Mays, L. W. 1988. Applied hydrology, McGraw-Hill, New York

Clarke, R.T. 1973. A review of some mathematical models used in hydrology, with observations on their calibration and use. Journal of Hydrology, 19: 1-20.

Crawford, H.H. and Linsley, R.K. 1966. Digital Simulation in Hydrology: Stanford Watershed Model IV. Technical Report No. 39, Department of Civil and Environmental Engineering, Stanford University, Stanford.

DHI. 2000. Mike ShE Flow Modules, Technical Reference. DHI Water and Environment, 174p.

Fetter, C.W. 2001. Applied hydrogeology, 4th ed.: Upper Saddle River, N.J., Prentice-Hall, Inc., 598 p.

Gan T. Y. 1988. Application of scientific modelling of hydrological response from hypothetical small catchments to assess a complex conceptual rainfall runoff model. Water Resources Series Technical reports no. 111. Department of Civil Engineering, University of Washington, Seattle, Washington

Golmohammadi, G. Prasher, S., Madani, A., Rudra, R. 2014. Evaluating Three Hydrological Distributed Watershed Models: MIKE-SHE, APEX, SWAT. Hydrology 1: 20-39.

Gupta H.V., S. Sorooshian, P.O. Yapo. 1999. Status of automatic calibration for hydrologic models: comparison with multilevel expert calibration. Journal of Hydrologic Engineering, 4: 135-143.

Haith, D. A. and Shoemaker, L. L., 1987. Generalized Watershed Loading Functions for stream flows nutrients. Water Resources Bulletin, 23: 471-478.

Hargreaves, G.L., G.H. Hargreaves, and J.P. Riley. 1985. Agricultural Benefits for Senegal River Basin. Journal of Irrigation and Drainage Engineering 111: 113–124.

Hvorslev, M.J.. 1951. Time Lag and Soil Permeability in Ground-Water Observations, Bull. No. 36, Waterways Exper. Sta. Corps of Engrs, U.S. Army, Vicksburg, Mississippi, pp. 1-50.

Leavesley, G.H., Lichty, R.W., Troutman, B.M., and Saindon, L.G. 1983. Precipitation-runoff modelling system—User's manual: U.S. Geol. Surv. Water Resour. Invest. Rep. 83-4238.

Legates, D.R., McCabe, G.J. 1999. Evaluating the use of ''goodness-of-fit" measures in hydrologic and hydro climatic model evaluation. Water Resources Research 35, 233–241.

Lu, J., G. Sun, D. M. Amatya, and S. G. McNulty. 2005. A comparison of six potential evapotranspiration methods for regional use in the southeastern United States. Journal of American Water Resources Association 41: 621–33.

Manning, R. 1891. On the flow of water in open channels and pipes. Transactions of the Institution of Civil Engineers of Ireland. 20: 161–207.

Makkink, G.F. 1957. Testing the Penman formula by means of lysimeters. Int. J. Water Engng 1: 277–288.

Mao LM, Bergman MG, Tai CC. 2002. Evapotranspiration measurement and estimation of three wetland environments in the upper St. Johns River basin, Florida. Journal of the American Water Resources Association 38: 1271– 1285.

Markstrom, S.L., Niswonger, R.G., Regan, R.S., Prudic, D.E., and Barlow, P.M., 2008, GSFLOW—Coupled ground-water and surface-water flow model based on the integration of the Precipitation-Runoff Modelling System (PRMS) and the Modular Ground-Water Flow Model (MODFLOW-2005): U.S. Geological Survey Techniques and Methods 6-D1. 240 p.

Metcalfe, RA, Petzold, H, Luce, JJ, Buttle, JM. 2019. Evaluating seasonal and regional calibration of temperature-based methods for estimating potential evaporation in Ontario. Canadian Water Resources Journal 44: 2–21.

Monteith, J.L. 1965. Evaporation and environment. Symposia of the Society for Experimental Biology 19: 205–224.

Nash, J. and Sutcliffe, J. 1970. River flow forecasting through conceptual models part 1 – a discussion of principles. Journal of Hydrology 10: 282- 290

OSU-CE (Oregon State University Civil Engineering). 2003. EPA Storm Water Management Model (SWMM), versions 4.31 and 4.4. URL: http://ccee.oregonstate.edu/swmm/

Refsgaard, J.C. and Storm, B. 1996. Construction, calibration and validation of hydrological models, Distributed Hydrological Modelling (eds. M.B. Abbott and J.C. Refsgaard), Kluwer Academic Publishers, 41-54.

Servat E, A. Dezetter. 1991. Selection of calibration objective functions in the context of rainfall–Runoff modelling in a Sudanese savannah area. Hydrological Science Journal., 36, pp. 307-330

Soil Conservation Service (SCS). 1972. Section 4: Hydrology In National Engineering Handbook. SCS.

Turc, L. 1961. Evaluation des besoins en eau d'irrigation, évapotranspiration potentielle, formulation simplifié et mise à jour. Annales Agronmique. 12, 13–49.
Priestley, C.H.B. and R.J. Taylor, 1972. On the Assessment of Surface Heat Flux and Evaporation Using Large-Scale Parameters. Monthly Weather Review 100. pg. 81-92.

Toronto and Region Conservation Authority (TRCA). 2016. Wetland Water Balance Monitoring Protocol. Available at: https://trca.ca/planning-permits/procedural-manual-and-technical-guidelines/

Toronto and Region Conservation Authority (TRCA). 2017. Wetland Water Balance Risk Evaluation. Available at: https://trca.ca/planning-permits/procedural-manual-and-technical-guidelines/

Appendix A: Feature-based Water Balance Analysis Report Template

The following structure is suggested as a standard format for the modelling part of feature based water balance analysis study report. Depending on the characteristics of impacts of the proposed development on the wetland, some sections may not be necessary, while additional sections may be required. The suggested report format and main section headings are listed below.

Suggested Report Format

1. **Introduction**
    a. Determine the scope of analysis applicable to the proposal using TRCA's *Wetland Water Balance Risk Evaluation* and establish the need for a continuous modelling exercise
2. **Understanding the wetland water balance based on monitored and secondary data**
    a. Analyze the monitored hydrological time series data to help answer the following questions:
        i. What are the dominant water transfer mechanisms between the wetland and its surroundings?
        ii. How long does the wetland contain standing water?
        iii. Do the maximum depth and areal coverage of surface water change from year to year?
        iv. How quickly do water levels draw down during extended dry periods?
        v. What is the wetland hydroperiod response to precipitation events?
        vi. Is the amount of surface water flowing into the wetland roughly equal to the amount flowing out?
        vii. What is the relationship between groundwater head and wetland water levels?
        viii. Is the hydraulic gradient in the wetland mostly upwards or downwards, and what is the hydraulic conductivity of the soil?
        ix. How do these observations relate to the observed distribution of wetland habitat?
    b. Identify wetland water sources
    c. Identify water transfer mechanisms
    d. Determine significant hydrological processes
3. **Developing the conceptual model**
4. **Testing and refining the conceptual model**
    a. The conceptual model should be tested using a tool that quantifies the terms of the wetland water balance
5. **Continuous hydrological model**
    a. Describe the selected software for the continuous hydrological model
    b. Provide technical justification for the suitability of the selected model or the criteria applied in selecting the model, referring to list of significant hydrological processes

c. Model setup
    i. Data requirements (data sources, any shortcomings, any data gap filling techniques employed, etc.)
    ii. Parameterization (limitations)
    iii. Representation of the wetland in the model
d. Model calibration
    i. Identify all parameters that were changed during calibration
    ii. Develop a table comparing all initial parameter values vs. all calibrated parameter values
    iii. Provide description and justification of calibrated values
e. Model performance assessment
    i. Graphical
    ii. Statistical – D<15%, r^2 >0.75 and ENS >0.65 for daily values
f. Model validation

6. Establishing a pre-development target hydroperiod
   a. Run a long-term analysis using forcing dataset from nearest available climate station (minimum 1991-2008)
   b. Save model output at daily timestep

7. Unmitigated post-development scenario hydroperiod
   a. Modify the parameters of the calibrated model to reflect post-development land use conditions and run the model using the same long-term forcing dataset (minimum 1991-2008)
   b. Save model output at daily timestep

8. Comparison of the pre-development target hydroperiod with the unmitigated post-development hydroperiod
   a. Comparisons should be made summarizing daily outputs at weekly, monthly, and annual intervals in a table
   b. Quantify changes in the water budget components at the same intervals
   c. Create a hydrograph for each model year showing the target (pre-development) hydroperiod, post-development hydroperiod, and the 95 percent upper and lower confidence interval boundaries of the target hydroperiod for each Julian day
   d. Assess the impacts of these changes on the wetland flora and fauna communities; an ecologist should analyze model outputs to determine potential ecological impacts
   e. If the pre-to-post development comparison shows that there will be a negative impact to the wetland, mitigation measures will be required to ensure maintenance of the pre-development wetland hydroperiod

9. Prepare mitigation measures
   a. Work collaboratively with an ecologist to understand the sensitivity of the wetland and to develop appropriate mitigation measures to ensure maintenance of the pre-development wetland hydroperiod
   b. Modify the parameters of the calibrated model to reflect post-development land use conditions including proposed mitigation measures and run the model using the same long-term forcing dataset (minimum 1991- 2008)

i. Provide a description of proposed mitigation measures such as clean roof drainage collector directed to bioswales, infiltration galleries, third pipe, etc.

c. Comparisons between the target (pre-development) hydroperiod and post-development mitigated hydroperiod should be made summarizing daily outputs at weekly, monthly, and annual intervals in a table
d. Quantify changes in the water budget components at the same intervals
e. Create a hydrograph for each model year showing the target (pre-development) hydroperiod, post-development hydroperiod, and the 95 percent upper and lower confidence interval boundaries of the target hydroperiod for each Julian day
f. Discuss the comparison results, deviations from the pre-development condition, and their implications on the ability of the wetland to sustain ecological processes; check with the ecologist to ensure the mitigated hydroperiod is consistent with the wetland community
g. Describe the design of the proposed mitigation and how it conveys water to the wetland and demonstrate event-based performance

10. Interim mitigation plan during construction of the project

a. Discuss the period of construction and its potential impact on the wetland
b. Outline interim mitigation measures and triggers for action

11. Monitoring and adaptive management plan

a. Discuss the post-implementation monitoring plan and reporting
b. Suggest methods to evaluate the effectiveness of the mitigation measures in maintaining the pre-development hydroperiod
c. Recommend actions for cases where a deficit or excess of water is observed and what adaptive management will be required
d. Discuss how the design of proposed mitigation measures can be modified to accommodate future adaptive management recommendations

12. Conclusions and recommendations

a. Summarize original objectives of the modelling exercise and the main outcomes for each objective
b. Summarize the results of the comparison between the pre-development hydroperiod and the post-development unmitigated hydroperiod as determined through the modelling exercise
c. Summarize the design recommendations and supporting rationale with regard to any water balance mitigation measures that have been determined to be necessary

Appendix B: Hydrological Processes: Governing Equations, Input Data Sources, and References

B1: Precipitation

Environment Canada, conservation authorities, and local municipalities own and operate local weather stations and can provide local precipitation data for these stations. Depending on the instrumentation at a particular station as well as the availability of data summaries, precipitation data can be retrieved at yearly, monthly, daily, or hourly time intervals, and in some cases as real-time data. The proponent should investigate if precipitation values from these weather stations can be utilized for the wetland water balance analysis.

Precipitation events are recorded by gauges at specific locations. If the location of available gauges is not in close proximity with the wetland study area, then the applicant should discuss with the local conservation authority to determine if there is a need for site-specific gauging. Depending the location of the wetland in relation to the gauges' locations, examining data from a nearby representative weather station is the method that is most often used to estimate precipitation input into a wetland system. Precipitation estimates that are based on a single data point, however, may be subject to substantial error and uncertainty because of the spatial variability associated with precipitation. This may cause discrepancies between the estimated total precipitation received by the catchment and the actual amount received, as well as the timing of rainfall at a sub-daily scale. To achieve a more accurate representation of the areal precipitation distribution, data from a network of stations can be used. There are several methods available for estimating average precipitation. The three most common methods for computing average rainfall in a catchment are the arithmetic mean, the Thiessen Polygon Method, and the Isohyetal Method. The steps used to quantify the precipitation amount of the wetland water balance are outlined in Figure 6.

B2: Surface Flow

Surface water inflow to a wetland is derived from channelized streamflow, non-channelized (i.e. overland) flow, and seasonal or periodic flooding of lakes, ponds, and rivers. Surface water outflow results when the storage capacity of a depressional area such as a wetland is exceeded. Outflows from a wetland may be concentrated into a channelized watercourse or may be more diffuse. Surface water inflows and outflows vary seasonally and generally correspond to variations in precipitation and spring thaw. In wetlands where groundwater is a major source to the wetland, surface water outflow may be more evenly distributed throughout the year.

Non-channelized Surface Flows

Non-channelized surface water flows entering a wetland are difficult to quantify using on-site measurements, and so are generally estimated using simple modelling approaches. The runoff curve number (CN) method developed by the United States Department of Agriculture's Soil Conservation Service (SCS) is widely used for estimating runoff from rainfall events in small- to medium-sized watersheds under varying land use and soil types (SCS, 1972). The CN method describes the production of runoff during a rain event, considering the initial depth of rainfall that is "abstracted" as storage in soil moisture in the upper soil horizons and in surface depressions.

Once this initial abstraction depth has been exceeded, all subsequent "excess" rainfall is converted directly to runoff.

The CN value for each combination of land use, land cover, and soil type is determined using a lookup table such as Table B1. The source for all CN values used should be cited. The catchment of the wetland is divided up into as many unique combinations of land use, land cover, and soil type as may be present, and a CN value assigned to each unique combination. A single CN value is then determined based on the areally weighted average for all CN values within the wetland catchment.

The SCS CN equation is (SCS, 1972):

$$Q_{surf} = \frac{(R_{day} - I_a)^2}{(R_{day} - I_a + S)}$$

Equation B-1

$$S = 25.4\left(\frac{1000}{CN} - 10\right)$$

Equation B-2

Where:

- Q_{surf} is rainfall excess (mm),
- R_{day} is daily total rainfall(mm),
- I_a is initial abstraction (sum of surface storage, interception, and infiltration) (mm),
- CN is the curve number determined for the catchment as a whole using lookup tables and the procedure described above (unitless), and
- S is the retention or storage parameter (mm), determined using the *CN* value for the catchment as a whole. The value of S may vary spatially and over time as a function of soil moisture content. The retention parameter varies spatially due to changes in soils, land use, management and slope and temporally due to changes in soil water content.

A common approach is to approximate initial abstraction I_a as 0.2 S, which substituted into Equation B1 then becomes:

$$Q_{surf} = \frac{(R_{day} - 0.2S)^2}{(R_{day} + 0.8S)}$$

Equation B-3

The SCS CN method was originally developed for single rainfall event analysis. To adapt this method for continuous modelling, use Equation B3 to determine the minimum daily total rainfall necessary to produce runoff, then determine runoff for each day where rainfall exceeds this minimum depth.

Landuse (TRCACode)	TIMP	Cover Type	Hydrologic Soil Group			
			A	B	C	D
Cemetery	35	35% Impervious + 65% Lawns	71	81	88	90
Commercial	95	95% Impervious + 5% Lawns	98	99	99	99
Conservation Lands	0	80% Woods + 20% Meadows	38	61	74	80
Estate Residential	40	40% Impervious + 60% Lawns	74	83	89	91
Farm	0	Cultivated	66	74	82	86
Golf Course	0	Lawns	56	71	81	85
Hydro Corridor	10	10% Impervious + 90% Meadows	51	69	79	84
Industrial	95	95% Impervious + 5% Lawns	98	99	99	99
Institutional	80	80% Impervious + 20% Lawns	91	94	96	97
Open Space	0	50% Woods + 50% Meadows	41	63	75	81
Park	10	10% Impervious + 45% Woods + 45% Meadows	47	67	78	82
Recreational	20	20% Impervious + 80% Lawns	65	77	85	88
Residential High	80	80% Impervious + 20% Lawns	91	94	96	97
Residential LowMed	60	60% Impervious + 40% Lawns	82	88	92	94
Road (ROW)	90	90% Impervious + 10% Lawns	96	97	98	99
Rural Residential	20	20% Impervious + 80% Lawns	65	77	85	88
Transportation	60	60% Impervious + 40% Lawns	82	88	92	94
Water	100	Impervious	100	100	100	100
Natural	0	50% Woods + 50% Meadows	41	63	75	81

Table B1: Updated lookup table for Curve Number (CN) based on total imperviousness

Channelized Surface Flows

All wetlands will receive some non-channelized surface water input, but some wetlands may receive equivalent or greater volumes of water from channelized flow as well. To quantify channelized surface water flows, direct on-site measurements made using weirs, flumes, and stage-gauging techniques are the preferred source of data. TRCA's *Wetland Water Balance Monitoring Protocol* (2016) outlines basic procedures for estimate channelized flow at concentrated inflow or outflow locations. Accurate on-site measurements are invaluable as input data for water balance analysis. If the wetland is on a higher order stream, it may be prudent to see if Environment Canada or the local conservation authority operates a stream gauge nearby. Techniques exist for transferring flow data from a watercourse in one basin to another nearby basin with similar characteristics; however, caution should be used before applying these techniques to ensure all underlying assumptions are met.

If direct discharge measurements are not available the next best option is to approximate channelized flows based on the shape of the inflow and/or outflow channel using the continuity equation:

$$Q = VA$$

Equation B-4

Where:

- Q is discharge (m^3/s)
- V is velocity (m/s)

- A is cross-sectional area of flow (m^2).

To calculate the velocity term, Manning's equation can be used:

$$V = \left(\frac{1}{n}\right) R^{2/3} S^{1/2}$$

Equation B-5

Where:

- V is velocity (m/s);
- n is Manning's roughness coefficient, based on lookup table;
- R is hydraulic radius(m), equivalent to the cross-sectional area of flow (A) divided by the wetted perimeter (W_p) such that $R = A/W_p$; and
- S is slope (m/m).

Manning's roughness coefficient values based on the type of material lining the channel are listed in Table B2.

The steps used to quantify the surface water portion of a wetland water budget are outlined in Figure 8. An adequate assessment of surface water inputs is important for all wetlands, but for riverine and other surface-water-driven wetlands it is critical. Contribution of non-channelized and channelized flow must be quantified for all sites. The sum of channelized and non-channelized flow values constitutes the overall surface water input to the wetland system. Daily and monthly surface-water flow values should be calculated for representative wet, dry, and average years, expressed in units of depth per unit time and plotted along with the other components of the water budget.

Some continuous hydrological models may have routines that use alternative methods for simulating surface water inputs from the catchment area. All methods and assumptions used in the calculation of the surface water component of the water budget should be listed in the relevant section of the report.

Surface Material	Manning's Roughness Coefficient (*n*)	Surface Material	Manning's Roughness Coefficient (*n*)
Asbestos cement	0.011	Glass	0.010
Asphalt	0.016	Gravel, firm	0.023
Brass	0.011	Lead	0.011
Brick	0.015	Masonry	0.025
Canvas	0.012	Metal, corrugated	0.022
Cast-iron, new	0.012	Natural streams – clean & straight	0.030
Clay tile	0.014	Natural streams – major river	0.035
Concrete – steel forms	0.011	Natural streams – sluggish, deep pools	0.040
Concrete (cement) – finished	0.012	Natural channels – very poor condition	0.060
Concrete – wooden forms	0.015	Plastic	0.009
Concrete – centrifugally spun	0.013	Polyethylene PE – corrugated with smooth inner walls	0.009 - 0.015
Copper	0.011	Polyethylene PE – corrugated inner walls	0.018 - 0.025
Corrugated metal	0.022	PVC – smooth inner walls	0.009 - 0.011
Earth, smooth	0.018	Rubble masonry	0.017
Earth channel – clean	0.022	Steel – Coal-tar enamel	0.010
Earth channel – gravelly	0.025	Steel – smooth	0.012
Earth channel – weedy	0.030	Steel – new, unlined	0.011
Earth channel – stony, cobbles	0.035	Steep – riveted	0.019
Floodplains – pasture, farmland	0.035	Vitrified sewer	0.013 - 0.015
Floodplains – light brush	0.050	Wood – planed	0.012
Floodplains – heavy brush	0.075	Wood – unplaned	0.013
Floodplains – trees	0.150	Wood stove pipe, small diameter	0.011 - 0.012
Galvanized iron	0.016	Wood stove pipe, small diameter	0.012 - 0.013

Table B24: Manning's Roughness Coefficient Values

B3: Evapotranspiration

Evapotranspiration (ET) is one of the most challenging components of a wetland water budget to estimate because of its high variability in time and space and the complexity of monitoring atmospheric water vapour fluxes. ET varies according to both meteorological variables as well as phases of vegetation growth. While the Penman-Montieth method (Monteith, 1965) is often considered the most accurate available empirical method, it requires a number of parameters that may be difficult and/or expensive to measure. For this reason, other estimation methods for ET, requiring a reduced set of input parameters, are more commonly used.

The steps involved in quantifying the ET portion of a wetland water budget are shown in Figure 9. A good first step for any modelling study is to determine the availability of meteorological data in proximity to the study site for the period of interest, and then to determine the necessity of collecting any additional required input data at the study site in order to apply the desired ET estimation method.

Direct Measurement Techniques

An evaporation pan is one example of a direct measurement technique to estimate evapotranspiration. The evaporative water loss from a standard class "A" pan is determined by measuring the decrease in water level or mass over time, or the volume or mass required to maintain a specified water level in the pan. A monthly variable crop coefficient (k) is generally used to convert pan evaporation (E_{pan}) into potential ET (*PET*) such that PET = $k \cdot E_{pan}$ (Mao *et al.,* 2002). If using a pan evaporation approach, it is important to use local crop coefficients that account for local climate conditions. Conservation authorities and universities can provide appropriate local crop coefficients. The calculated PET is the subtracted from available water held in storage on the surface and in soils at each calculation timestep.

Thornthwaite Method

The Thornthwaite method (Thornthwaite, 1948) calculates PET at monthly resolution using only monthly temperature as an input:

$$PET = 16 * \left(\frac{10 \cdot Ti}{I}\right)^{a} \left(\frac{N}{12}\right)\left(\frac{d}{30}\right)$$

Equation B-6

$$I = \sum_{i=1}^{12} \left(\frac{Ti}{5}\right)^{1.514}$$

Equation B-7

$$a = (492390 + (17920 \cdot I) - (771 \cdot I^2) + (0.675 \cdot I^3)) * 10^{-6}$$

Equation B-8

Where:

- PET is monthly potential evapotranspiration (mm/month)
- T_i is monthly average temperature (°C)
- N is the number of monthly daylight hours for a given latitude, from a lookup table (Thornthwaite, 1948)

- d is the number of days in the given month
- I is the annual heat index for the given year (Equation B6)
- a is a function of I (Equation B7)

While the Thornthwaite method is useful for estimating PET as part of a conceptual water balance model or coarse scale exercise, its monthly output resolution means it may not be appropriate for continuous modelling exercises. Locally calibrated monthly adjustment coefficients to further refine PET estimates from the Thornthwaite method are available (see Metcalfe *et al.,* 2019) and generally show the method to underestimate PET in the spring and fall while slightly overestimating PET in the summer. For any month where T_i is ≤0, estimated PET will be zero.

Hargreaves / Hargreaves-Samani Method

The method of Hargreaves *et al.* (1985), sometimes referred to as the “Hargreaves-Samani 1982” method, is also widely applied because it requires as input only the daily maximum and minimum air temperature. The radiation term does not require site-scale data but rather is calculated for a given latitude and day of year using solar radiation theory (see for example Allen *et al.,* 1998). The equation is given as:

$$\lambda(PET) = 0.0023(T_m + 17.8)\left(\sqrt{T_{max} - T_{min}}\right)R_a$$

Equation B-9

Where:

- λ is the latent heat of vapouration (J/kg)
- PET is daily potential evapotranspiration (mm/day)
- T_m is daily mean air temperature (°C),
- T_{max} is daily maximum air temperature (°C),
- T_{min} is daily minimum air temperature (°C), and
- R_a is extraterrestrial radiation (MJ m^{-2} day^{-1}).

Metcalfe *et al.* (2019) recommend replacing the coefficient of 0.0023 with a monthly variable coefficient calibrated to regional climate conditions. For example, for southwestern Ontario, the locally-calibrated coefficients range from a high of 0.0025 in April to a low of 0.0020 over June through September (Metcalfe *et al.*, 2019).

Makkink Method

The Makkink (1957) method was developed for use in the Netherlands and has been found by TRCA staff to perform well in the Toronto region. The method requires incoming solar radiation at the site or regional scale as well as air temperature as inputs, and can be calculated at variable timesteps:

$$\lambda(PET) = 0.61\, R_s \frac{\Delta}{\Delta + \gamma} - 0.12$$

Equation B-10

Where:

- PET is potential evapotranspiration (mm),
- Δ is the slope of the saturation vapour pressure vs. temperature curve (kPa/K) for the average air temperature over each time interval,

- R_s is incoming solar radiation (W/m^2),
- Υ is the Psychrometric Constant (kPa/K), and
- 0.61 and 0.12 are empirical fitting parameters

Turc Method

The Turc (1961) method was developed for western Europe and requires the same inputs as the Makkink (1957) method, as well as a correction factor for when relative humidity is <50%. TRCA staff have found that this method performs well in the Toronto region.

$$\lambda(PET) = 0.013\, C_{RH} \frac{T}{T + 15} (R_s + 50)$$

Equation B-11

Where:

- PET is daily potential evapotranspiration (mm),
- C_{RH} is an adjustment factor for relative humidity, equal to 1 when RH≥50% and to (1+((50-RH)/70)) when RH<50%, where RH is relative humidity expressed in percent,
- T is daily average air temperature (°C), and
- 0.013 and 50 are empirical fitting parameters

For any day where T is ≤0, estimated PET will be zero.

Priestley Taylor Method

The Priestley-Taylor (1972) method was developed as a simplified form of the Penman-Montieth equation. While it has ben applied in a variety of different settings, it requires site-scale data or appropriate downscaling techniques for the net radiation, ground heat flux, and alpha terms, and as such may be challenging to apply in the absence of site-scale data.

$$\lambda(PET) = \alpha \frac{\Delta}{\Delta + \gamma} (R - G)$$

Equation B-12

Where:

- *PET* is potential evapotranspiration (mm),
- *α* is an empirical coefficient that varies based on land cover and regional climate, generally set to a default value of 1.26,
- *R* is net radiation (W/m^2), and
- G is ground heat flux, (W/m^2; positive in the downwards direction).

Penman-Monteith Method

The Penman-Monteith (Monteith, 1965) method was developed as a modification of Penman's formula for evaporation from open water surfaces to account for the atmospheric resistance of the vegetation canopy. It considers all major factors contributing to PET, meaning that it is appropriate for use without calibration to local conditions but is also very data intensive.

$$\lambda(PET) = \frac{\Delta(R - G) + \rho_a c_p \dfrac{(e_s - e)}{r_a}}{\Delta + \gamma\left(1 + \dfrac{r_s}{r_a}\right)}$$

Equation B-13

Where:

- r_a is aerodynamic resistance (s/m)
- r_s is stomatal or canopy resistance (s/m)
- e is the vapour pressure (kPa)
- e_s is the saturated vapour pressure (kPa)
- ρ_a is the density of air (g/m³)
- c_p is the specific heat capacity of air (≈1.004 J/g/K)

B4: Groundwater Flow

Groundwater is taken to be all subsurface water in the saturated zone below the water table. Although the cost and complexity of subsurface investigations makes accurate quantification challenging, some assessment of the groundwater flux is critical to assessing the water balance of a wetland. TRCA advises applicants to begin with obtaining historical groundwater information in the vicinity of the subject wetland. The Ontario Ministry of Environment, Conservation, and Parks (MECP) well records database and the Oak Ridges Moraine Groundwater Program database are good starting places to help determine the amount and types of data that need to be collected on-site to fully understand groundwater fluctuations and groundwater movement between the wetland and the surrounding area. Because the groundwater environment is hidden from view and can vary dramatically over short distances, it is essential to collect data on-site in order to ascertain local hydrogeologic conditions. Drive point piezometers can be a relatively inexpensive way to assess the subsurface environment of wetlands, for example by determining the presence or absence of vertical hydraulic gradients within the study wetland. Once on-site data have been collected using the *Wetland Water Balance Monitoring Protocol* (TRCA, 2016), the following calculations and models can be used to estimate ground-water inputs to and outputs from the wetland system.

Darcy's Law describes the movement of water through a porous medium from areas of high pressure to low pressure, with the rate of flow being proportional to the difference in hydraulic head between two points and inversely proportional to the length of flow path between two points (Fetter, 2001):

$$Q = KA\left(\frac{\Delta \mathrm{h}}{\mathrm{L}}\right)$$

Equation B-14

Where:

- Q is volumetric discharge (L^3/T; m^3/d),
- K is hydraulic conductivity (L/T; m/d), a proportionality constant,
- A is the cross-sectional area of flow (L^2; m^2),
- L is the flow length (L; m), and
- Δh is the difference in hydraulic head along the flow length L

Using this equation, the rate of flow of ground water into or out of a wetland can be estimated from measurements made on-site, because a number of the above parameters can be measured in the field following installation of wells. The difference in hydraulic head, Δh, can be determined from water-level measurements made in two different wells, where L represents the distance between the wells. The cross-sectional area, A, is calculated as the confined aquifer's saturated thickness, multiplied by the aquifer width. The hydraulic conductivity, K, must be estimated using either on-site tests (e.g. slug tests or bail tests, such as the Hvorslev (1951) method) or existing information about the hydrogeological properties of geological strata. . Note that the hydraulic conductivity is typically greater in the horizontal direction than in the vertical direction as a consequence of bedding planes, laminae, and other sedimentary structures. This information can then be used to estimate the rate and quantity of ground-water inflow to and outflow from a wetland.

A form of Darcy's Law that is used to quantify flow through unconfined aquifers is Dupuit's Equation (Fetter, 2001):

$$q' = \frac{1}{2}K\left(\frac{h_1^2 - {h_2}^2}{L}\right)$$

Equation B-15

Where:

- q' is flow per unit width (L^2/T; m^2/d)
- K is hydraulic conductivity (L/T; m/d)
- h_1 is head at the origin (L; m)
- h_2 is head at flow length (L; m)
- L is flow length (L; m).

For more complex wetlands, an analytical solution using Darcy's Law may not be practical and not all bedrock-dominated flow systems can be characterized using Darcy's Law. Under these circumstances, a numerical groundwater flow model can be used to simulate groundwater flow. Numerical groundwater flow models are mathematical representation of an actual groundwater system that can be used to predict water levels as well as the direction and magnitude of flow. Models range from simple to very complex in terms of data input requirements, calibration requirements, and data output. An internally drained wetland where the outflows from the wetland are only in the form of groundwater outflow and evapotranspiration will almost certainly require a complex numerical groundwater flow model to accurately estimate the groundwater flow exchange between the wetland and the surrounding areas. The applicant should consult with the local Conservation Authority to determine if there any existing calibrated numerical ground-water flow models in the vicinity of the study site.

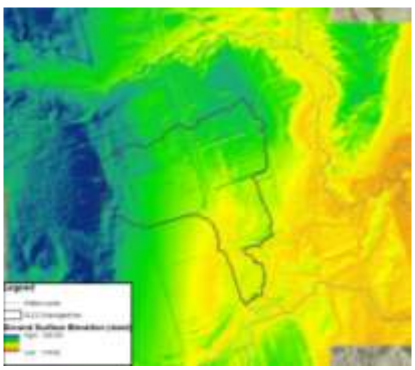
The steps used to quantify the groundwater portion of a wetland water budget are outlined in Figure 10. In summary, historical data should be evaluated to identify data gaps and determine the data needs for feature-based water balance analysis. Historical groundwater data also may be used to generate a long term record from shorter-term measurements and to determine representative wet, dry, and average conditions. Available data on the site's topography, soil type, surficial geology, and hydrography should be examined to determine the number of sections of groundwater flow at a site.

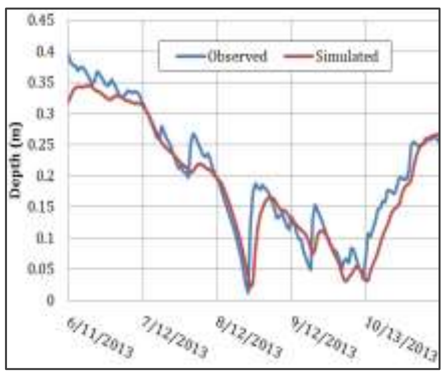
Wells must be installed to adequately characterize water table fluctuations and groundwater movement across the site, both vertically and horizontally. The hydraulic conductivity of both aquifers and aquitards also must be determined from soil borings, wells, infiltrometers, permeameters, and/or aquifer tests. The monitored data should be used to calculate groundwater flow using Darcy's Law and/or outputs from numerical ground-water flow models (e.g. MODFLOW). The results of the analysis can be used to determine groundwater inputs to and outputs from the wetland system. Daily and monthly groundwater flux values can then be tabulated and graphed for the monitoring time period.

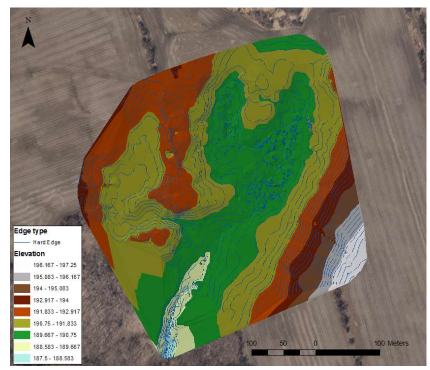
Wetland Water Balance Modelling Case Studies

(Appendix to TRCA Wetland Water Balance Modelling Guidance Document)

July 2018







Toronto and Region Conservation Authority

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1.0 Introduction

1.1 Purpose and Scope

Continuous hydrological models are a key tool for predicting the impact of land development and infrastructure construction on the hydrology of wetlands and other natural features. Models can also be used in the design of stormwater management facilities to offset such impacts, where mitigation is deemed necessary. Determining the appropriate model to simulate wetland hydrology can be challenging, as there are many factors to consider: the hydrological processes operating at a particular wetland, the representation of these processes in the model as they relate to wetland storage dynamics, the representation of stormwater management and low impact development (LID) facilities, and the personal preferences and abilities of the modeler in question, to name just a few. This appendix is intended to be a resource for modelers to help them make more informed decisions in modelling wetland water balance scenarios.

This appendix provides a series of case studies illustrating the set-up, calibration, and validation process for five commonly used continuous hydrology models (HEC-HMS, HSPF, MIKE SHE, Visual Otthymo, and SWMM). The calibrated and validated models are then used to explore the effects of different development scenarios to predict the change in wetland storage relative to the baseline condition, both with and without hypothetical mitigation measures. The modelling case studies shown here were produced by TRCA staff and external contributors from the University of Guelph and Civica Infrastructure. All the examples shown are based on two wetland sites located in central Pickering Township, where monitoring data was collected by TRCA starting in 2013 in anticipation of eventual development of the catchment areas. Additional data on the wetland catchment and basin were compiled for these two sites to inform the modelling exercise. The development scenarios and proposed mitigation measures were hypothetical, as plans for the development of areas surrounding the two wetlands were not sufficiently advanced at the time of writing, but the scenarios are based on realistic assumptions about development form and layout that draw on the experience of professional water resource engineers.

This appendix is intended to be used as a resource for modelers to consult for applications requiring a wetland water balance. It is not intended to definitively outline best practices for modelling, but rather to provide examples of considerations for the application of the five continuous hydrology models shown here, including data requirements, model complexity or simplicity, calibration and validation procedures, representation of different hydrological processes, and so on.

2.0 Common Data Sources

2.1 Aerial Photography

Recent aerial photographs can provide useful information about the land use context in the vicinity of the wetland and can be used to help classify different land cover types for the purposes of subdividing and/or parameterizing the wetland catchment. Some municipalities may be able to provide data free of charge, whereas others may not. TRCA cannot provide aerial photography data to proponents at present. Data can also be purchased from other sources (e.g. First Base Solutions).

2.2 Topography & Bathymetry

Topography data is essential in the delineation of wetland catchments and in understanding how water is stored in and released from the wetland. A minimum vertical resolution of 25 cm is recommended for the area contributing drainage to the wetland. Within the wetland pool itself, a higher vertical resolution is required because wetlands often occur in broad, flat areas, where there can be dramatic differences in the area of ponded water with relatively small changes in stage. Similarly, where surficial outflow channels are poorly defined, the stage-discharge curves must be very precise in order to define the elevation at which a wetland begins to discharge. For these reasons, a vertical resolution of 5 cm is recommended for the area of the wetland that might contain standing water at any point during the year. Where there is standing water at the time of topographic data collection, it may be necessary to collect bathymetry data to better constrain wetland storage volumes. High resolution (e.g. LiDAR-derived) topographic data exists for the entire TRCA jurisdiction and can be purchased from private vendors.

2.3 Wetland Pool Rating Curves

For the reasons cited above, realistic and accurate simulation of wetland storage dynamics requires precise topography and bathymetry data within the wetland pool. The elevation at which wetland pools begin to discharge is a key variable to inform development of wetland pool rating curves. As these rating curves can change dramatically over a small elevation range where outlets are less well defined, a vertical resolution of 5 cm is recommended. Some hydrodynamic models (e.g. MIKE-11) also have hydrodynamic routines to determine inflow and outflow condition dynamics and the inundation process of the wetland; these may be accepted in lieu of rating curves where model capabilities allow.

Some wetlands may consist of multiple pool areas that may be connected by overland flow or channelized flow, particularly for larger wetlands. Representation of these wetlands as a single storage unit with one associated rating curve or as separate units is a decision that will depend on expert opinion and the capabilities of the model(s) under consideration.

2.4 Catchment Delineation

Delineation of the wetland catchment should be completed using the highest resolution digital elevation model available. In most cases, software packages (e.g. ArcHydro) will offer the highest degree of precision in delineating the wetland catchment. However, it may be appropriate in some cases to manually correct delineated catchments to reflect the influence of subsurface or concealed drainage features (e.g. culverts, tile drains) on the wetland's contributing drainage area.

2.5 Land Use

Land use data is important for catchment parameterization, and is available from a variety of sources. Land Information Ontario offers a wide variety of classified land use layers for purchase. Municipalities and conservation authorities may also offer land use datasets free of charge or for a nominal data service fee. Aerial photographs may also be used to manually classify land use.

2.6 Soils

The surficial soils within the catchment, in combination with the topography, control to a large extent the catchment's hydrological response, and are often used in combination with land use data to determine catchment parameters and/or delineate hydrologic response units. As regional-scale datasets (e.g. Ontario Ministry of Agriculture and Rural Affairs soil atlas) generally offer little detail at the site scale, local geotechnical investigations or the finest resolution surficial sediment mapping data available are always preferred.

2.7 Monitored Well Data

Monitoring well data can be used to estimate the potential degree of groundwater interaction at the wetland in question. Some models require groundwater timeseries data to calibrate an aquifer component or the groundwater component of an integrated groundwater-surface water model. The Ontario Ministry of the Environment collects data through the Provincial Groundwater Monitoring Network. The Oak Ridges Moraine Groundwater Program (https://oakridgeswater.ca/) provides groundwater data on a subscription basis, with data coverage across south central Ontario. Municipalities and conservation authorities often have groundwater monitoring networks and may be able to provide data.

2.8 Meteorological Data

Environment Canada maintains a data portal with current and historical meteorological records varying in temporal resolution from daily to 5-minute intervals. Conservation authorities and municipalities may also have precipitation gauges and meteorological stations. It is always preferable to use multiple meteorological stations to interpolate precipitation and other forcing variables between stations, rather than simply using the closest station available, to increase model accuracy.

3.0 Continuous Hydrologic Models

3.1 Hydrologic Modelling System (HEC-HMS)

3.1.1 HEC-HMS: Background

The US Army Corps of Engineers (USACE) Hydrologic Engineering Centre Hydrologic Modelling System (HEC-HMS) model is designed to simulate the complete hydrologic processes of watershed systems. HEC-HMS is comprised of a graphical user interface, integrated hydrologic analysis components, data storage and management capabilities, and graphics and reporting facilities. HEC-HMS is flexible in that there are many different methods available to calculate the losses, runoff transform, baseflow, routing, and reservoirs, each of which can be selected separately. The soil moisture accounting (SMA) loss method in conjunction with potential evapotranspiration data and snowmelt routines is ideal for conducting continuous simulations. The SMA model is patterned after Leavesley's Precipitation-Runoff Modelling System (1983) and is described in detail in Bennett (1998). **Figure 1** presents a conceptual model schematic for the continuous soil moisture accounting algorithm.

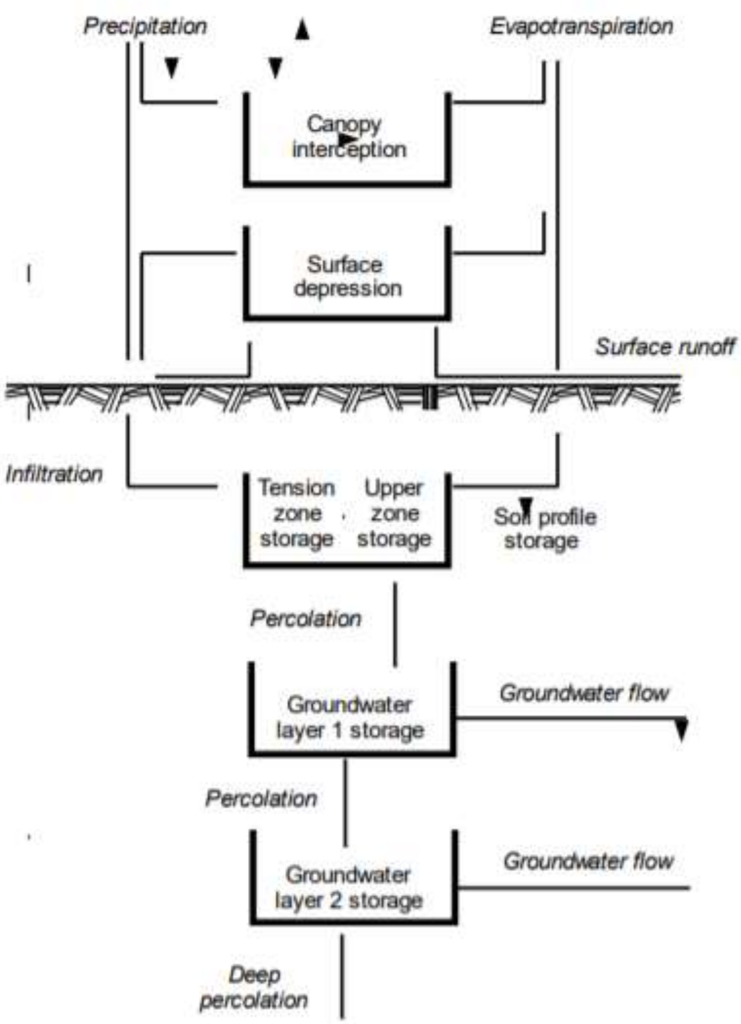


Figure 1: Conceptual schematic of the continuous soil moisture accounting algorithm (Bennett, 1998)

3.1.2 HEC-HMS: Model Setup, Existing Conditions

The case study area used for evaluation is a wetland at Seaton Sideline 26, which is located in the City of Pickering within the Duffins Creek Watershed. **Figure 2** shows the wetland and drainage areas, which were delineated using a 1m by 1m bare earth grid that was generated using LiDAR data from 2014. The wetland is divided into two pools. 2.05 hectares drain to the west pool of the wetland. The west pool drains overland to the east pool. The east pool receives runoff from an additional 7.31 hectares of land, for a total drainage area of 9.36 hectares.

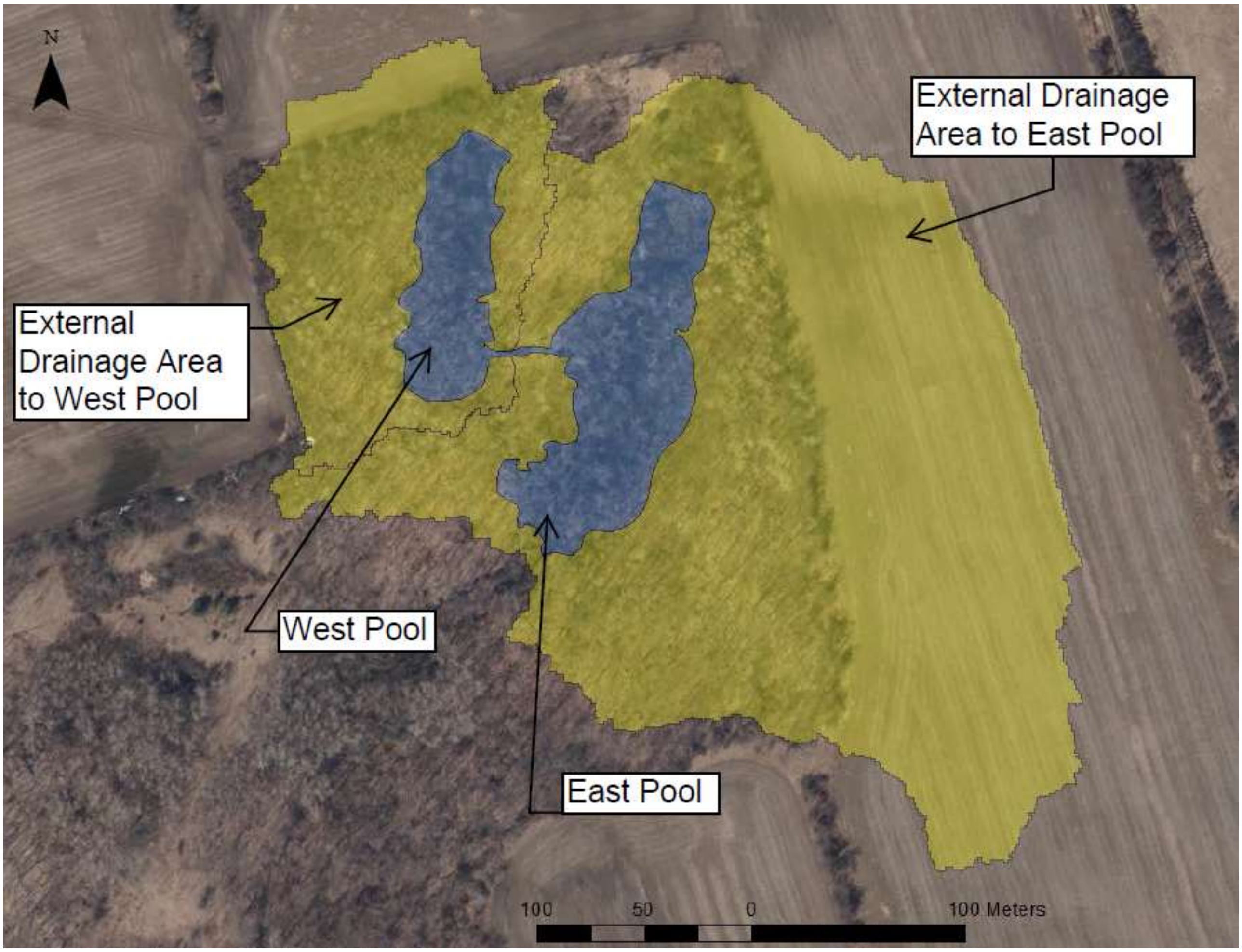


Figure 2: Sideline 26 Wetland Drainage Areas

Figure 3 shows the land use within the wetland drainage area, which includes farmland, forest, successional, and wetland. The parameters for each subbasin were lumped based on the area-weighted parameters of each of the four land use categories.

Figure 3: Sideline 26 Wetland Land Use

The soil classification for the entire drainage area to the wetland is a Gleyed Gray Brown Luvisol. A soil description from Agriculture and Agri-Food Canada was used to generate initial parameters for the maximum infiltration, soil storage, tension storage, soil percolation, groundwater percolation, and groundwater storage parameters.

Figure 4 shows the topography and bathymetry of the wetland, which was generated from a site survey. The elevation information was used to create detailed stage-storage relationships for each of the two major wetland pools. In order to estimate the discharge at each stage, the wetland was modeled in HEC-RAS as two storage areas connected by a broad-crested weir, and discharging over a second broad-crested weir to the downstream channel. Cross-sections were cut at the outlet of each pool using the elevation information, and the cross-section information was used for the weir geometry. An unsteady simulation was performed, with flow rates gradually ramped up from a low flow to a high flow, in order to ensure that the results would have a good spread of stage-discharge information. Equations were fit to the resulting rating curves, so that discharge values could be calculated at each known elevation and storage for each pool. The resulting stage-storage-discharge information was used in two separate reservoir commands which represent the surface storage at the west pool and the east pool of the wetland. The exact elevation at which each pool begins to discharge, as well as the discharge estimates closest to these elevations were treated as a calibration parameters. The outflow structures reservoir method was used in order to account for percolation from the wetland. A depth-surface area relationship for each pool was also required in order to account for the monthly evaporation from the wetland.

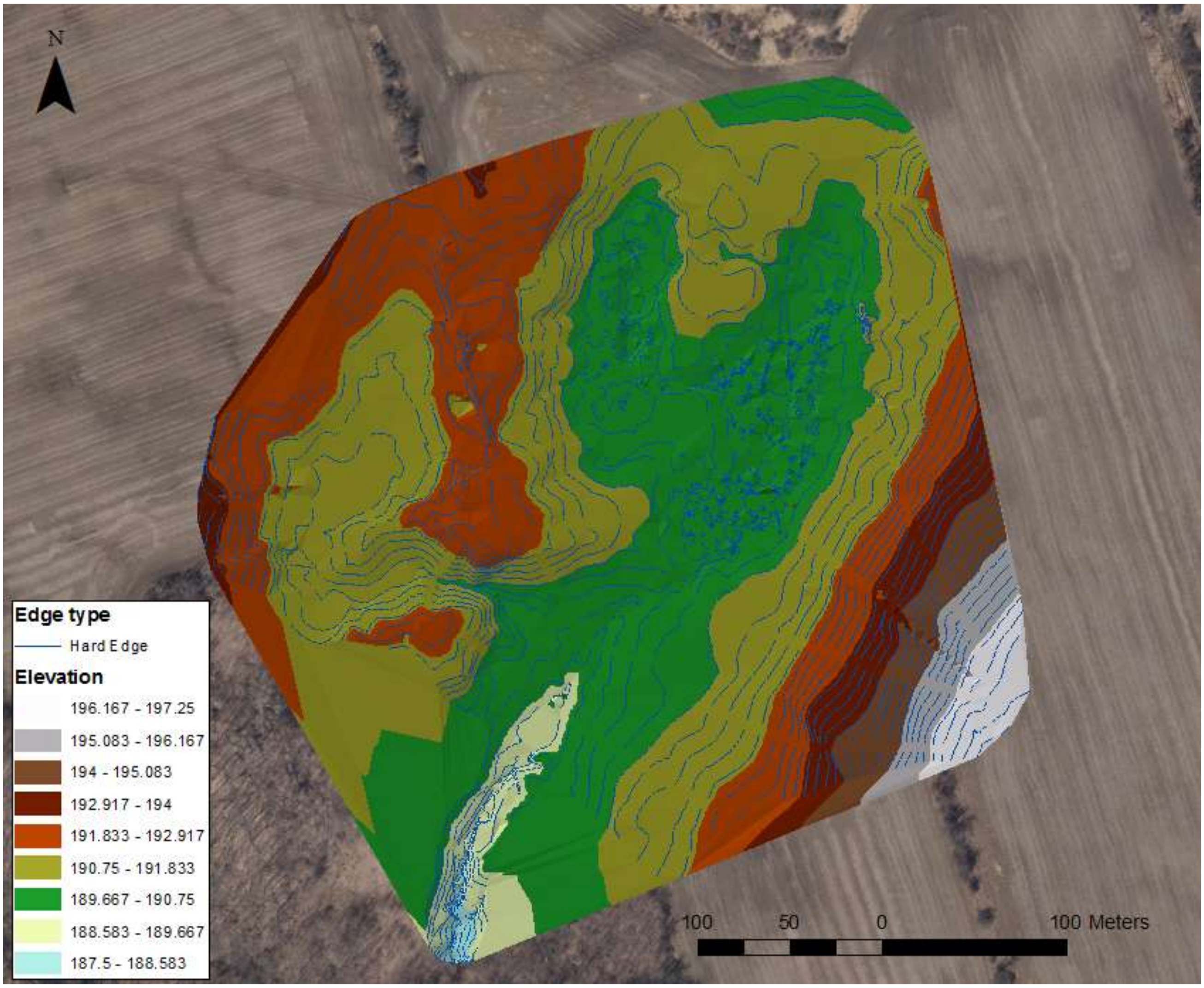


Figure 4: Sideline 26 Wetland Topography and Bathymetry

3.1.3 HEC-HMS: Calibration, Existing Conditions

Figure 5 shows the location of monitoring stations at Sideline 26. There were a set of three wells at four main locations in the wetland, each with a 30cm long screen. One well (SW well) had a screen from +0.05 to -0.25m relative to the surface, another well (1m well) had a screen from -0.7m to -1m relative to the surface, and the third well (2m well) had a screen from -1.7m to -2.0m relative to the surface. The SW well at *Transect 1 - 40m* was used to calibrate the west pool, and the SW well at *Transect 2 – 40* was used to calibrate the east pool. The water levels in the wetland were used for calibration instead of discharge for two main reasons. Firstly, the flume downstream of the wetland became blocked and was circumvented by flow, so there was not enough confidence in the monitored data to use it for calibration. Secondly, the water level in each pool is a variable that can be directly and easily used to assess impact on the ecological functioning of the wetland. Differences in observed water levels between the SW, 1m, and 2m wells were used to gain an understanding of the vertical hydraulic gradients for the monitored periods, and differences in observed water levels at the 1m wells between stations were used to gain an understanding of the horizontal hydraulic gradients for the monitored periods. These values were used to calculate time-series of percolation values from the reservoir commands that represent the wetland pools.

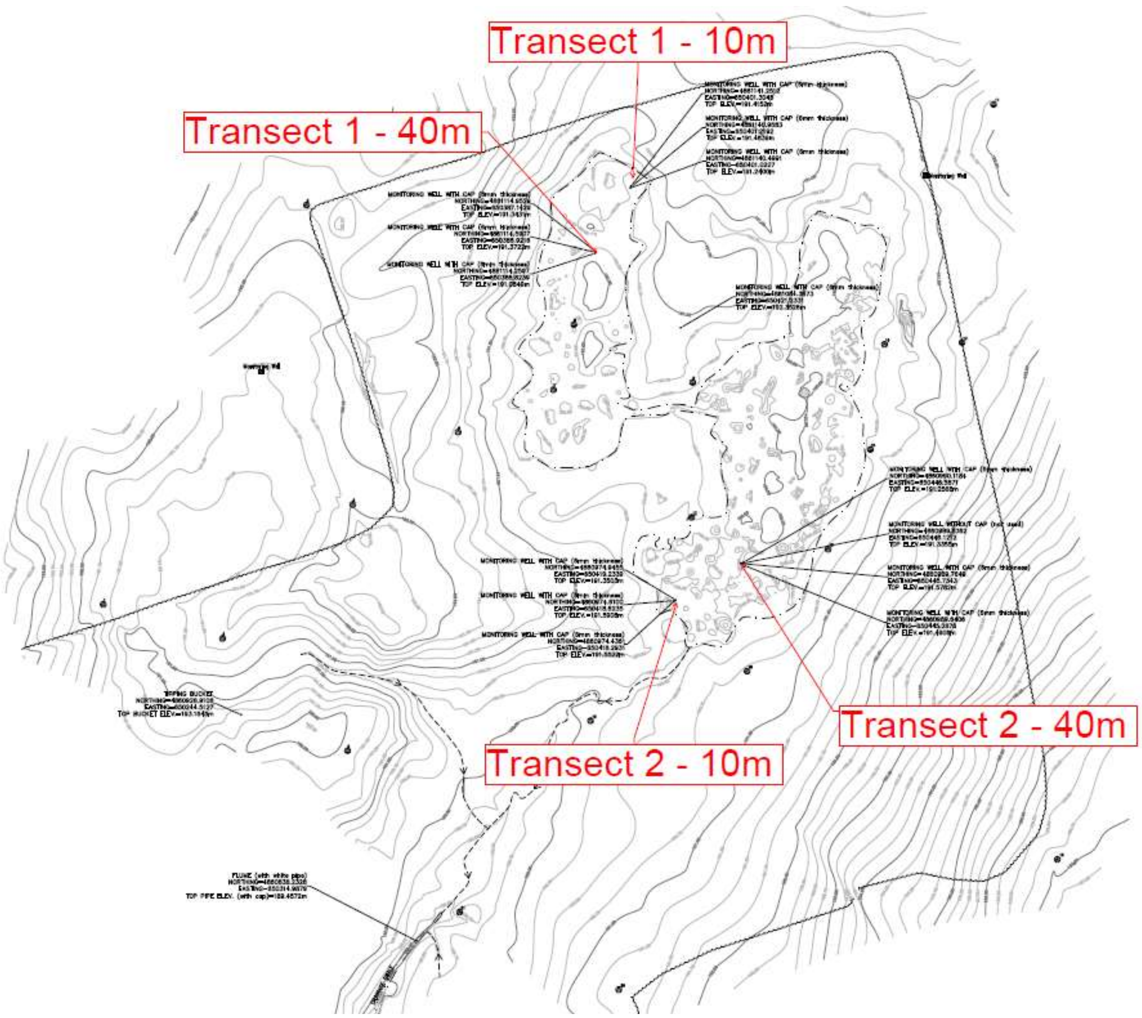


Figure 5: Sideline 26 Monitoring Stations

Observed data for 2013 was used to calibrate the model. The water level observations were recorded hourly, and converted to a daily average for the purpose of calibration. The model was run with an hourly time step, and daily average output was used for comparison with observed data.

After achieving a reasonable visual match, the procedure was repeated twice using data from 2014 and 2015 in order to validate the calibration. The initial model calibrations did not produce simulation results that closely matched observed data for the validation years, so the calibration process was iterated until all three years showed reasonable results.

Table 1 shows the main parameters that were modified from initial parameters during the calibration and validation process.

3.1.4 HEC-HMS: Validation, Existing Conditions

Table 1: HEC-HMS calibration parameters

Parameter	Units	Initial Value	Calibrated Value
Canopy: Max Storage	mm	1 to 2.7	1.03 to 1.2
SMA Loss: Max Infiltration	mm/hr	3 to 15	7
SMA Loss: Soil Storage	mm	121.75	153.2
Tension Storage	mm	39	39
Modeled stage-discharge curve for west pool	n/a	as modeled	elevation of first discharge and low flow discharge values were modified during calibration
Modeled stage-discharge curve for east pool			
Additional outlet for west pool percolation	m^3/s	0	1E-05 to 3E-05
Additional outlet for east pool percolation		0	1E-05 to 1.2E-04

After a reasonable visual match with all three years of data was achieved, three statistical measures were used to compare the goodness of fit between observed and simulated water level: Percent Difference (%D), coefficient of determination (R^2), and Nash-Sutcliffe simulation efficiency (E_{NS}).

Figures 6 through 11 show the calibration and validation results for the two wetland pools.

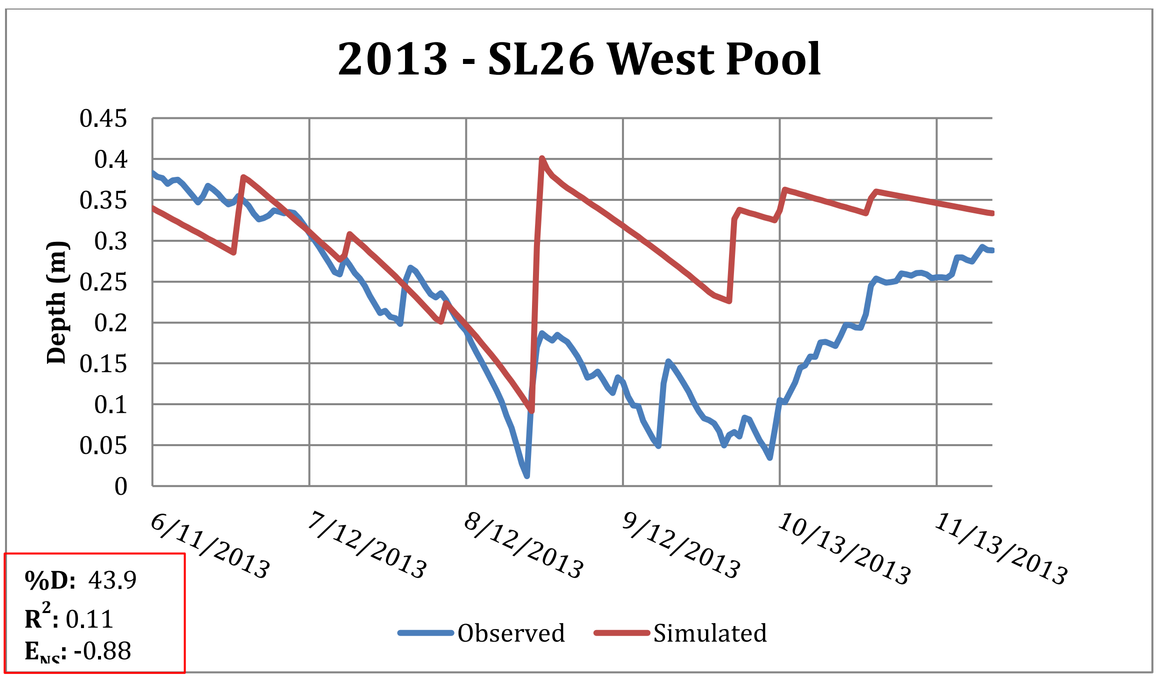


Figure 6: Sideline 26 West Pool Calibration with 2013 data

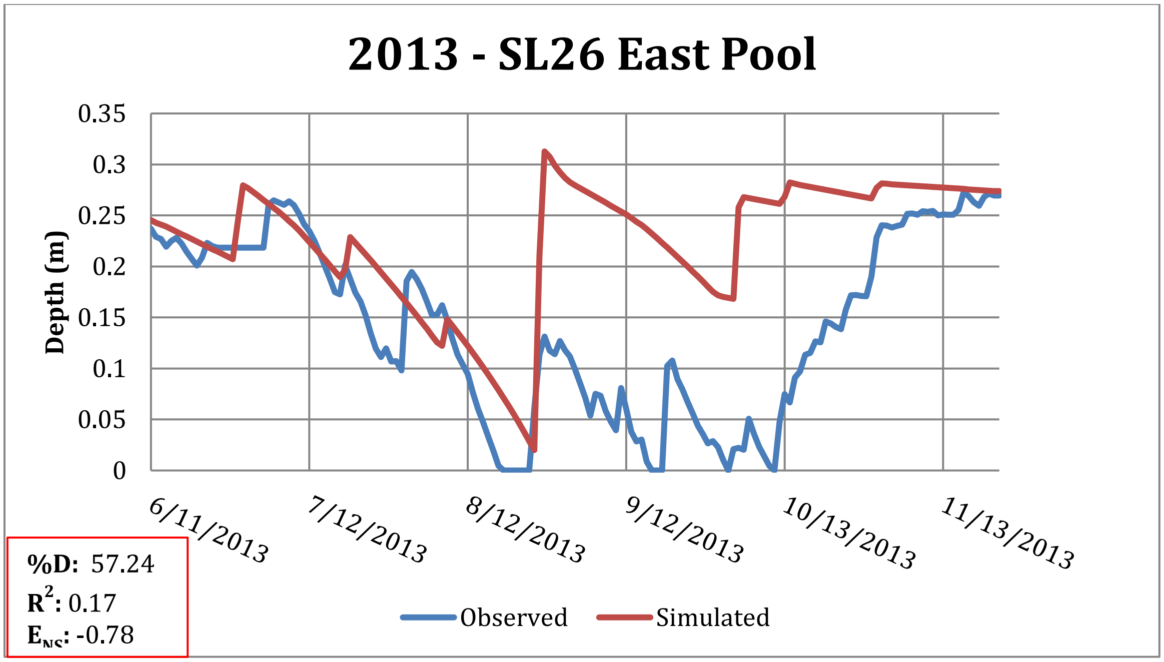


Figure 7: Sideline 26 East Pool Calibration with 2013 data

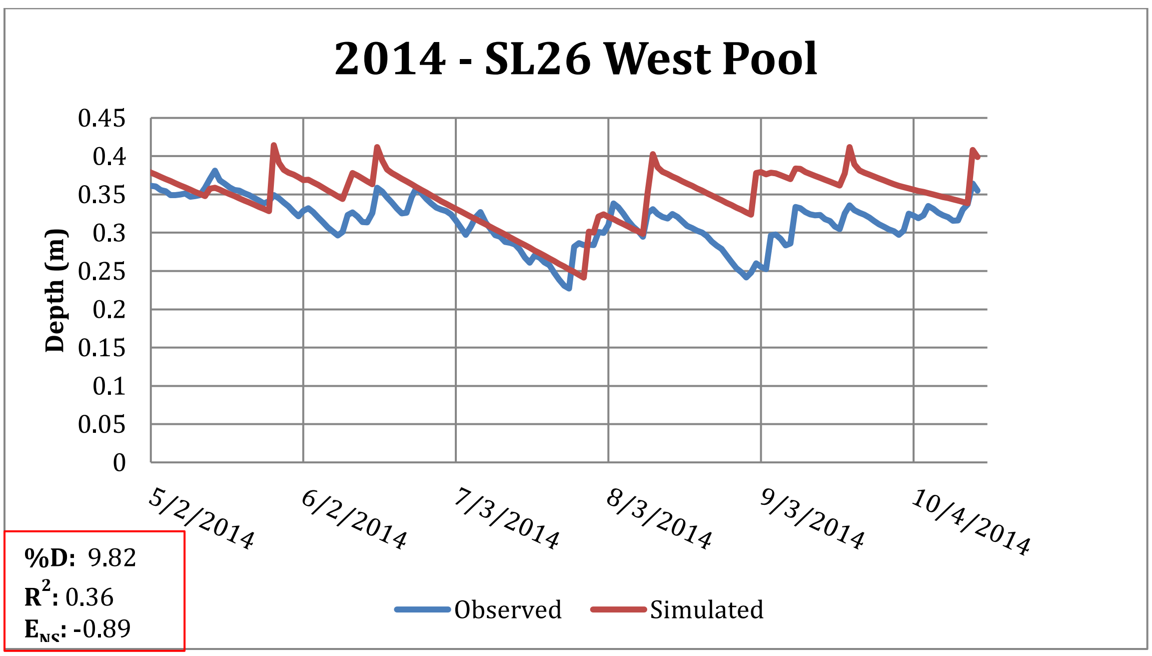


Figure 8: Sideline 26 West Pool Validation with 2014 data

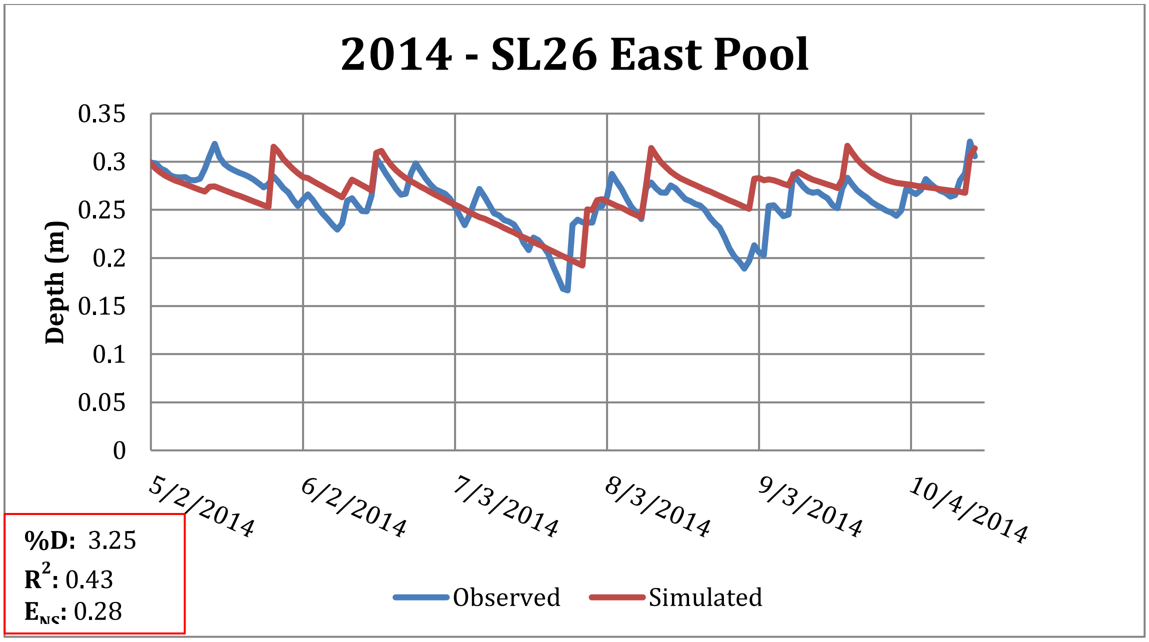


Figure 9: Sideline 26 East Pool Validation with 2014 data

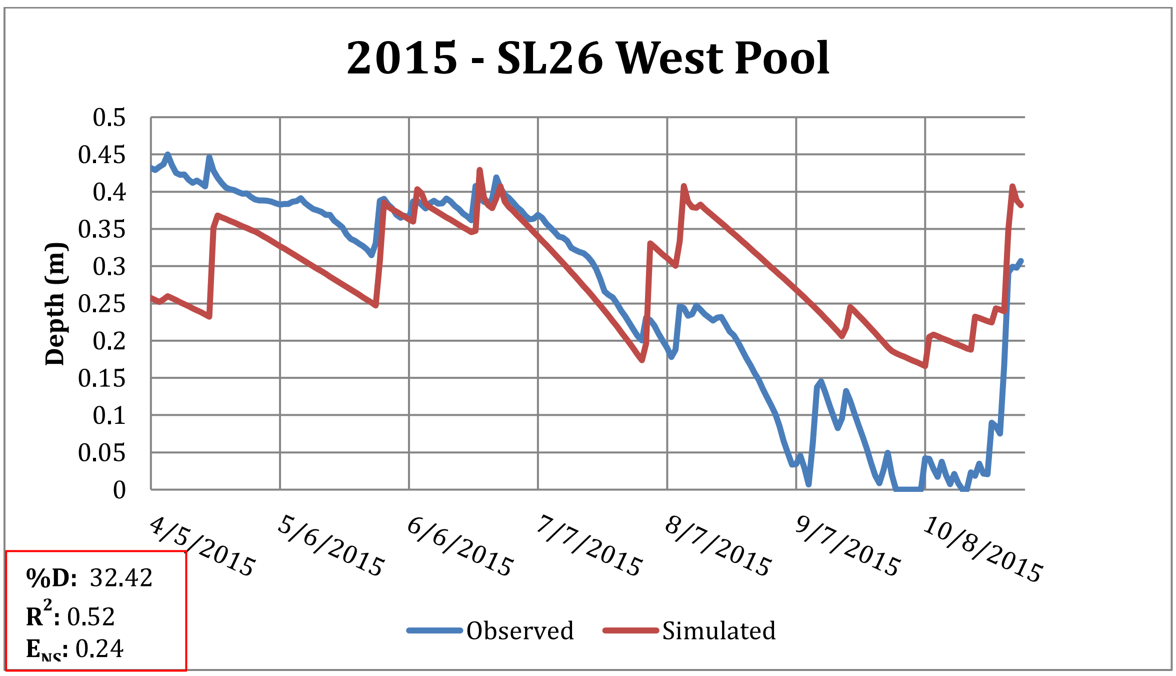


Figure 10: Sideline 26 West Pool Validation with 2015 data

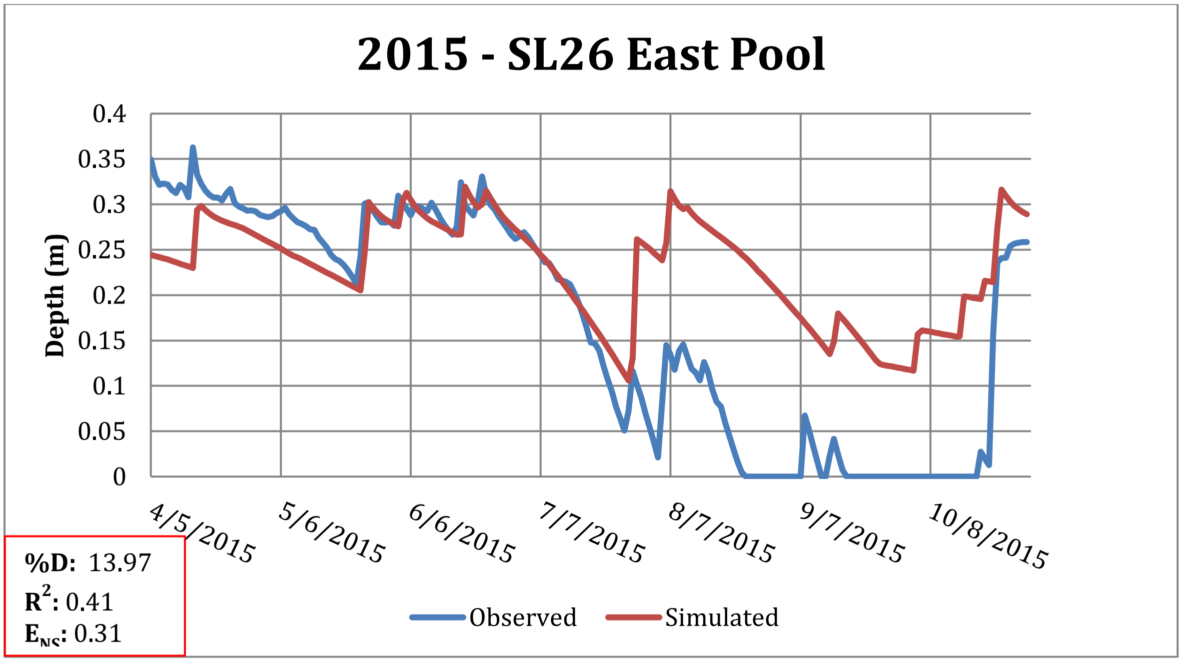


Figure 11: Sideline 26 East Pool Validation with 2015 data

3.1.5 HEC-HMS: Long-term Simulation, Proposed Conditions without Mitigation

Once the model was calibrated and validated, a post-development model was created. 3 hectares of farmland draining to the East Pool of the wetland was urbanized and diverted away from the wetland. A long-term simulation was conducted with the pre-development and post-development models in which 20 years of historical meteorological were used. These simulations used a daily time-step. Since the evaporation from the wetland is represented by fixed monthly values, the discharge to the wetland from the affected drainage area was compared instead of the wetland water level. Figure 12shows a comparison of pre and post development cumulative discharge volume from the disturbed drainage area.

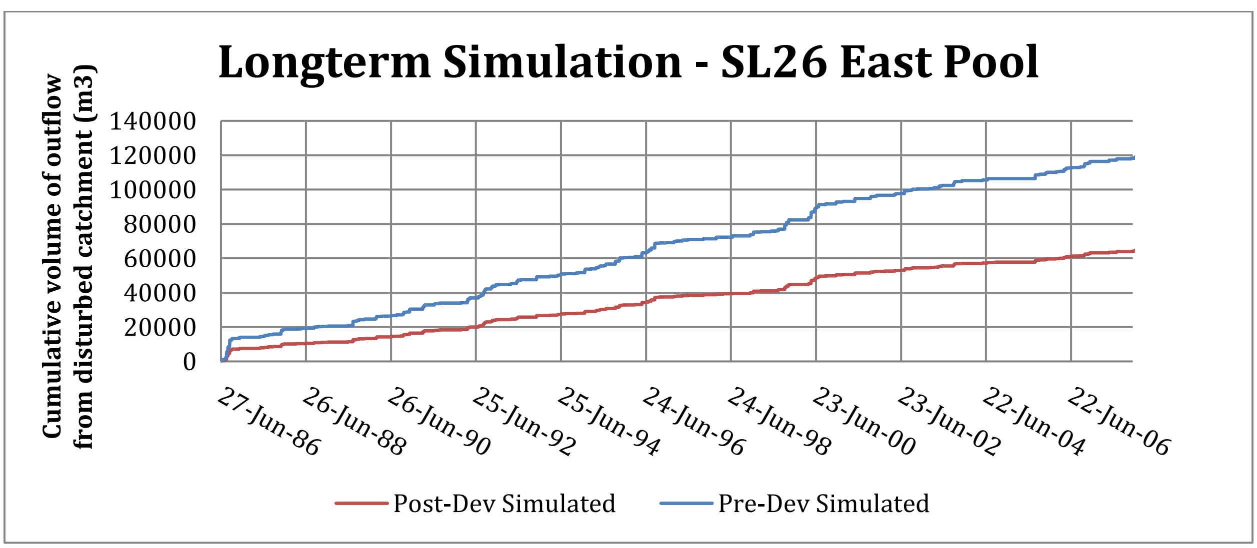


Figure 12: Long-term simulation for Pre-development and Post-development land use condition

3.1.6 HEC-HMS: Long-term Simulation, Proposed Conditions with Mitigation

A third model was created to inform the mitigation measures that would be required to ensure minimal changes to the wetland hydrology as a result of the land-use change. A percentage of the impervious area diverted away from the wetland was re-introduced to the wetland in order to maintain the existing-condition wetland hydro period. It was found that the discharge to the wetland was maintained when 11% of the 3 hectare urbanized catchment was allowed to drain to the wetland. A portion of clean runoff from the roof area of the new development equal to 11% of the 3 hectare urbanized catchment could be directed to the wetland's East Pool to maintain the wetland hydroperiod. Figure 13shows a comparison of the long-term simulations for the pre-development and mitigated post-development cumulative discharge volume from the disturbed drainage area.

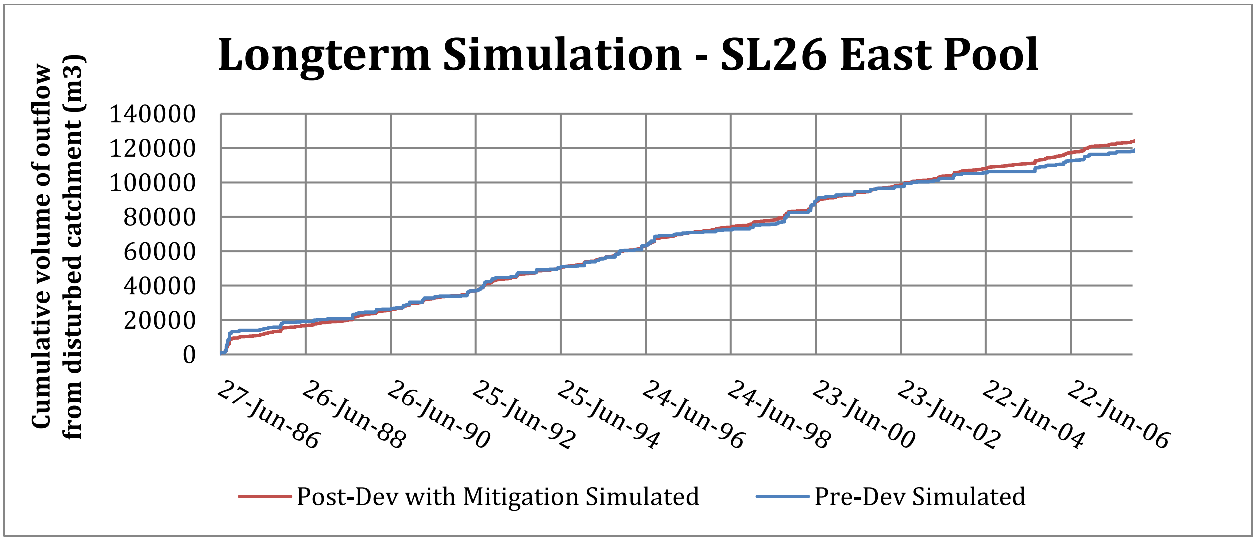


Figure 13: Long-term simulation for Pre-development and Mitigated Post-development land use condition

3.1.7 HEC-HMS: Benefits, Challenges, Recommendations and References

In conducting this case study, a number of benefits, challenges, and recommendations for using HEC-HMS for feature based water balance analysis were identified and summarized below.

Benefits

- User friendly interface, and very intuitive for new users
- Interception storage and crop coefficients can be variable based on time of year
- *Outflow Structures* reservoir method allows for multiple outlets, so percolation losses from the surface storage in the reservoir command can be accounted for separately from the stage-storage-discharge relationship
- The reservoir command allows for monthly evaporation to be accounted for
- Time-series simulation results for all model variables can be easily viewed and compared, which speeds up manual calibration and validation process.
- Quick model run-time
- Many low impact development measures could be easily represented through a combination of subbasin and reservoir commands

Challenges

- When modelling the wetland as a combination of a subbasin (to account for interception storage, underlying soil storage, and to generate runoff from the catchment area) and a downstream reservoir command (to accept flow from external drainage areas, and to account for the stage-storage-discharge relationship of the wetland surface) evapotranspiration must be partitioned between the subbasin and the reservoir commands.
- Evaporation from the reservoir command is represented by fixed monthly values. This introduces a source of error into the simulation, and it also greatly decreases the feasibility of conducting long-term simulations for the wetland water level. To avoid this drawback, long-term simulations could be conducted on the inflows to the wetland; the limitation being that if there are differences in the pre-development and mitigated post-development scenarios, the severity of those differences cannot be assessed with as much certainty as with a comparison of wetland water levels.
- When modelling the wetland as a combination of a subbasin and a downstream reservoir command, a calculation outside of the program is required to represent percolation from the reservoir command. This can become problematic during long-term simulations where monitored groundwater data is not available, especially if the percolation values are highly influenced by down-gradient soil and groundwater storage
- Dynamic interaction with groundwater that is outside of the surface drainage area of the wetland is not possible

Recommendations

- HEC-HMS may be suitable for conducting feature-based water balance analyses on low-medium risk wetlands that are surface-water driven
- Fixed monthly evaporation from the reservoir command is a major limitation when attempting to simulate and compare wetland water levels

References

Bennett, T.H. (1998). Development and application of a continuous soil moisture accounting algorithm for the Hydrologic Engineering Center Hydrologic Modelling System (HEC-HMS). MS thesis. Dept. of Civil and Environmental Engineering, University of California, Davis.

Feldman, A. (2000). Hydrologic Modelling System HEC-HMS Technical Reference Manual . U.S. Army Corps of Engineers Hydrologic Engineering Center, March 2000.

Leavesley, G.H., Lichty, R.W., Troutman, B.M., and Saindon, L.G. (1983). Precipitation-runoff modelling system user's manual, Water-Resources Investigations 83-4238. United States Department of the Interior, Geological Survey, Denver, CO.

Scharffenberg, W (2016). Hy drologic Modelling System HEC-HMS User's Manual. U.S. Army Corps of Engineers Institute for Water Resources Hydrologic Engineering Center, August 2016.

US Army Corps of Engineers, Hydrologic Engineering Center. *HEC-HMS.* Retrieved from http://www.hec.usace.army.mil/software/hec-hms/

3.2 Hydrologic Simulation Program – Fortran (HSPF)

3.2.1 HSPF: Background

The US Environmental Protection Agency (US-EPA) HSPF (Hydrologic Simulation Program-Fortran) program has its origin in the Stanford Watershed Model developed by Crawford and Linsley (1966). It can reproduce spatial variability by dividing the basin in hydrologically homogeneous land segments and simulating runoff for each land segment independently. A segment of land can be modeled as pervious or impervious. In pervious land segments HSPF models the movement of water along three paths: overland flow, interflow and groundwater flow. Snow accumulation and melt, evaporation, precipitation and other fluxes are also represented. HSPF uses a continuous simulation approach, and is a highly flexible model that aims to be comprehensive in its representation of watershed hydrology and water quality processes. The potential applications and uses of the model are comparatively large, and include flood control planning and operations, hydropower studies, river basin and watershed planning, storm drainage analyses, water quality planning and management, point and nonpoint source pollution analyses, soil erosion and sediment transport studies, evaluation of urban and agricultural best management practices, fate, transport, exposure assessment, and control of pesticides, nutrients, and toxic substances, and time-series data storage, analysis, and display (AQUA TERRA Consultants, 2011).

Figure 14 presents a conceptual model schematic for HSPF.

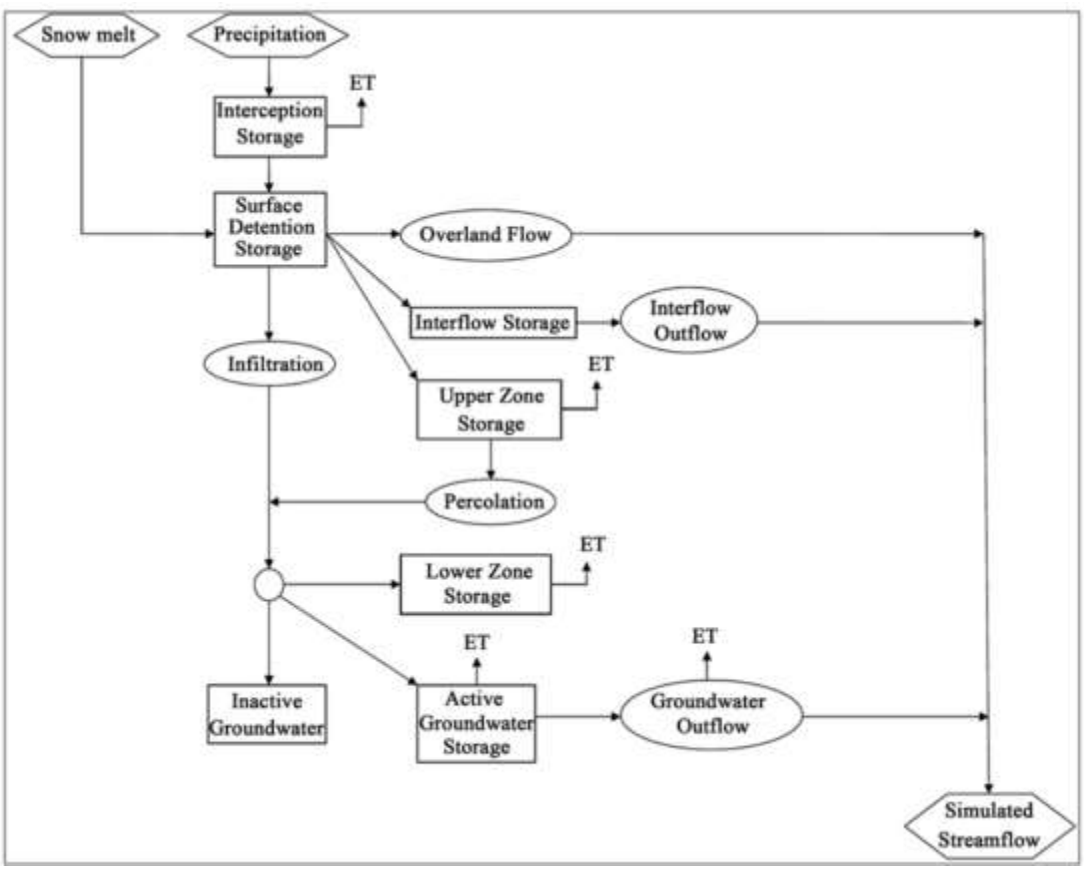


Figure 14: Conceptual Model Schematic for HSPF (Source: Amirhossien et al., 2015)

3.2.2 HSPF: Model Setup, Existing Conditions

The case study area used for evaluation is a wetland at Seaton Sideline 26, which is located in the City of Pickering within the Duffins Creek Watershed. Figure 2 shows the wetland and drainage areas, which were delineated using a 1m by 1m bare earth grid that was generated using LiDAR data from 2014. The wetland is divided into two pools. 2.05 hectares drain to the west pool of the wetland. The west pool drains overland to the east pool. The east pool receives runoff from an additional 7.31 hectares of land, for a total drainage area of 9.36 hectares.

Figure 3 shows the land use within the wetland drainage area, which includes farmland, forest, successional, and wetland. The drainage areas were further separated into these four land use categories, in order to use different parameters for each land use within the model. In particular, the difference in land use was reflected in different values for the interception storage capacity (CEPSC) and the lower zone evapotranspiration (LZETP) parameters.

The soil classification for the entire drainage area to the wetland is a Gleyed Gray Brown Luvisol. A soil description from Agriculture and Agri-Food Canada was used to generate initial parameters for Lower Zone Nominal Storage (LZSN) Infiltration (INFILT) and Upper Zone Nominal Storage (UZSN). In particular, the values for the volume of air in the soil at various pore pressures and the saturated hydraulic conductivity at the various soil horizons in the soil description were used to estimate the LZSN, INFILT, and UZSN parameters in the model.

Initial values for the groundwater recession rate (AGWRC) parameter were first estimated by observing the rate of decline of flow at a flume downstream of the wetland. Initial values for the initial active groundwater storage (AGWS) parameter were first estimated by observing the starting water level at the 2m deep well relative to the 1m deep soil column that was represented by the UZSN and LZSN parameters. Both of these parameters were used as calibration parameters. The initial values for the DEEPFR parameter (fraction of groundwater inflow which will enter deep inactive groundwater and thus be lost from the system as defined in HSPF) were initially set to zero, with the knowledge that they would be one of the main calibration parameters that determine how much moisture is lost from the system.

Figure 4 shows the topography and bathymetry of the wetland, which was generated from a site survey. The elevation information was used to create detailed stage-storage relationships for each of the two major wetland pools. In order to estimate the discharge at each stage, the wetland was modeled in HEC-RAS as two storage areas connected by a broad-crested weir, and discharging over a second broad-crested weir to the downstream channel. Cross-sections were cut at the outlet of each pool using the elevation information, and the cross-section information was used for the weir geometry. An unsteady simulation was performed, with flow rates gradually ramped up from a low flow to a high flow, in order to ensure that the results would have a good spread of stage-discharge information. Equations were fit to the resulting rating curves, so that discharge values could be calculated at each known elevation and storage for each pool. The resulting stage-storage-discharge information was used in two separate FTABLES in HSPF which represent the surface storage at the west pool and the east pool of the wetland. The exact elevation at which each pool begins to discharge, as well as the discharge estimates closest to these elevations were treated as a calibration parameters.

3.2.3 HSPF: Calibration and Validation, Existing Conditions

Figure 5 shows the location of monitoring stations at Sideline 26. There were a set of three wells at four main locations in the wetland, each with a 30cm long screen. One well (SW well) had a screen from +0.05 to -0.25m relative to the surface, another well (1m well) had a screen from -0.7m to -1m relative to the surface, and the third well (2m well) had a screen from -1.7m to -2.0m relative to the surface. The SW well at *Transect 1 - 40m* was used to calibrate the west pool, and the SW well at *Transect 2 – 40* was used to calibrate the east pool. The water levels in the wetland were used for calibration instead of discharge for two main reasons. Firstly, the flume downstream of the wetland became blocked and was circumvented by flow, so there was not enough confidence in the monitored data to use it for calibration. Secondly, the water level in each pool is a variable that can be directly and easily used to assess impact on the ecological functioning of the wetland.

In order to make the calibration process more intuitive, the observed water levels were converted into ‘observed’ surface storage volumes, so that differences between observed and simulated inputs, outputs, and storages could be more easily conceptualized during calibration. Observed water levels in the 2m wells were used to approximate initial groundwater storage values. Differences in observed water levels between the SW, 1m, and 2m wells were used to gain an understanding of the vertical hydraulic gradients for the monitored periods, and differences in observed water levels at the 1m wells between stations were used to gain an understanding of the horizontal hydraulic gradients for the monitored periods.

Observed data for 2013 was used to calibrate the model. The water level observations were recorded hourly, and converted to a daily average for the purpose of calibration. The model was run with an hourly time step, and daily average output was used for comparison with observed data.

Daily average observed water level was converted to daily average ‘observed’ storage, and visually compared with simulated daily average storage within the wetland. After achieving a good visual match, the procedure was repeated twice using data from 2014 and 2015 in order to validate the calibration. The initial model calibrations did not produce simulation results that closely matched observed data for the validation years, so the calibration process was iterated until all three years showed good results. All model parameters remained the same between simulations with two exceptions: AGWS (used to specify the initial active groundwater storage at the start of the simulation) and VOL (initial volume of water in the reach/reservoir) were different for each of the three years to account for the different observed water levels at the start of the simulation period for each of the three years.

Table 2 and Table 3 show the main parameters that were modified from initial parameters during the calibration and validation process.

Table 2: HSPF calibration parameters related to Pervious Land Segments

Parameter	Parameter Description	Units	Initial Value	Calibrated Value	Comments
PWAT-PARM2					
LZSN	Lower zone nominal storage	mm	128.2	319	Initially calculated as volume of voids in soil column (minus voids taken up by hygroscopic water) in A and B soil horizon minus 25.4mm for UZSN. Modified during calibration to include voids in C soil horizon (minus voids taken up by hygroscopic water), and to account for calibrated UZSN value
INFILT	Index to infiltration capacity of soil	mm/hr	7	3.3	Modified during calibration to allow for more surface runoff and interflow during higher intensity rainfall events
PWAT-PARM3					
DEEPFR	Fraction of groundwater that becomes inactive	fraction	0	0.73 to 0.8	Last parameter to be modified during calibration, once the other losses (PET fraction and percolation from RCHRES had been selected)
PWAT-PARM4					
UZSN	Upper zone nominal storage	mm	25.4	5	Modified during calibration to allow for more surface runoff and interflow during higher intensity rainfall events
PWAT-STATE1					
AGWS	Initial active groundwater storage	mm	1	1 to 12	Modified during calibration to reflect initial groundwater conditions and allow for difference in simulation between years that had different groundwater conditions

Table 3: HPSF calibration parameters related to Reach-Reservoir commands

Parameter	Parameter Description	Units	Initial Value	Calibrated Value	Comments
HYDR-INIT					
VOL	Initial volume of water in RCHRES	1.0E-6 m^3	n/a	n/a	Modified during calibration in conjunction with AGWS to ensure that initial volume in wetland matches with observed initial volume in wetland
FTABLES					
FTABLE for West Pool RCHRES	Stage-storage-discharge relationship	n/a	n/a	n/a	Because stage-discharge relationships were estimated using hydraulic models rather than measured, the elevation where discharge first occurs needed to be modified to match observed water levels.
FTABLE for East Pool RCHRES					
Additional outlet for West Pool RCHRES	To account for percolation from RCHRES	m^3/s	0	1.04E-05	A harmonic mean of saturated hydraulic conductivity estimates from Agriculture and Agri-food Canada's soil description, as well as a range of saturated hydraulic conductivity estimates from pumping tests conducted in the field were used in conjunction with observed lateral hydraulic gradients to provide estimates of percolation from the wetland pools.
Additional outlet for East Pool RCHRES			0	1.40E-04	
EXT SOURCES					
MultFact of POTEV for West Pool RCHRES	Fraction of PET applied to RCHRES	fraction	0	0.33	In order to calibrate using water level in a RCHRES, a fraction of the evapotranspiration needs to be deducted after the water enters the RCHRES
MultFact of POTEV for East Pool RCHRES	Fraction of PET applied to RCHRES	fraction	0	0.33	

After a good visual match with all three years of data was achieved, three statistical measures were used to compare the goodness of fit between observed and simulated water level: Percent Difference (%D), coefficient of determination (R^2), and Nash-Sutcliffe simulation efficiency (E_{NS}).

Figures 15 through 20 show the calibration and validation results for the two wetland pools.

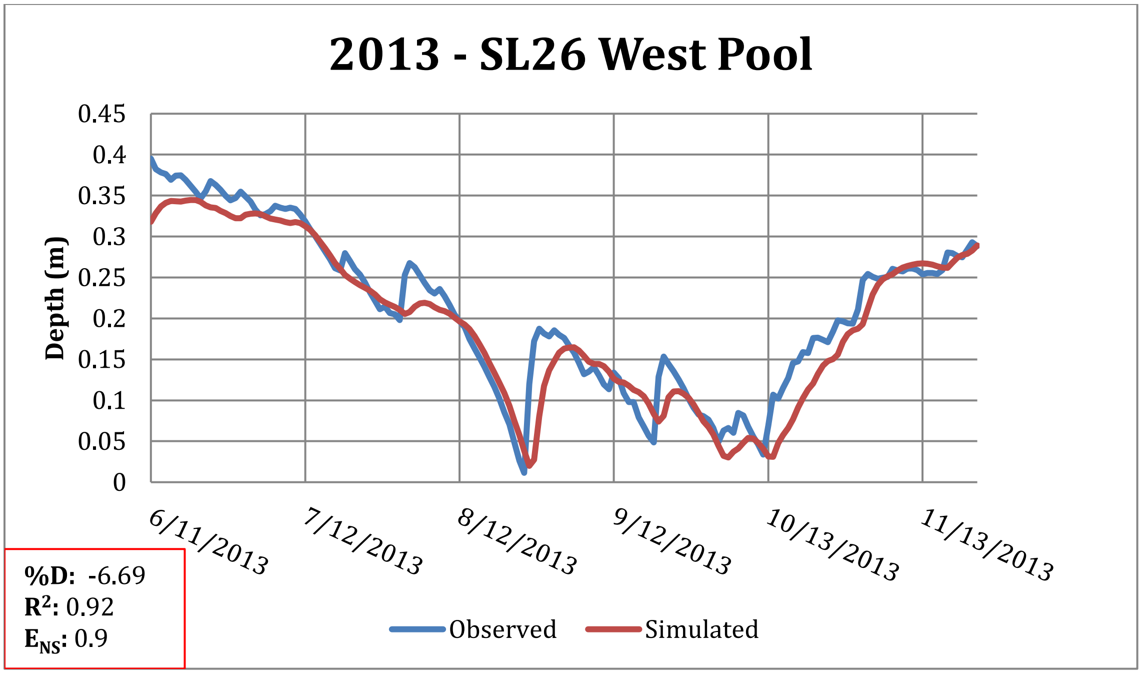


Figure 15: Sideline 26 West Pool Calibration with 2013 data

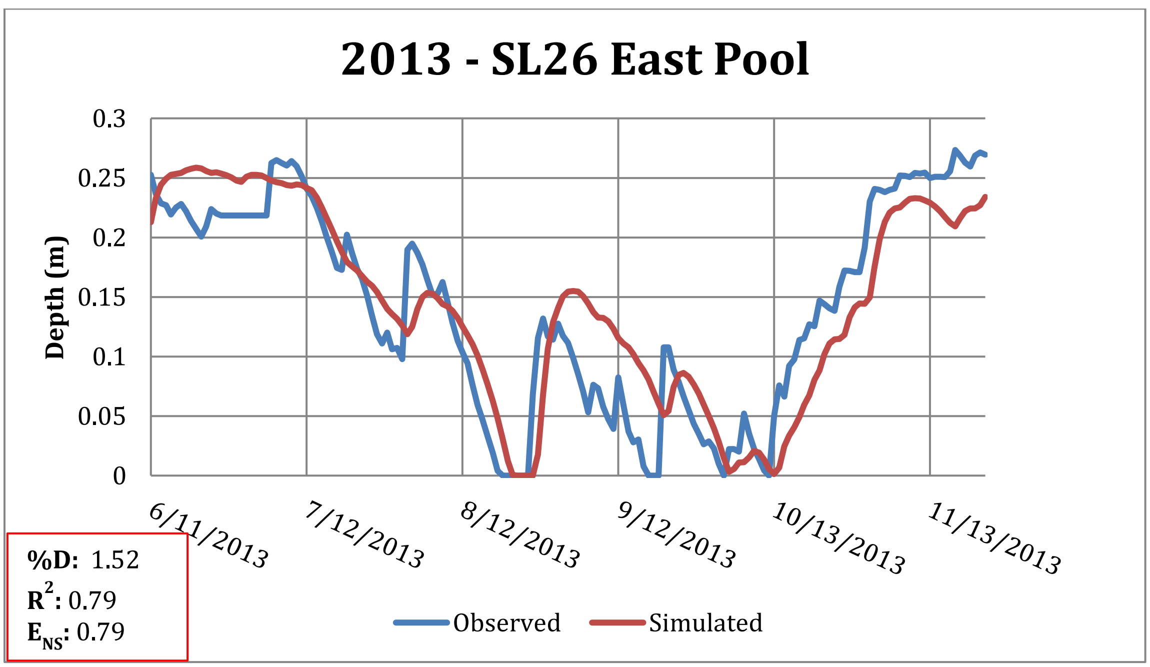


Figure 16: Sideline 26 East Pool Calibration with 2013 data

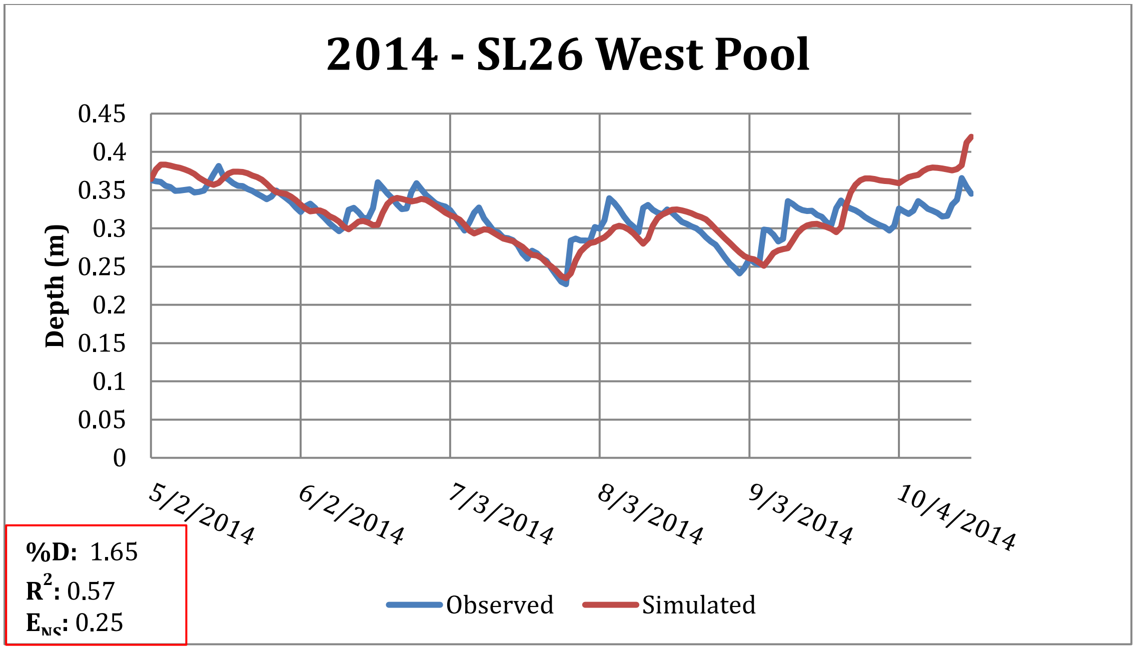


Figure 17: Sideline 26 West Pool Validation with 2014 data

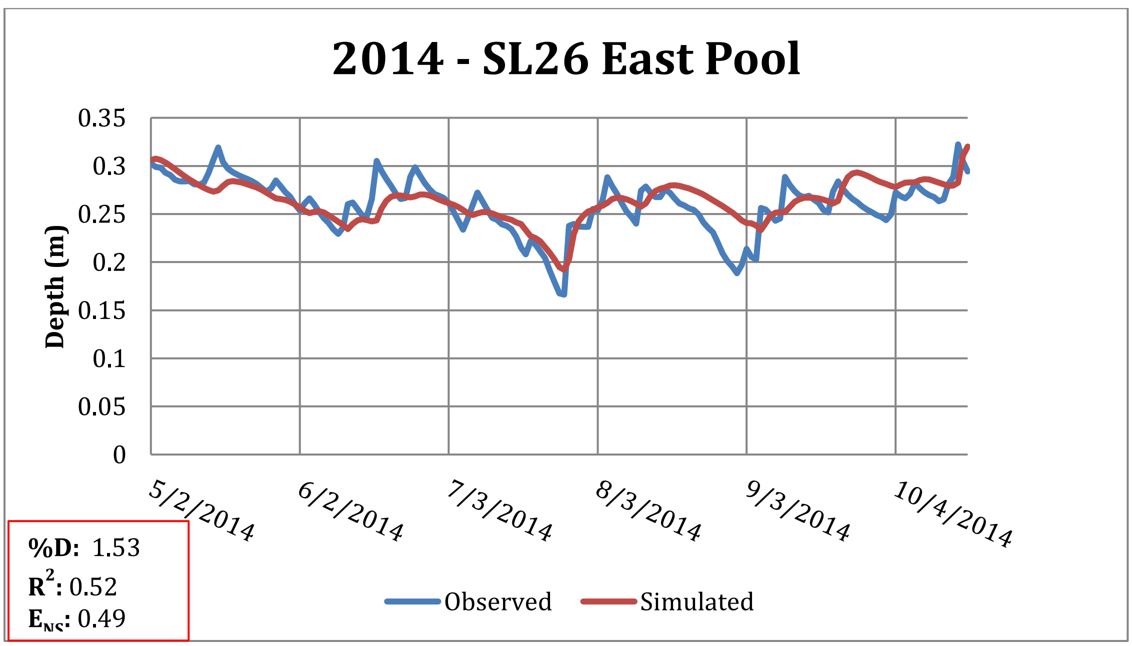


Figure 18: Sideline 26 East Pool Validation with 2014 data

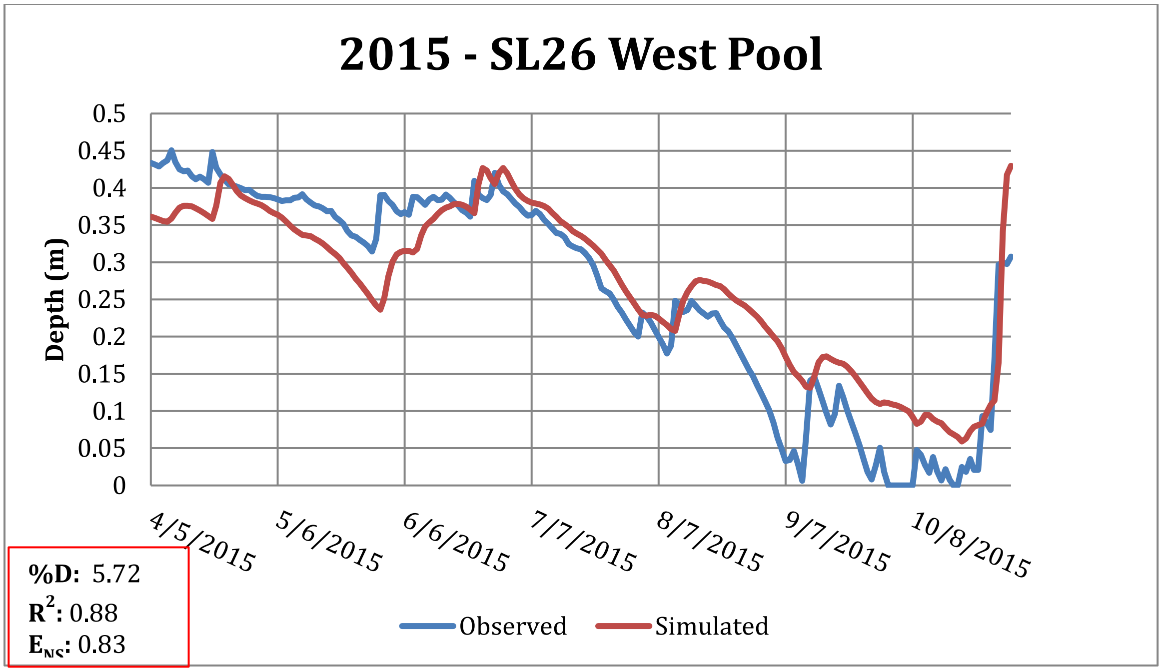


Figure 19: Sideline 26 West Pool Validation with 2015 data

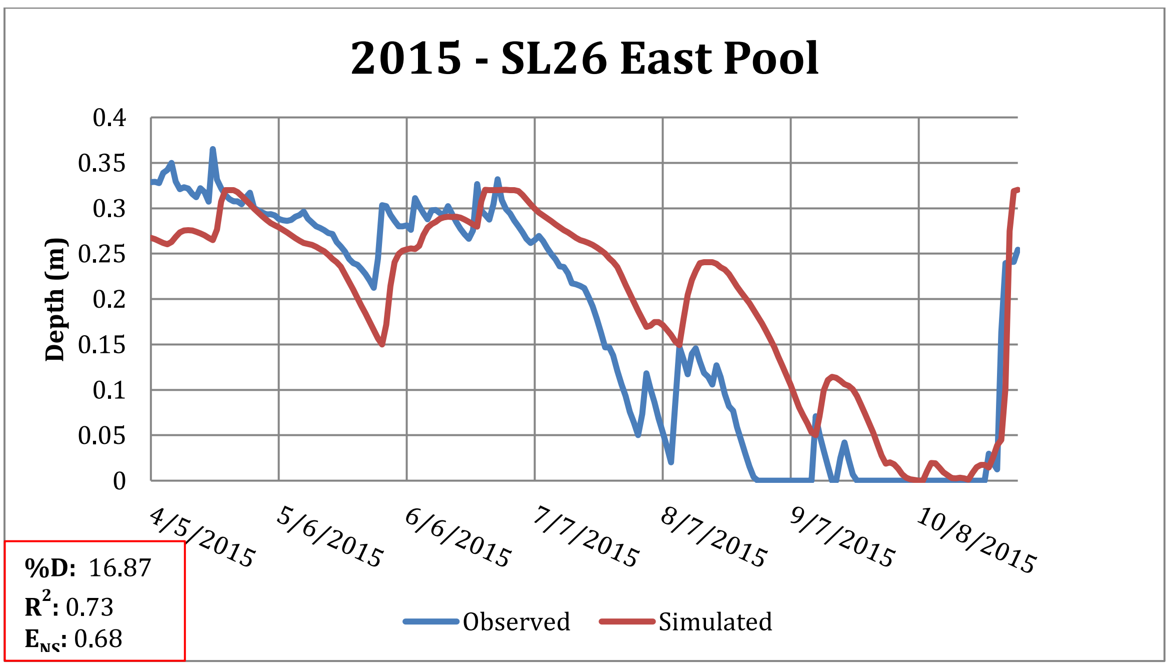


Figure 20: Sideline 26 East Pool Validation with 2015 data

3.2.4 HSPF: Long-term Simulation, Proposed Conditions without Mitigation

Once the model was calibrated and validated, a post-development model was created. 3 hectares of farmland draining to the East Pool of the wetland was urbanized and diverted away from the wetland. A long-term simulation was conducted with the pre-development and post-development models in which

20 years of historical meteorological were used. These simulations used a daily time-step, and the results were compared visually using a running monthly-average, as shown in Figure 21: Long-term simulation for Pre-development and Post-development land use condition.

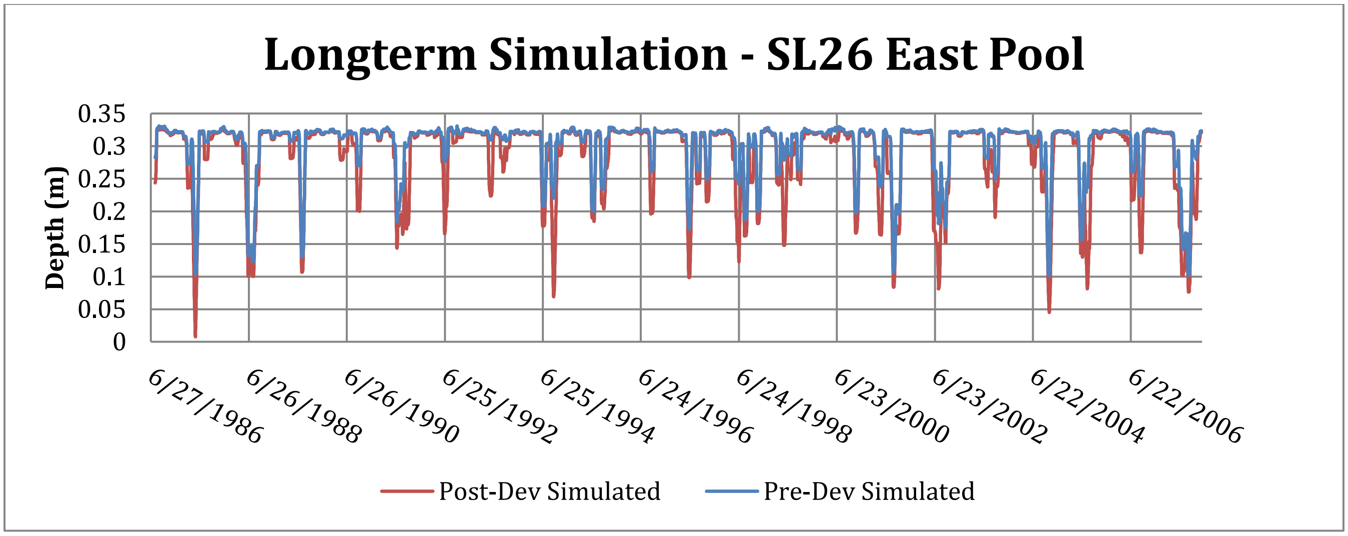


Figure 21: Long-term simulation for Pre-development and Post-development land use condition

3.2.5 HSPF: Long-term Simulation, Proposed Conditions with Mitigation

A third model was created to inform the mitigation measures that would be required to ensure minimal changes to the wetland hydrology as a result of the land-use change. A percentage of the impervious area diverted away from the wetland was re-introduced to the wetland in order to maintain the existing-condition wetland hydro period. It was found that the hydroperiod was maintained when 25.9% of the 3 hectare urbanized catchment was allowed to drain to the wetland. A portion of clean runoff from the roof area of the new development equal to 25.9% of the 3 hectare urbanized catchment could be directed to the wetland's East Pool to maintain the wetland hydroperiod. Figure 22 shows a comparison of the long-term simulations for the pre-development and mitigated post-development scenarios.

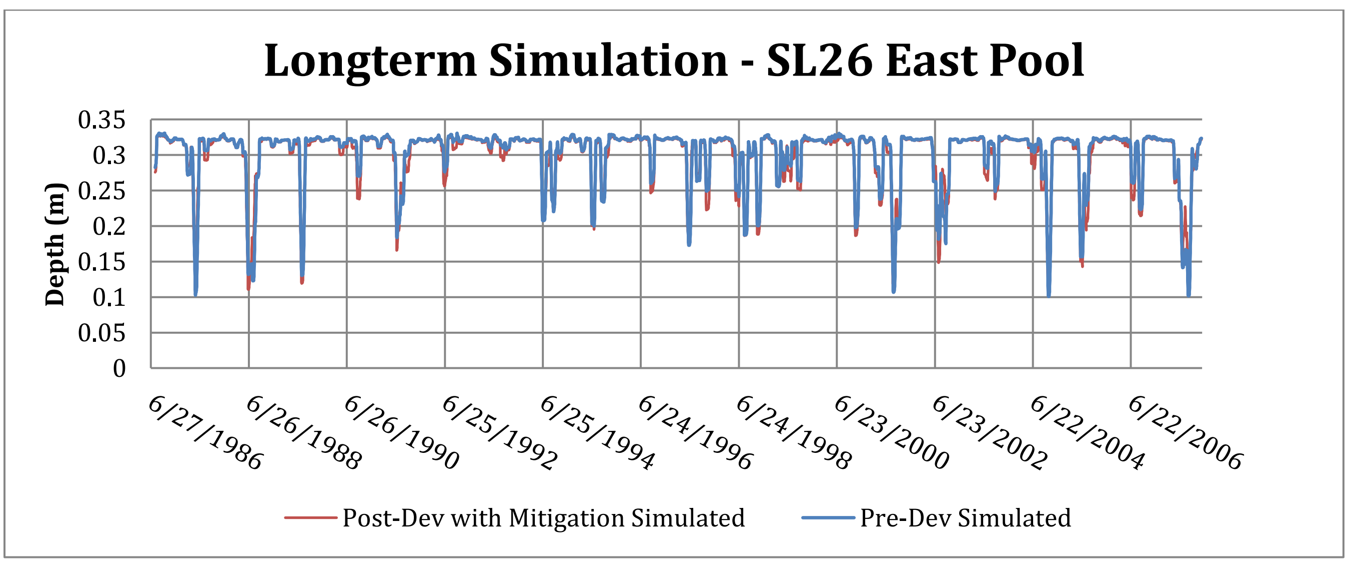


Figure 22: Long-term simulation for Pre-development and Mitigated Post-development land use condition

3.2.6 HSPF: Benefits, Challenges, Recommendations and References

In conducting this case study, a number of benefits, challenges, and recommendations for using HSPF for feature based water balance analysis were identified and summarized below.

Benefits

- The WinHSPF 3.0 interface is helpful for new users to parameterize the model after the User Control Input (UCI) file has been created.
- Many key parameters can be varied monthly
- Time-series simulation results for all model variables can be viewed and compared using Basins, which speeds up manual calibration and validation process.
- Potential Evapotranspiration time-series can be used for both land segments and the reach/reservoir storage-discharge relationships. For modelling of wetlands, it is critical that evapotranspiration can be accounted for after the runoff and/or groundwater discharge enters the reach/reservoir command.
- Shallow water table conditions can be simulated by including the PWAT-PARM6 and PWAT-PARM7 tables, which allow for the water table to rise above groundwater storage and fill upper and lower zone soil storages.
- Reach/Reservoir command allows for multiple outlets, so percolation losses from the surface storage in the reach/reservoir command can be accounted for separately from the stage-storage-discharge relationship
- Quick model run-time
- Many low impact development measures could be easily represented through a combination of land segment and reach/reservoir commands
- BMP Reach Toolkit in Win HSPF 3.0 helps with parameterization of BMP's for infiltration-based stormwater control practices

Challenges

- Creating an initial UCI file can be time-consuming for new users
- WDMUtil tool for managing the time-series WDM files is not currently available for download on the Aqua Terra Website
- When modelling the wetland as a combination of a pervious land segment (to account for interception storage, underlying soil storage, and to generate runoff from the catchment area) and a downstream reach/reservoir command (to accept flow from external drainage areas, and to account for the stage-storage-discharge relationship of the wetland surface) evapotranspiration must be partitioned between the pervious land segment and the reach/reservoir commands.
- When modelling the wetland as a combination of a pervious land segment and a downstream reach/reservoir command, a calculation outside of the program is required to represent percolation from the reach/reservoir command. This can become problematic during long-term simulations where monitored groundwater data is not available, especially if the percolation values are highly influenced by down-gradient soil and groundwater storage
- Dynamic interaction with groundwater that is outside of the surface drainage area of the wetland must be calculated outside of the program.
- Calibration process can be challenging and time-consuming. In particular, the DEEPFR (fraction of groundwater inflow which enters deep inactive groundwater) has a large influence on

simulation results, and appropriate values of this parameter are highly dependent on the spatial scale of the model and the particular feature of interest.

Recommendations

- HSPF is generally well-suited for conducting feature-based water balance analysis
- Calibration in HSPF using wetland water level is possible, but can be time-consuming
- For wetlands with significant groundwater contribution from outside of the surface-water drainage areas, many calculations external to the model would be required

References

Amirhossien, F., Alireza, F., Kazem, J. and Mohammadbagher, S. (2015). A Comparison of ANN and HSPF Models for Runoff Simulation in Balkhichai River Watershed, Iran. *American Journal of Climate Change*, **4**, 203-216.

AQUA TERRA Consultants (2011). *HSPF Support.* Retrieved from http://www.aquaterra.com/resources/hspfsupport/index.php

United States Environmental Protection Agency, Office of Water (2000). EPA BASINS Technical Note 6 Estimating Hydrology and Hydraulic Parameters for HSPF. United States Environmental Protection Agency, Office of Water, July 2000.

Phillips, Andrew. Rural HSPF modelling Technical Guide. Catchment Science Centre, University of Sheffield. Retrieved from https://www.sheffield.ac.uk/polopoly_fs/1.483500!/file/C2C_HSPF_Rural_Modelling__Technical_Guide.pdf

Bicknell, B., Imhoff, J., Kittle, J., Jobes, T., Donigian, A (2005). HSPF Version 12.2 User's Manual. National Exposure Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Athens, Georgia (July 2005).

3.3 MIKE SHE

3.3.1 MIKE SHE: Background

MIKE SHE is a physically-based distributed model that represents an extension of the Systéme Hydrologique Européen (SHE) model, and is maintained and distributed by DHI. MIKE SHE is flexible in terms of the level of detail in which each hydrologic process is simulated. The choice of the appropriate methodology to use for each of the simulated components is a function of a) the specific questions that need to be addressed by the model, and b) the availability of input data with which to construct and calibrate the model. The model has a long history (relative to other integrated flow models) and is used worldwide.

Figure 23 presents the process schematic for MIKE SHE. With the exception of channel routing, all calculations, including precipitation, unsaturated flow, overland flow, and saturated flow are calculated on the same (uniform) grid basis. MIKE SHE links to MIKE-11, DHI's 1D hydraulic model, for channel routing. Table 4 summarizes the major model features in MIKE SHE

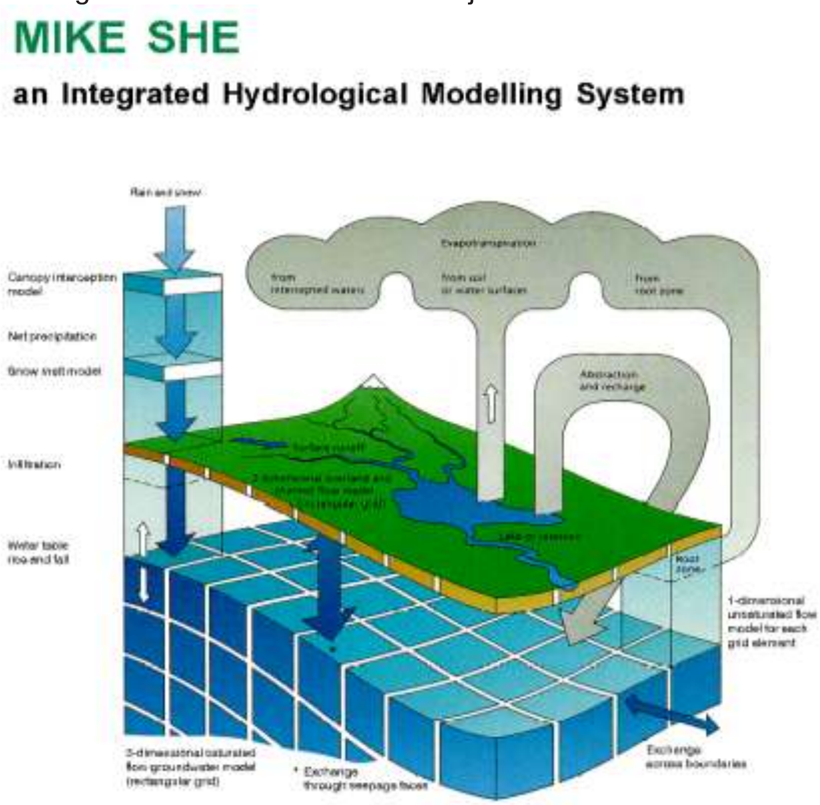


Figure 23: MIKE SHE Process Schematic (Source: DHI, 2009a)

Table 4: MIKE SHE Model Features

Model Features	MIKE SHE
Model Type	Physically-based distributed parameter/lumped parameter
Simulation Type	Continuous/ single-event
Precipitation	Multiple/single hyetograph

Snow Melt	Modified Degree-day approach
Evapotranspiration	Vegetation-based ET (LAI/Rooting Depth)
Infiltration	Fully Richards equation
	Gravity Flow equation
	Two-Layer Water Balance plus Green-Ampt for dry soil condition
Overland Flow	2D diffusive wave approximation/lumped sub-catchment-based
Subsurface Soil Water Flow	1D unsaturated flow
Channel/Reservoir	1D fully dynamic wave approximation
	1D diffusive wave approximation
	1D kinematic wave flow
	Muskingum /Muskingum-Cunge Routing
Groundwater Flow	3D groundwater flow/Linear Reservoir Approach
GIS interface	Accept GIS format data including point/contour/polygon/polyline/ASCII

Applications of the MIKE SHE model have a very long publication record including the recent work of Vazquez et al. (2008), Hansen et al. (2007) and Thompson et al. (2004). Additionally, MIKE SHE has consistently ranked high in a number of model comparison studies including Gordon et al. (2005), Weber et al. (2004) and Camp Dresser & McKee (2001). Because the model is proprietary, the source code is not available. The model is well-documented and actively being maintained and updated. DHI, the developers of MIKE SHE, also provide numerous training courses on their software at locations around the world. MIKE SHE can be purchased online at: www.mikepoweredbydhi.com. The cost of the code varies depending on the options the user wishes to include. Prices range from approximately CAD $14,160 for government agencies to CAD $17,700 for standard commercial use for a perpetual license that includes the first year of technical support and upgrades. While the perpetual license does not time-out, an annual service and maintenance fee is required after the first year in order to continue receiving technical support and software updates. The annual cost of the service agreement is approximately CAD $5,000.

3.3.2 MIKE SHE: Model Setup, Existing Conditions

The case study area used for evaluation is Seaton Sideline22 Wetland area, which is located in City of Pickering within Duffins Creek watershed. Total drainage area is 17.34ha, and wetland pool area is 0.58ha. A1-m LiDAR map (Figure 24) shows the topography of the area. In the study area land cover is dominated by agricultural fields and wood areas (see Figure 25), and soil is dominated by sandy loam/loam. An existing regional groundwater model (MODFLOW) was available covering most of TRCA’s jurisdiction. Table 5: MIKE SHE data sourcesTable 5 summarizes the available data collected for this study.

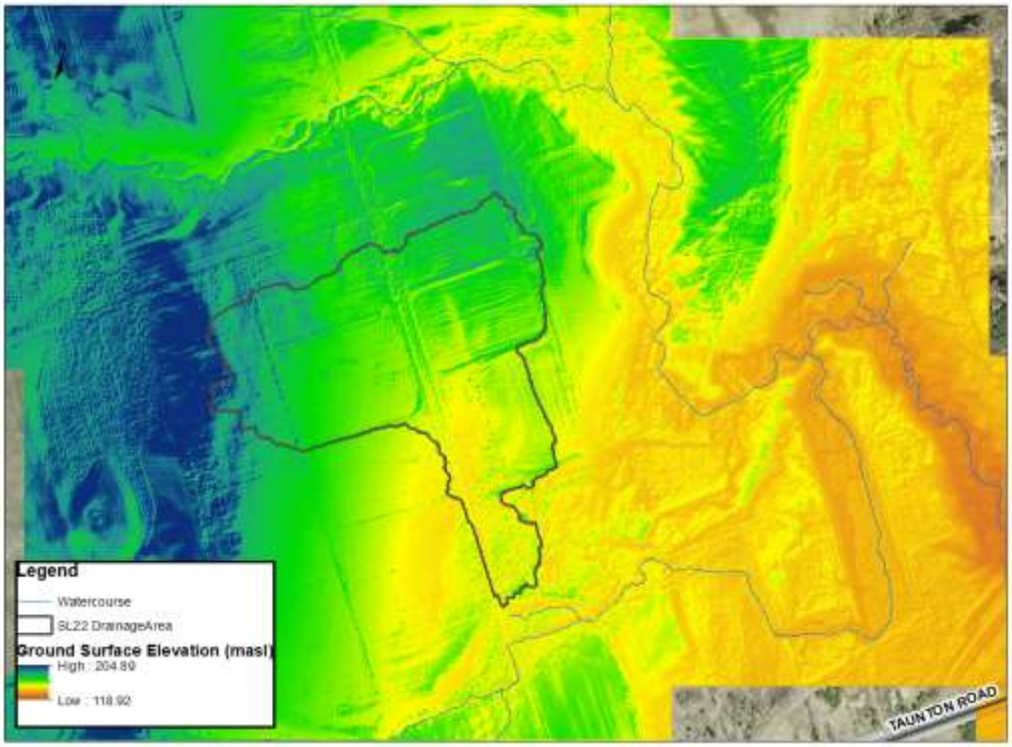


Figure 24: 1-m LiDAR Data in Seaton Sideline 22

Figure 25: Land use map of Seaton Sideline 22

Table 5: MIKE SHE data sources

Data Type	Data Sources
Topography	10-m DEM, 1-m LiDAR, wetland bathymetry
Climate data	5-min precipitation, temperature, and daily Potential ET (2013 – 2015) estimated using Hargreaves Equation
Land use	TRCA Existing Land use, and Land use for Post Development
Soil data	Detailed Soil Database from Agriculture and Agri-Food Canada
Channel	TRCA water-course layer and cross-sections cut from 1-m LiDAR data
Groundwater Model	Import from broader regional groundwater model provided by Oak Ridges Moraine Groundwater Program
Water Level Monitoring	1-hr water level data at 0m, -1m and -2m (reference to ground surface) within/near wetland area (2013 – 2015)

Model Domain

In order to have proper groundwater boundary conditions, a regional MIKE SHE model was first built and initially calibrated against observed water levels and then a local-scale MIKE SHE model was built using extracted groundwater boundaries from the regional model. shows the regional model domain and local-scale model domain. Regional model has 100m by 100 grid cell size, and local-scale model has 10m by 10m grid cell size. Table 6 summarizes the processes included in the model and approaches associated to each process.

Table 6: MIKE SHE model process approaches

Model Process	Approach
Precipitation	5-min hyetograph
Snow Melt	Modified Degree-day approach
Evapotranspiration	Kristensen and Jensen, Vegetation-based ET (time varying LAI/Rooting Depth)
Unsaturated flow	1D Fully Richards equation
Overland Flow	2D diffusive wave approximation of the St. Venant equations of flow.
Channel/Reservoir	1D fully dynamic wave approximation of the St. Venant equations of flow.
Groundwater Flow	3D Finite Difference implementation of Darcy's equation.

Climate

For calibration and validation of the model, simulation period was used for this study is year of 2013 – 2015, and year of 2013 was used as calibration period and years of 2014 and 2015 were used for validation/verification periods. As with any hydrologic model, climate data is a critical input. Climate data from the TRCA climate station (HY009) was used to represent the climate for the study area. Available data fields are maximum/minimum 5-min temperature, 5-min precipitation. Daily potential evapotranspiration rates were generated by Hargreaves potential evapotranspiration method (Hargreaves et al, 1985). This method considers daily temperature maximum and minimum as well as daily solar radiation to compute an estimate of potential evapotranspiration.

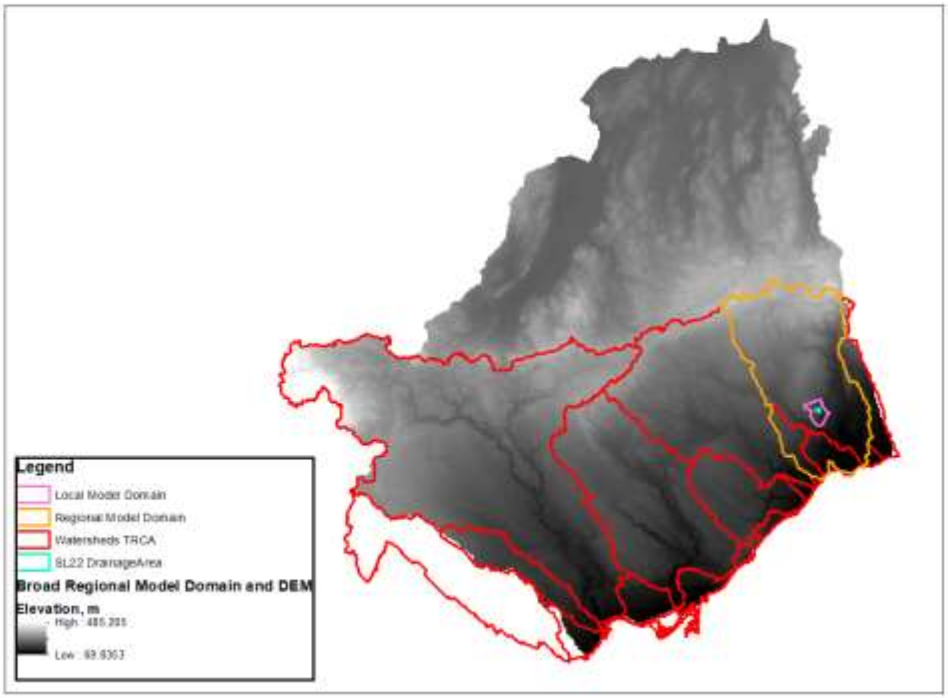


Figure 26: MIKE SHE Regional Model Domain and Local-scale Model Domain

Land use

Land use is used within hydrologic models to consider the effects of the land surface on hydrologic processes such as overland flow, infiltration, evapotranspiration and unsaturated soil zone processes. Based on the land use categories and TRCA standard Manning's n values shown in Table 7, a spatial distribution of overland roughness was generated. These coefficients were then adjusted during the calibration process. Land use data are also used to generate vegetation-specific datasets, specifically the leaf area index (LAI) and the rooting depth. LAI has significant seasonal variation, and it normally reaches a lower limit during winter time and an upper limit during summer time with full leaf cover. No specific information is available for LAI in the study area, thus values from scientific literature (Scurlock et al., 2001) and professional judgement were used in the model. MIKE SHE utilizes a rooting depth parameter to represent the maximum depth of vegetation roots. Significant seasonal variations in the rooting depth are typical for annual and deciduous plants, whereas for many perennial and evergreen plants, rooting depth values remain relatively constant throughout the year. The primary function of the rooting depth specification in MIKE SHE is in establishing the depth to which plants can remove water from the subsurface for transpiration. Specific rooting depth values were not available for the study area, therefore the values used in the model represent literature values for similar vegetation, climate, and soil conditions (Schenk and Jackson, 2003).

Table 7: MIKE SHE catchment parameters by land use type

Land Use Type	Manning's n Value
Farm	0.08
Meadow	0.05
Road	0.025
Wetand	0.035
Forest	0.08

Soil
The materials present at the ground surface play a critical role in partitioning precipitation into runoff and infiltration. To represent these materials, either soils or surficial geology mapping is used in hydrologic investigations. For this study, soil data is from detailed Soil Database from Agriculture and Agri-Food Canada, and it includes soil horizon, soil texture, saturated conductivity, water contents at different pressure levels.

Stream Network
MIKE SHE relies on the MIKE 11 1D hydraulic model to represent the stream network. The MIKE SHE/ MIKE 11 linkage uses a two-way exchange to collect overland flow, calculate exchange flux between the surface and groundwater systems, and route streamflow downstream. The stream network included in the model included the major rivers and tributaries in the local-scale model. In total, 14 branches are included, and are shown in Figure 27: MIKE 11 1D River network. Cross sections were extracted from the 1 m LiDAR with 30m spacing in order to capture the conveyance of those complexes. In total, 372 cross sections were used in the model.

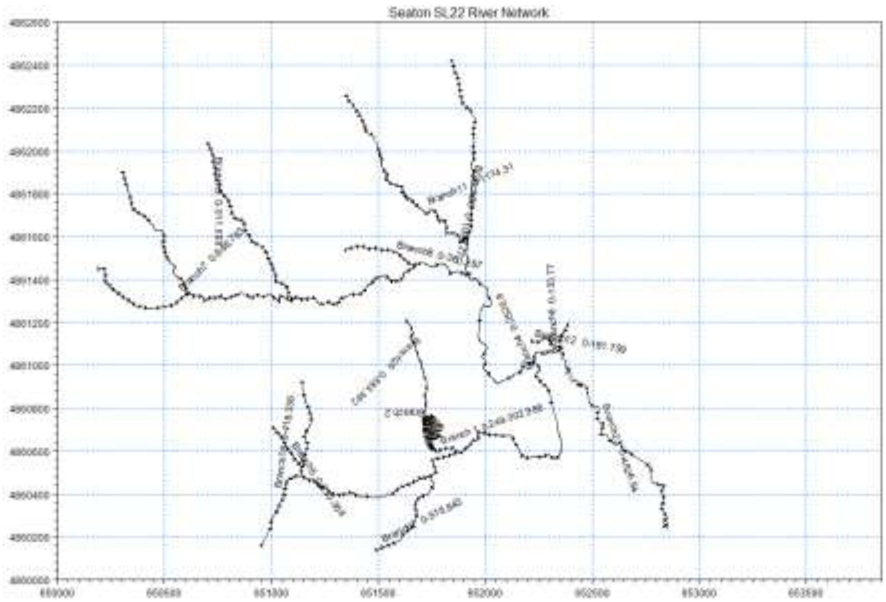


Figure 27: MIKE 11 1D River network

Groundwater
To simulate the groundwater flow system, the properties of the subsurface materials (e.g., hydrostratigraphic layer elevations, hydraulic conductivity distributions) must be specified. All saturated zone properties for the MIKE SHE model were directly taken from existing regional MODFLOW model provided by Oak Ridges Moraine Groundwater Program. This includes layer elevations, hydraulic conductivities, specific storage and specific yield values. As mentioned in Model Domain section, a regional MIKE SHE model was first developed and initially calibrated. For local-scale model, the initial groundwater heads and external boundary conditions were extracted from regional MIKE SHE model.

3.3.3 MIKE SHE: Calibration, Existing Conditions

There are nine water level monitoring wells installed within/near wetland pool area (see **Figure 28**), and water levels were collected at 0m, 1m and 2m below ground surface with 5-min interval for 2013, 2014 and 2015. The year of 2013 was used as calibration period, and the years of 2014 and 2015 were used as validation period.

Figure 28: Location of water level monitoring wells at Sideline 22

When working with a highly parameterized model like MIKE SHE, it is critical to identify which parameters are most sensitive so that the calibration effort can be focused on a subset of the available model parameters. An additional consideration is the degree to which a given parameter is known. For those parameters that are well-constrained by measurements or detailed studies there is less justification for making adjustment. On the other hand, some parameters are based on limited or no site-specific information or are known to have a wide range of reasonable values. For the latter group of parameters, there is significantly more leeway with which to make adjustments. For all parameters, however, it is important to consider the upper and lower bounds of reasonable values to ensure that all model parameter values remain realistic. Table 8summarizes the major calibration parameters in MIKE SHE model.

Table 8: List of parameters adjusted during MIKE SHE calibration process

Model Parameter	Description
Detention Storage	This parameter is used to limit the amount of runoff that the model produces as well as control the timing of runoff relative to precipitation. The parameter also has an indirect effect on infiltration and ET

Riverbed Leakage Coefficient	This parameter regulates the exchange of water between the groundwater and channel flow components of the model.
Soil Moisture Contents	This set of parameters influences the amount of ET, infiltration, and groundwater recharge and indirectly affects the timing and magnitude of runoff.
Saturated Hydraulic Conductivity	This parameter controls the infiltration rate and indirectly affects the rate of groundwater recharge, ET, and runoff.
Manning's Roughness	This parameter controls the timing and magnitude of runoff.
Horizontal/Vertical Hydraulic Conductivity	This set of parameters controls the groundwater flow rate and direction, and interactions with rivers, soils and overland flow.

During simulation, MIKE SHE generates calibration plots at each selected calibration locations, and also produces calibration statistics for each plot with available observation data. Table 9 lists available statistics generated in MIKE SHE calibration plot, and Figures 29 through 32 show calibration plots.

Table 9: MIKE SHE statistical performance metrics

Statistics	Description
ME	Mean Error
MAE	Mean Absolute Error
RMSE	Root Mean Square of Error
STDres	Standard Deviation of Residual (Error)
R(Correlation)	Correlation Coefficient
R2(Nash_Sutcliffe)	Nash Sutcliffe Correlation Coefficient

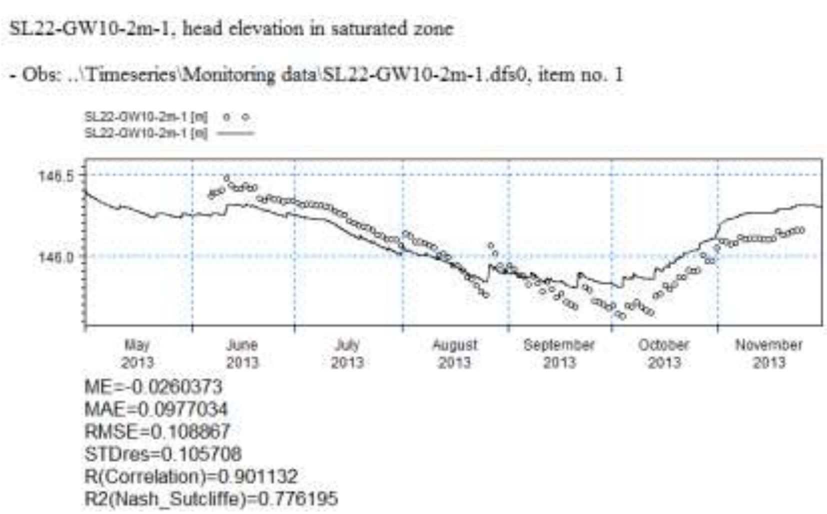
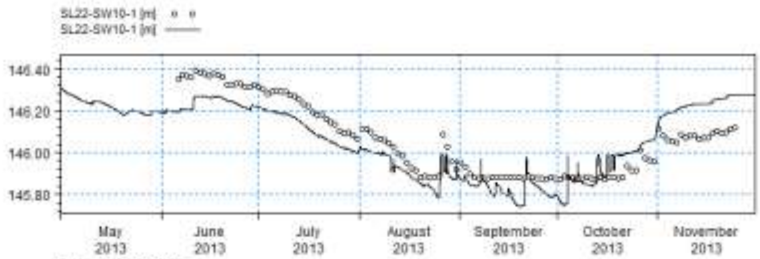


Figure 29: Sideline 22 calibration with 2013 data (1)

SL22-SW10-1, head elevation in saturated zone

- Obs: ..\Timeseries\Monitoring data\SL22-SW10-1.dfs0, item no. 1

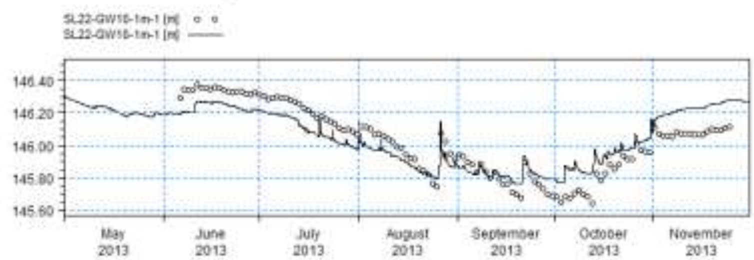


ME=0.0280615
MAE=0.0866865
RMSE=0.0955888
STDres=0.0913771
R(Correlation)=0.854547
R2(Nash_Sutcliffe)=0.688697

Figure 30: Sideline 22 calibration with 2013 data (2)

SL22-GW10-1m-1, head elevation in saturated zone

- Obs: ..\Timeseries\Monitoring data\SL22-GW10-1m-1.dfs0, item no. 1

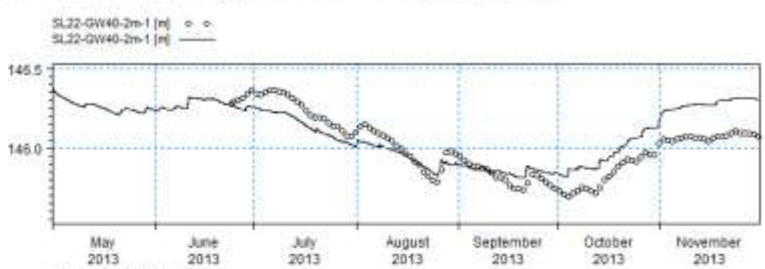


ME=-0.00248879
MAE=0.092044
RMSE=0.101217
STDres=0.101187
R(Correlation)=0.883944
R2(Nash_Sutcliffe)=0.772946

Figure 31: Sideline 22 calibration with 2013 data (3)

SL22-GW40-2m-1, head elevation in saturated zone

- Obs: ..\Timeseries\Monitoring data\SL22-GW40-2m-1.dfs0, item no. 1



ME=-0.0441166
MAE=0.10505
RMSE=0.122955
STDres=0.114767
R(Correlation)=0.797729
R2(Nash_Sutcliffe)=0.570157

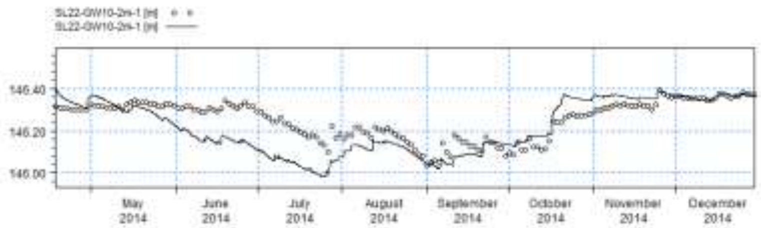
Figure 32: Sideline 22 calibration with 2013 data (4)

3.3.4 MIKE SHE: Validation, Existing Conditions

After calibration, next step is to validate the model against different set of monitoring data with calibrated parameters. The years of 2014 and 2015 were used as validation period. Figure 33 through Figure 36 show the validation plots.

SL22-GW10-2m-1, head elevation in saturated zone

- Obs: ..\Timeseries\Monitoring data\SL22-GW10-2m-1.dfs0, item no. 1

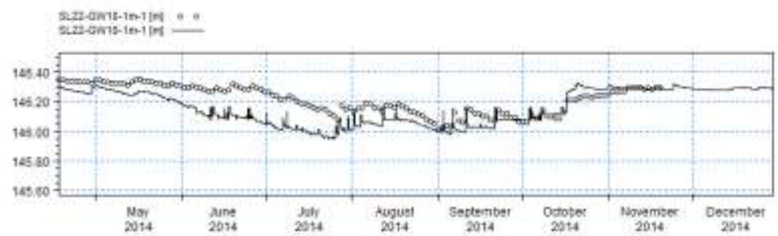


ME=0.0354861
MAE=0.0666811
RMSE=0.0872202
STDres=0.0796749
R(Correlation)=0.771932
R2(Nash_Sutcliffe)=0.0975033

Figure 33: Sideline 22 validation with 2014 data (1)

SL22-GW10-1m-1, head elevation in saturated zone

- Obs: ..\Timeseries\Monitoring data\SL22-GW10-1m-1.dfs0, item no. 1

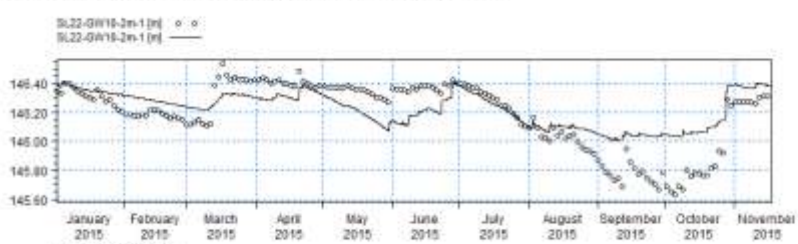


ME=0.0771666
MAE=0.0902138
RMSE=0.110121
STDres=0.0785613
R(Correlation)=0.725502
R2(Nash_Sutcliffe)=-0.328011

Figure 34: Sideline 22 validation with 2014 data (2)

SL22-GW10-2m-1, head elevation in saturated zone

- Obs: ..\Timeseries\Monitoring data\SL22-GW10-2m-1.dfs0, item no. 1



ME=-0.0325616
MAE=0.126404
RMSE=0.15626
STDres=0.152829
R(Correlation)=0.803928
R2(Nash_Sutcliffe)=0.541733

Figure 35: Sideline 22 validation with 2014 data (3)

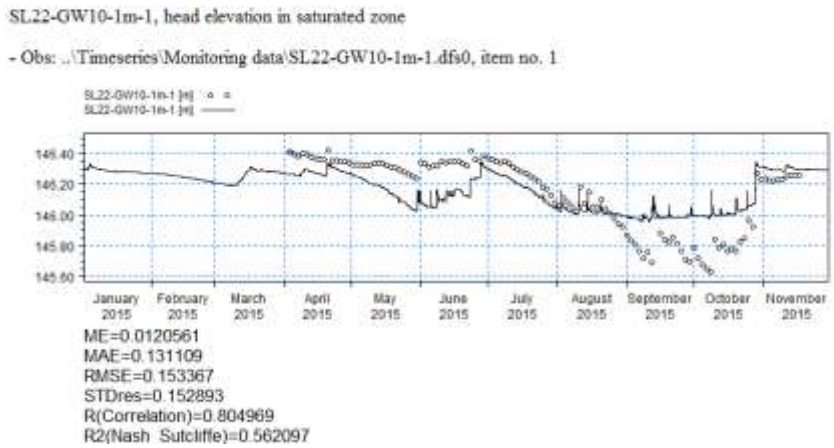


Figure 36: Sideline 22 validation with 2014 data (4)

3.3.5 MIKE SHE: Long-term Simulation, Proposed Conditions without Mitigation

The proposed development area in SL22 is North Division which is shown in Figure 37: Location of Proposed Development Area - North Division. The assumption is 60% of North Division is paved surface but there is no grading change, i.e. ground surface in North Division remained unchanged.

Figure 37: Location of Proposed Development Area - North Division

MIKE SHE's Ponded Drainage Feature was used to implement development area, and this feature was developed to support green infrastructure such Low Impact Developments (LIDs) and Sustainable Urban Drainage (SUDs). MIKE SHE's Ponded Drainage Feature allows directly drain storm water to internal depressions, boundaries and streams and paved surface areas was integrated into reduced surface-subsurface leakage function.

A long term simulation was carried out for period of 6/1/1996 – 12/30/2009 (13 years) without mitigation measure for post condition.

3.3.6 MIKE SHE: Long-term Simulation, Proposed Conditions with Mitigation

A long term simulation was carried out for period of 6/1/1996 – 12/30/2009 (13 years) with mitigation measure for post condition by diverting surface runoff from paved surface directly to wetland using MIKE SHE Ponded Drainage Feature. Figure 38 shows the diverted flow from paved surface in North Division to wetland, Figure 39 shows the comparison of water levels between No Mitigation and With Mitigation and Figure 40 shows the comparison of wetland depth and extent between No Mitigation and With Mitigation.

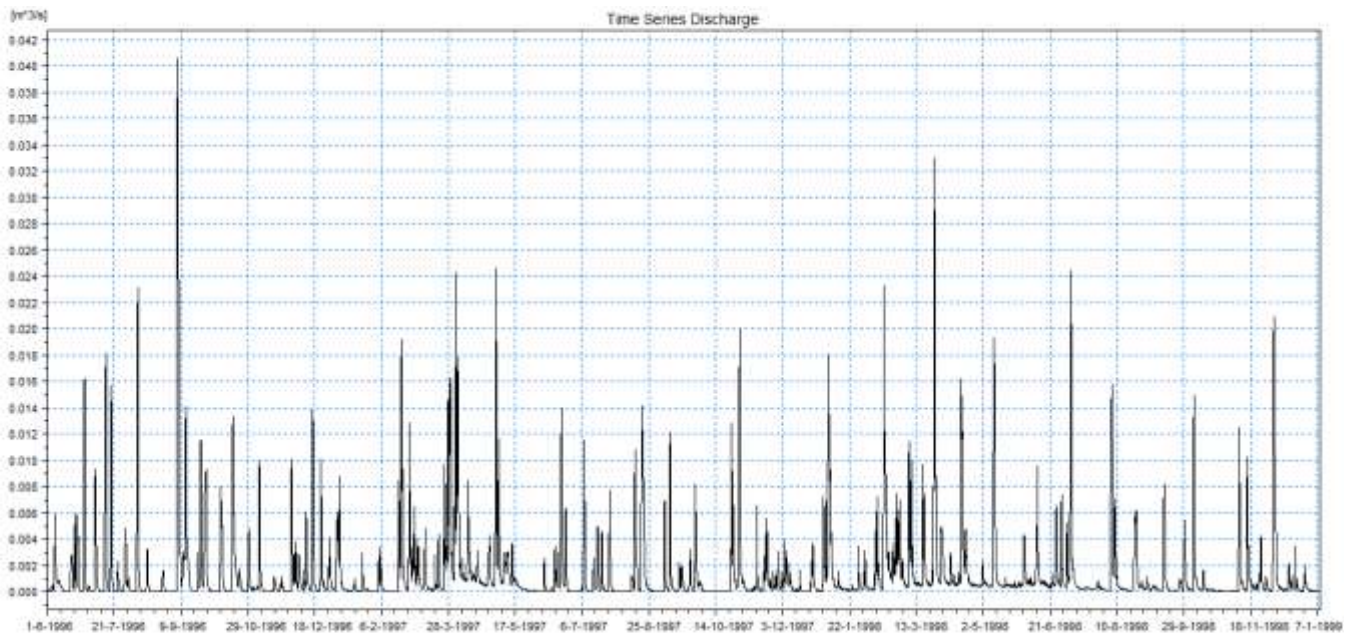


Figure 38: Diverted flow from North Division to Wetland

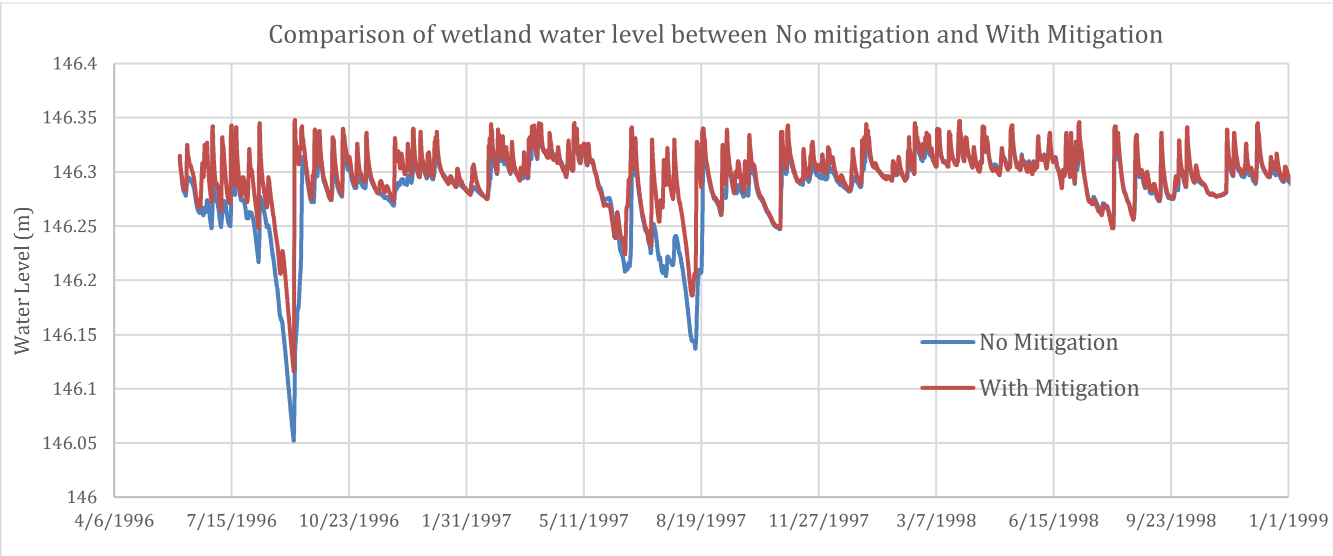


Figure 39: Comparison of wetland water levels between No Mitigation and With Mitigation scenarios

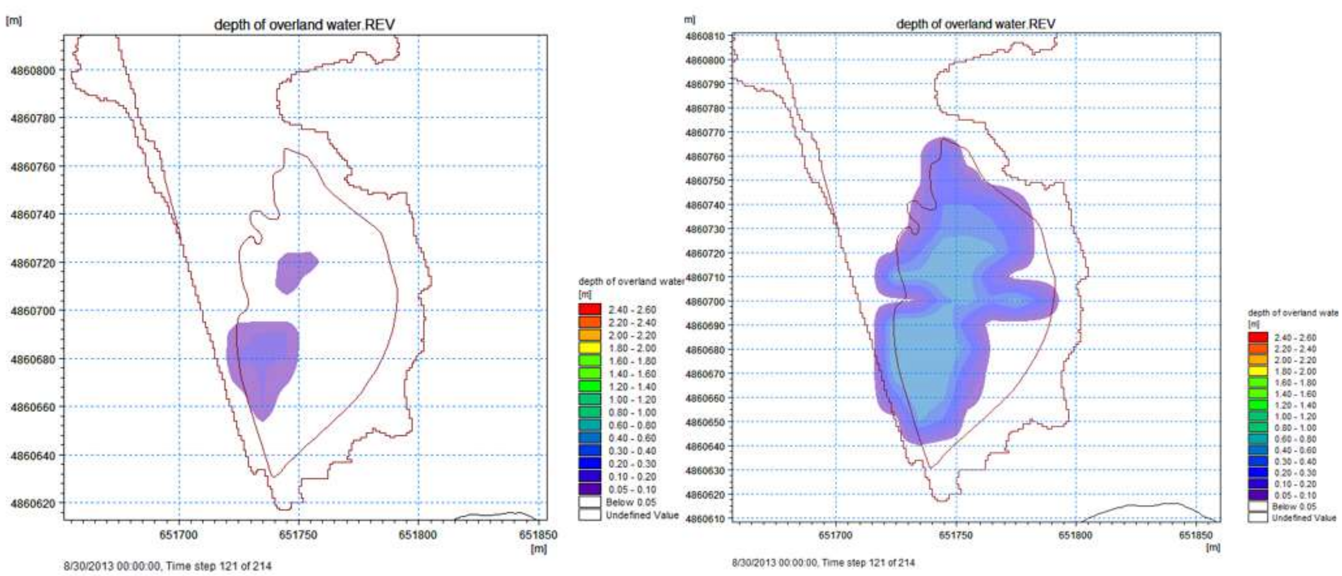


Figure 40: Comparison of wetland water depth and extent between No Mitigation (left) and With Mitigation (right)

3.3.7 MIKE SHE: Benefits, Challenges, Recommendations and References

Benefits

- A well-developed graphical user interface that strongly aids in model construction, debugging and calibration phases as well as ongoing pre and post processing of model data during these phases.
- The ability to import input data as GIS surfaces or shape files directly into the model greatly expedites the model construction phase and reduces the possibility of data conversion errors.
- Input dataset can have different spatial resolution (e.g. finer grid than model grid) and time interval (e.g. shorter time interval than model time steps) as model used.
- Scalable modular structure and multiple algorithms allow certain processes to be simplified, and allow to focus on properly representing other processes.

- MIKE SHE generates calibration plots with common used statistics during simulation that helps speed up the calibration process.
- MIKE SHE includes Ponded Drainage feature that supports LIDs and SUDs green infrastructure and makes implementation of proposed development much easier.
- MIKE SHE includes water budget calculation tool that can calculates water balance on both model domain basis and sub-catchment/area basis, and produces water balance items such as precipitation, actual evapotranspiration, infiltration/recharge, surface runoff, exchange flow between river/wetland and aquifer etc.
- MIKE SHE generates variety of output (timeseries, 2D time varying outputs and 3D groundwater outputs), especially 2D time varying depth of overland output that can be used to analyze wetland hydroperiod.

Challenges

- MIKE SHE uses uniform grid. By not being able to increase the spatial resolution locally within areas of interest, the modeler needs to increase the resolution globally or create a regional model prior to build a local scale model focusing on area of interest. This increases the level of complexity throughout the model, and adds considerably to the computational requirements or effort of model construction.
- MIKE SHE is physical-based, highly parameterized model, and therefore requires extensive model data and physical parameters. Calibration of model can be challenge sometime.
- Model use requires a great deal of technical expertise and the learning curve is steep for new modelers.
- Source code is not available to the public. The proprietary source code of MIKE SHE is also a limitation in that users cannot examine or modify the source code of the model.
- MIKE SHE is not free software. Prices range from approximately CAD $14,160 for government agencies to CAD $17,700 for standard commercial use, and the annual cost of the service agreement is approximately CAD $5,000.

Recommendations

- MIKE SHE is well suitable for wetland study for both short-term and long-term simulations.
- MIKE SHE has capability to model impact of development due to land use change and model mitigation measure using Ponded Drainage feature.

References

DHI, 2009a. MIKE SHE Volume 1: User Guide. (2009 Edition). 230p

Gordon, S., Jones, J.P., Jackstiet, R. and Diiwu, J., 2005. Review of groundwater and surface water interaction - knowledge and modelling approaches for streamflow prediction in Alberta. Prepared by the Alberta Research Council for Michael Seneka of Alberta Environment.

Camp Dresser and McKee, 2001. Evaluation of Integrated Surface Water and Groundwater Modelling Tools. Water Resources Research & Development Program.

Hansen, J.R., J.C. Refsgaard, S. Hansen and V. Ernstsen, 2007. Problems with heterogeneity in physically based agricultural catchment models. Journal of Hydrology, 342: 1-16.

Hargreaves, G. H., & Samani, Z. A. (1985). Reference crop evapotranspiration from temperature. Applied Engineering in Agriculture, 1(2), 96–99.

Scurlock, J.M.O., G.P. Asner and S.T. Gower, 2001. Worldwide Historical Estimates and Bibilography of Leaf Area Index, 1932-2000. ORNL Technical Memorandum TM-2001/268. Oak Ridge National Laboratory. Oak Ridge, Tennessee.

Thompson, J.R., H. R. Sorenson, H. Gavin and A. Refsgaard, 2004. Application of the MIKE SHE/MIKE 11 modelling system to a lowland wet grassland in southeast England. Journal of Hydrology, 293: 151-179.

Vazquez, R.F., P. Willems and J. Feyen, 2008. Improving the predictions of MIKE SHE catchment-scale application by using a multi-criteria approach. Hydrological Processes, 22: 2159-2179.

Weber, M., S. Gordon, I. Judd-Henrey and J. Beckers, 2004. Management Strategies to Reduce Vulnerability to Climate Change in the South Saskatchewan River Basin. Prepared by the Alberta Research Council for Andy Ridge of Alberta Environment.

3.4 Visual Otthymo 5 (VO5)

3.4.1 VO5: Background

Visual OTTHYMO (VO) is a hydrologic modelling software which primarily uses the HYMO model engine developed by J.R. Williams in 1973. This engine was further developed at the University of Ottawa, where it was named OTTHYMO 83. The first graphical interface was developed by the founder of Civica in 1998 (Visual OTTHYMO 1.0). VO is currently being developed by Civica Infrastructure, and additional features and commands continue to be added.

The continuous version of VO (5.0) was released in 2017 with the ability to simulate snow melt, infiltration, evapotranspiration and groundwater infiltration. Continuous VO uses the same commands as the single event simulation (with some additional parameters required for continuous modelling). The approach used for the continuous engine is as follows:

- Snow accumulation, compaction, refreezing and melt is modelled using the approach in GASWER model;
- Infiltration is modeled using the SCS equation to account for soil moisture and unit hydrographs are used to transform the excess rainfall to runoff;
- Flow is routed through channels and reservoirs using the variable storage coefficient method;
- Routing through reservoirs is modeled using the storage indication method.
- Evapotranspiration can be entered as Potential evapotranspiration,

The wetland command is a new feature added to VO 5.0 in 2018. This command is designed to model all the hydrologic processes in a wetland including inflow, evaporation, seepage and outflow. The interface for the wetland command is similar to that used in continuous VO, however a groundwater component has been added to the wetland. Groundwater seepage into and out of the wetland are calculated using Darcy's equation and the difference in elevation between the ground water and either the stored water or, if the wetland is dry, the bottom of the wetland.

Features specific to the VO5 water balance are as follows:

Ground water elevations are treated as model parameters and are entered as a time series similar to the way precipitation is added to a model. This means you do not have to calibrate an aquifer component in your model to represent the ground water interactions with a wetland.

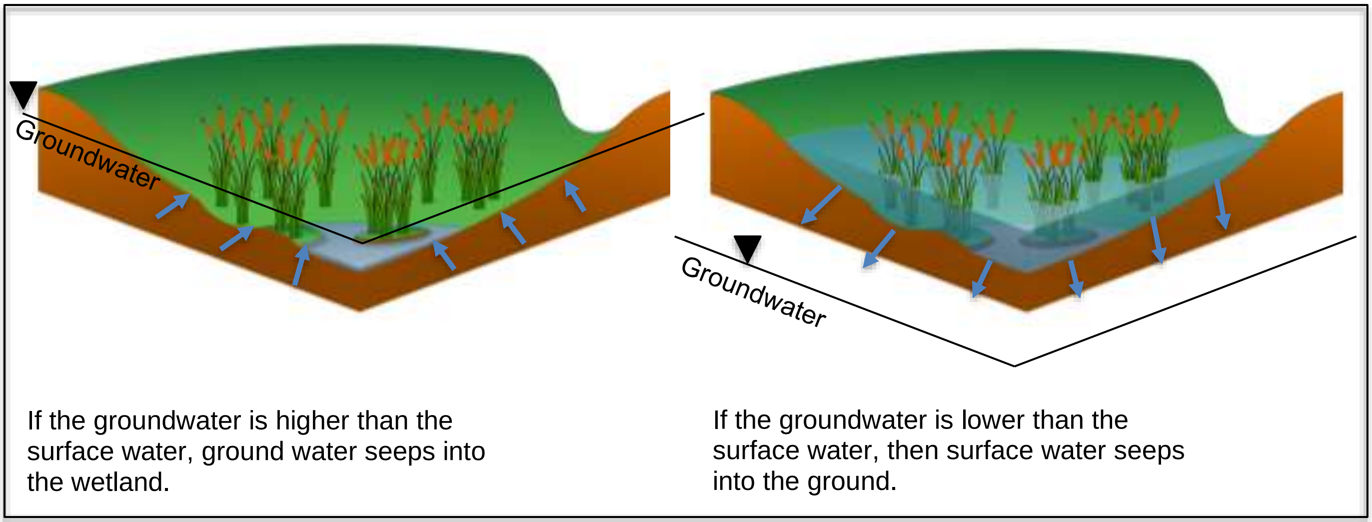


Figure 41: Groundwater Impacts on Wetland

The wetland command combines a rural runoff command (NasHYD) and a Route Reservoir command to model dry and wet areas of the wetland. These areas change size as the wetland storage area fills and drains. This allows users to more accurately model the runoff generated by the dry area of a wetland.

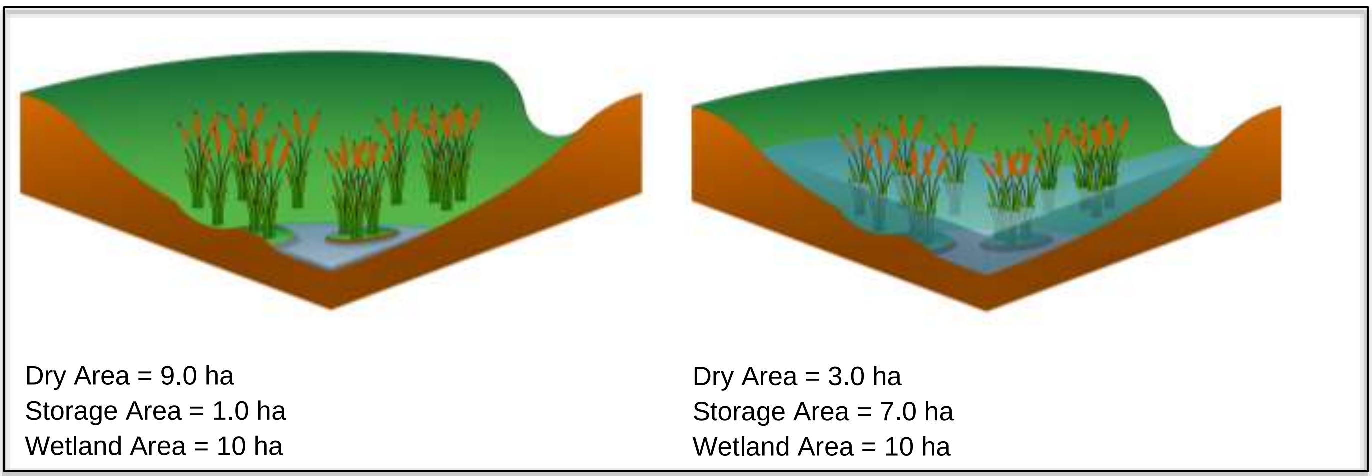


Figure 42: Dynamic wet and dry areas in wetland

The user interface for this model is simple to use and guidance on parameter selection is provided through direct links to the user manual. The model also provides tools for model calibration and produces easy to follow result summaries and scenario comparison reports.

3.4.2 VO5: Model Setup, Existing Conditions

The VO5 model was simple to set up; only an upstream drainage area and the wetland were included in our model. The data required to complete the wetland water balance in VO5 is summarized in Table 10.

Table 10: Data required for VO5 Wetland Water Balance model

	Upstream catchment	Wetland
Command Used	NasHYD	RouteWetland
Topography	10-m DEM, 1-m LiDAR, wetland bathymetry Provided by TRCA	Depth/area and depth/outflow curves provided by TRCA
Land Cover	Air photo and TRCA land use classification (Refer to **Figure 43**)	
Soil data	Data from existing geotechnical reports	
Ground water levels	1-hr groundwater level data from piezometers at multiple depths within wetland; data Provided by TRCA	
Water Levels	1-hr surface water level data from piezometers at multiple depths within wetland; data Provided by TRCA	
Precipitation (Rain / Snow)	5-min precipitation from nearby Brock West Landfill station (provide by TRCA)	
Evapotranspiration	Daily PET calculated by TRCA using Hargreaves Equation	
Temperature	Daily min / max temperature provided by TRCA	

The data summarized in Table 10 was used to assign parameters to the upstream drainage area and wetland. Model parameters for the wetland are summarized in **Figure 43: Land Use for Sideline** 26 **Wetland**

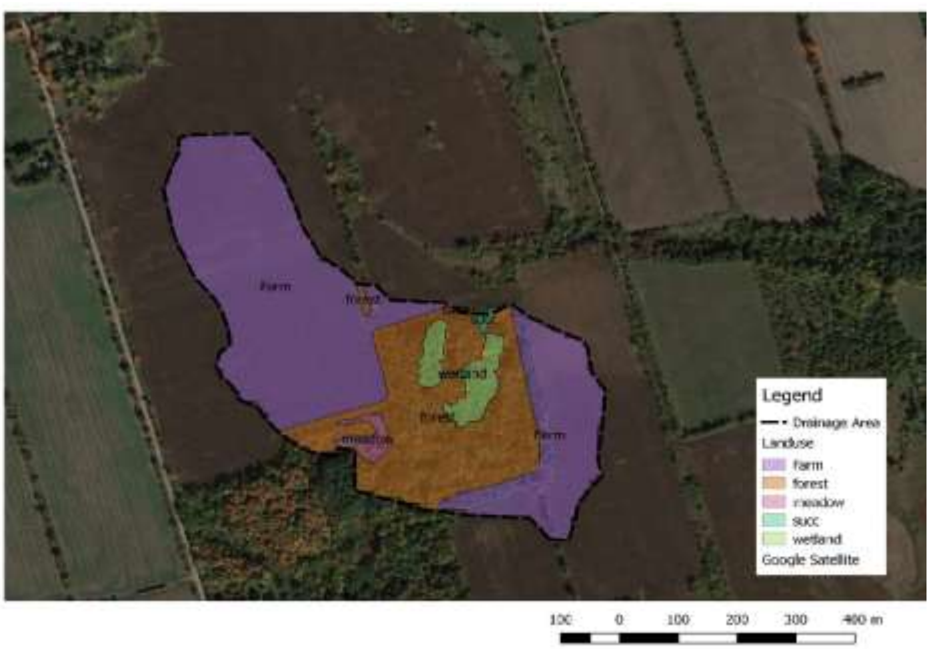


Table 11 and Table 12**.**

Figure 43: Land Use for Sideline 26 Wetland

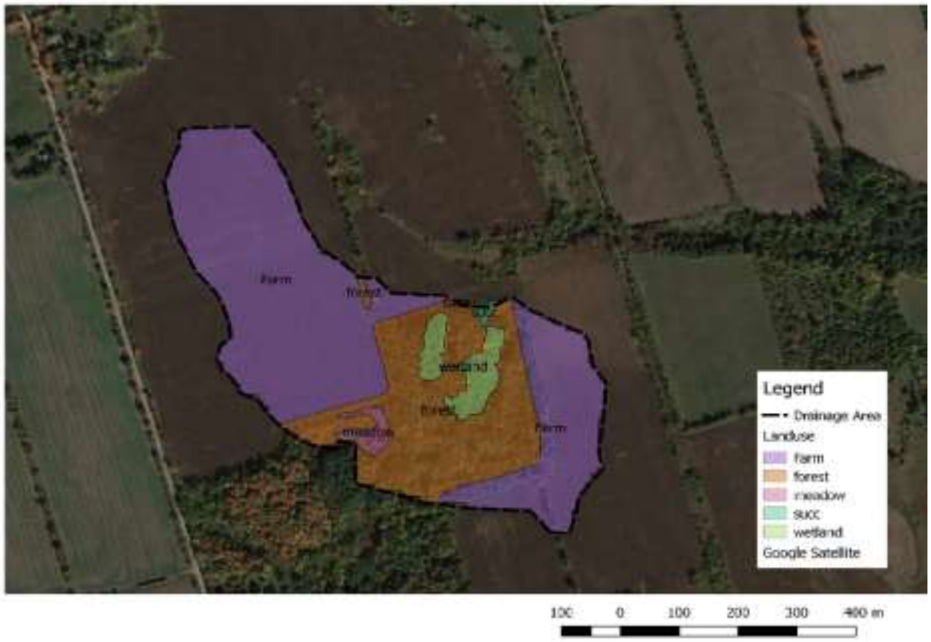


Table 11: Continuous NasHyd Parameter Table (Sideline 26)

Parameter	Description	Upstream Drainage Area
Command		NasHyd
Area (ha)	Drainage area calculated using topography and watercourse layers	28 ha
CN	Curve number used for SCS	68
IA (mm)	Pervious Area Depression Storage	8 mm
Inter event time	Minimum amount of time without precipitation required to define a new event	4 hr
N	Number of linear reservoirs	3.0
TP (hr)	Time to peak	0.66 hrs
Land Cover	General description of vegetation	Crops to shoulder height
K	K = GI /Pan Evaporation - Growth index of a crop / Pan Evaporation. Used to estimate potential evapotranspiration.	1.4
VEGK3	ET opportunity coefficient, used to calculate ET from soil	6.0
Soil Texture	Description of soil base on relative content of sand, silt, clay particles	Clay Loam
Total Porosity	Fraction of soil that is made up of spaces (pores) between particles	0.464

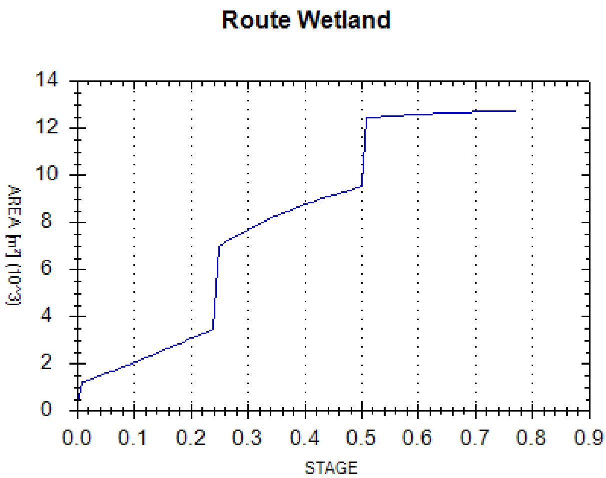
Field Capacity	Soil moisture held in soil after excess water has drained away	0.310
Wilting Point	Moisture left in dry soil that is not accessible to plants, causing them to wilt	0.187
Saturated K (mm/day)	Hydraulic conductivity of the soil when saturated, represent the ease at which moisture can move through a soil in which all easily drained pore spec is filled with liquid.	24.38 mm/day

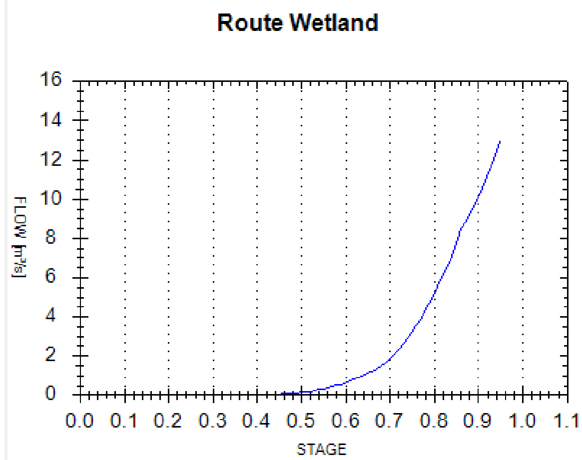
Table 12: Wetland Parameter Table (Sideline 26)

Parameter	Description	Wetland
Command		RouteWetland
Storage Area Geometry		
Initial water Depth (m)	Depth of water in the wetland at the start of a model run	0.40m
Bottom Elevation (m)	Elevation at the lowest point in the wetland	189.96m
Depth Area Curve	Depth area curve for the entire wetland (Dry and wet areas), Starts at the bottom elevation of the wetland	See Error! Reference source not found.
Storage Area - Soil		
Soil Thickness (m)	Thickness of the soil layer constraining movement between surface and ground water	1.5m
Hydraulic Conductivity (mm/day)	Saturated hydraulic conductivity for soils in areas with ponded water, represent the ease at which moisture can move through a soil in which all easily drained pore space is filled with liquid	1800 mm/day
Fringe Area		
Soil Texture	Description of soil base on relative content of sand, silt, clay particles	Clay Loam
Total Porosity	Fraction of soil that is made up of spaces (pores) between particles	0.464
Field Capacity	Soil moisture held in soil after excess water has drained away	0.310
Wilting Point	Moisture left in dry soil that is not accessible to plants, causing them to wilt	0.187
Saturated K (mm/day)	Hydraulic conductivity of the soil in dry areas when saturated, represent the ease at which moisture can move through a soil in which all easily drained pore spec is filled with liquid	24.38 mm/day
CN	Curve number used for SCS	68
IA (mm)	Pervious Area Depression Storage	10 mm
Evapotranspiration		
Land Cover	General description of vegetation	Crops to shoulder height
k	K = GI /Pan Evaporation - Growth index of a crop / Pan Evaporation	1.4
VEGK3	ET opportunity coefficient, used to calculate ET from soil	6.0
Outlet		
Type	Choice of method for defining outlet (Currently only Stage Discharge is available)	Stage Discharge

Discharge Curve	Depth discharge curve for the wetland, depth is defined from the bottom elevation of the wetland	Refer to Error! Reference source not found.

Figure 44: Depth Area and Depth Discharge Curves for the Sideline 26 Wetland





Stage vs Area Curve

Stage vs Discharge Curve

Although there are two distinct pool in this wetland only one stage area curve was used, this being the total area in the wetland for each depth starting with the lowest elevation in the wetland. Figure 45 shows the user interface once the upstream area and wetland were linked together in the model.

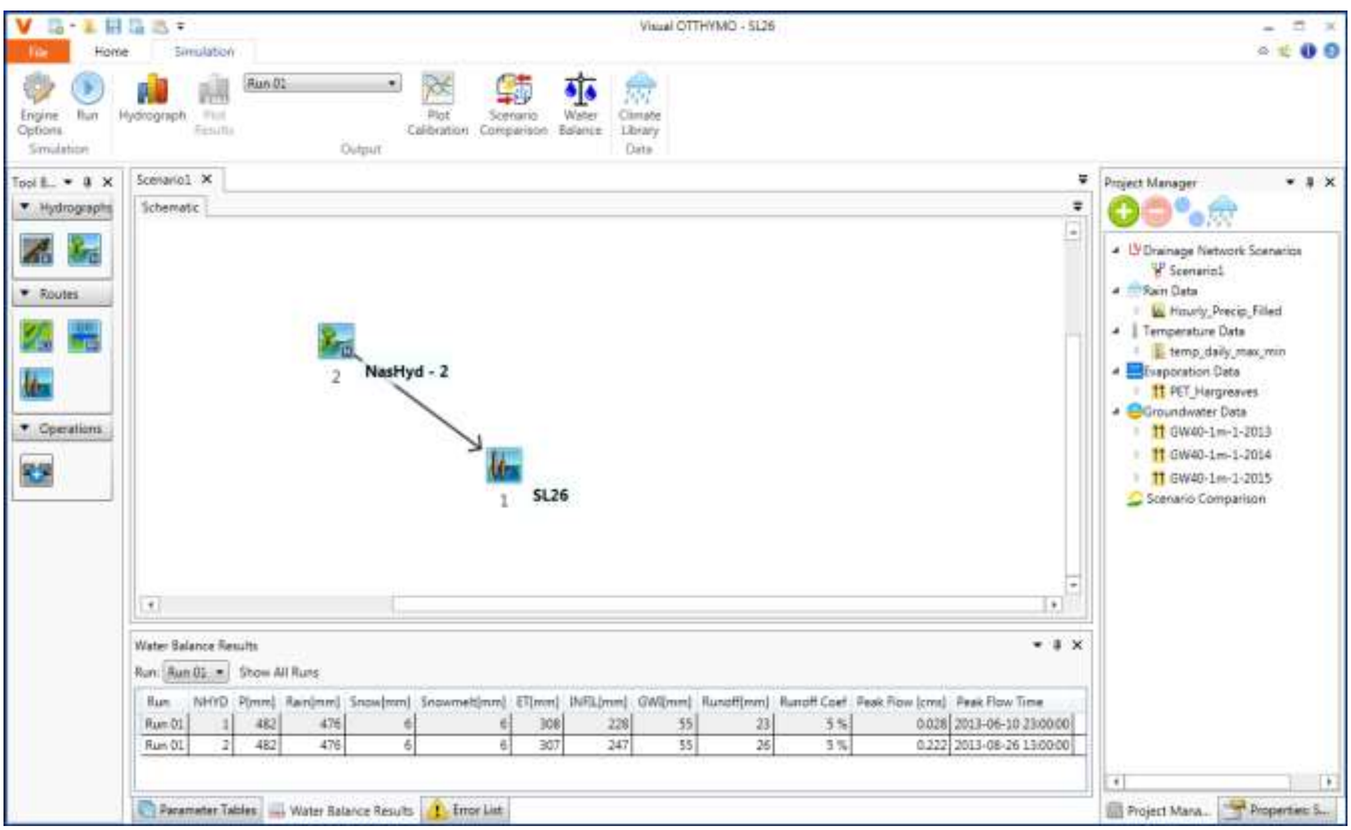


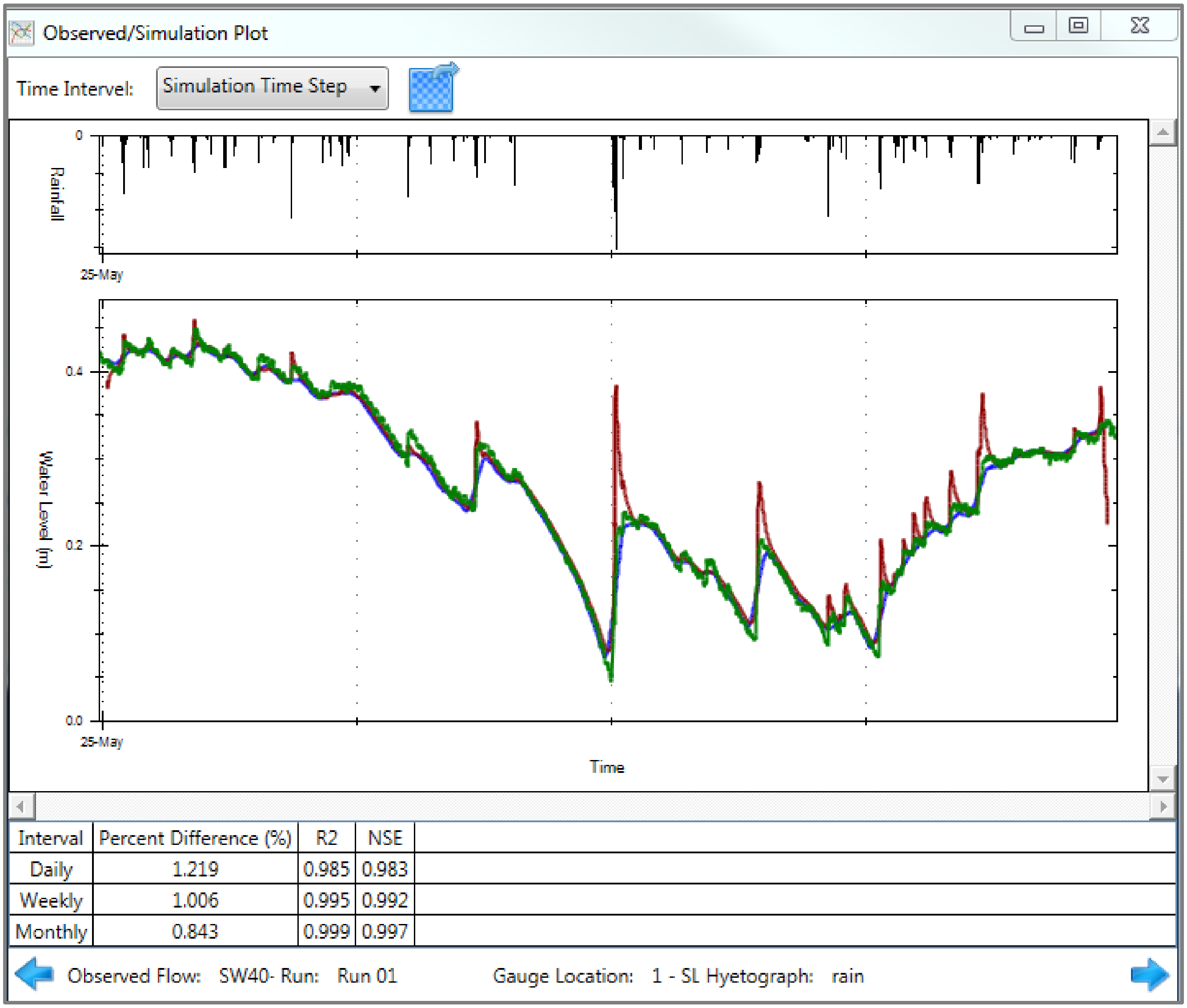
Figure 45: VO5 model schematic

For more complex wetland systems multiple wetland and drainage areas can be added to the model and either diretly linked or linked through route channel and route pipe commands. For a simple wetland such as this one the model build time is approximately 2 days to review and convert data to the appropriate file formats and 2 hours to build the model. Climate data and groundwater time series are .csv files formated as follows:

- Precipitation
  - Column 1 – Date / Time (year/month/day hour:minutes:seconds)
  - Column 2 – Value (mm)
- Temperature
  - Column 1 – Date (year/month/day)
  - Column 2 – Minimum Value (^{0}C)
  - Column 3 – Maximum Value (^{0}C)
- Evapotranspiration
  - Column 1 – Date (year/month/day)
  - Column 2 – Value (mm)
- Groundwater Elevations (at the lowest point in the wetland)
  - Column 1 – Date / Time (year/month/day hour:minutes:seconds)
  - Column 2 – Value (masl)

3.4.3 VO5: Calibration, Existing Conditions

Once the wetland was built, the model was calibrated using the monitoring data for 2013. The VO5 calibration interface allows users to graph modeled and monitored water levels providing users with a visual representation of the calibration after each run. Statistics (percent difference in water level, Coefficient of determination (R^2) and Nash Sutcliffe (NSE)) are shown at the bottom of the graph to quantify the calibration results.



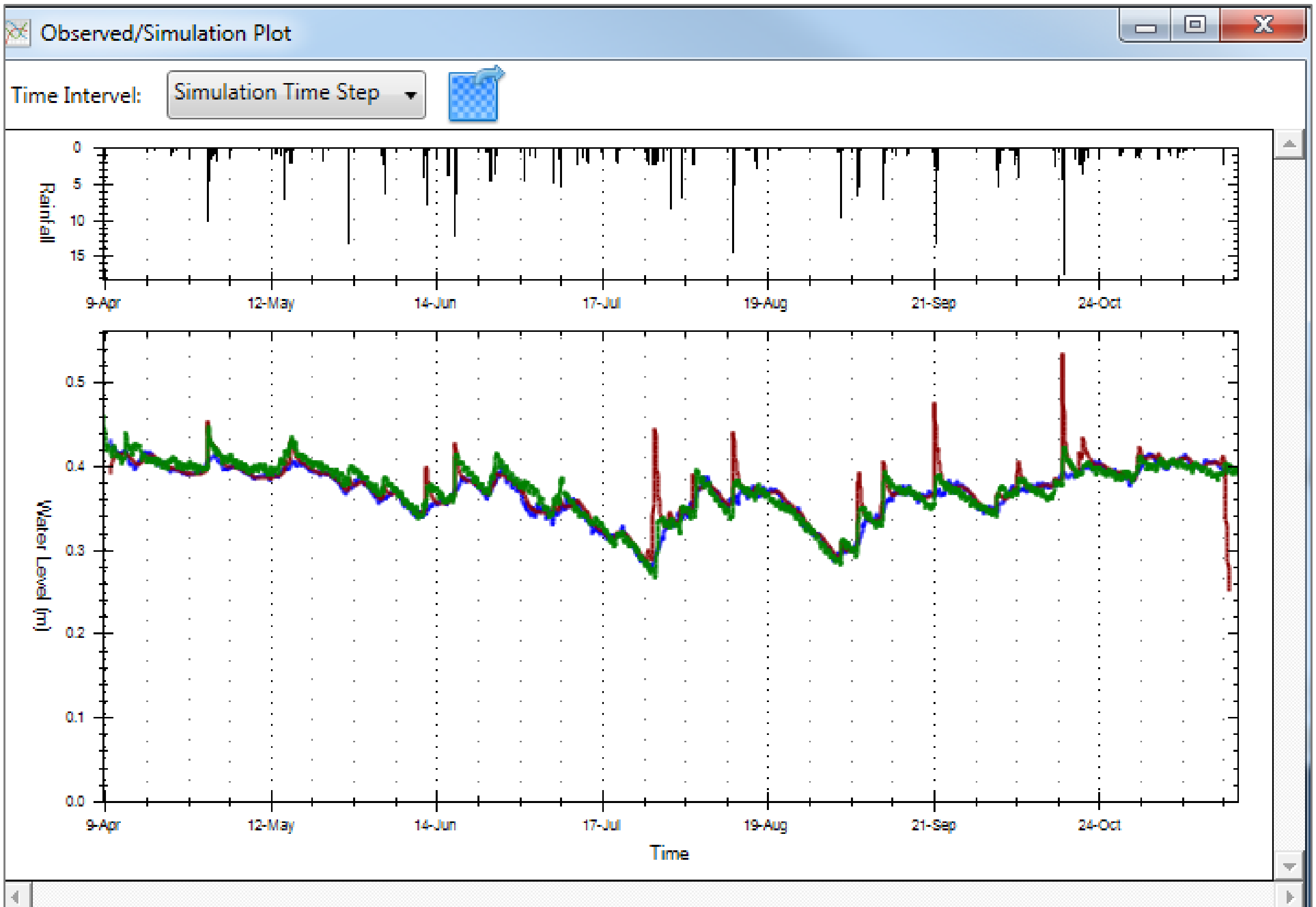
Interval	Percent Difference (%)	R2	NSE
Daily	1.219	0.985	0.983
Weekly	1.006	0.995	0.992
Monthly	0.843	0.999	0.997

Figure 46: Sideline 26 Wetland Calibration Results (2013)

As can be seen in Figure 46 the modeled data (shown in red) matches closely with the monitored data (shown in green). The blue line shows the ground water elevations used in the model. The statistics provided at the bottom of the graph also support a strong correlation between modeled and monitored data.

3.4.4 VO5: Validation, Existing Conditions

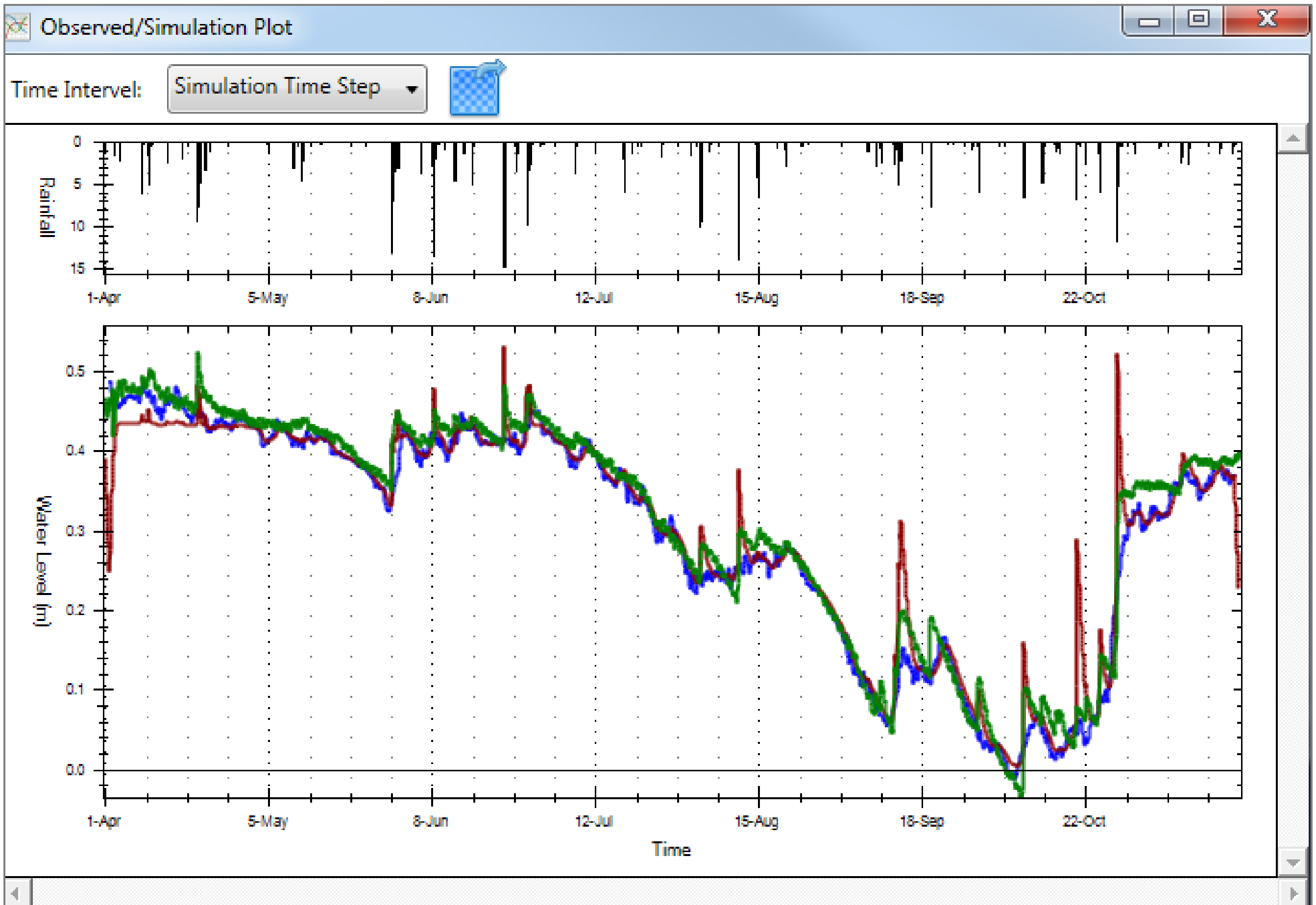
The model was then validated using monitored data from 2014 and 2015. Model validation results are provided in Figure 47 and **Figure 48** respectively. As with the model calibration the validation runs show a close match to the monitored data.



Interval	Percent Difference (%)	R2	NSE
Daily	0.060	0.833	0.832
Weekly	0.085	0.945	0.939
Monthly	-0.016	0.967	0.957

Observed Flow: SW40- Run: Run 02 Gauge Location: 1 - SL Hyetograph: rain

Figure 47: Sideline 26 Wetland Validation Results (2014)



Interval	Percent Difference (%)	R2	NSE
Daily	-3.350	0.966	0.958
Weekly	-3.341	0.987	0.976
Monthly	-3.554	0.995	0.981

Observed Flow: SW40- Run: Run 03 Gauge Location: 1 - SL Hyetograph: rain

Figure 48: Sideline 26 Wetland Validation Results (2015)

3.4.5 VO5: Long-term Simulation, Proposed Conditions without Mitigation

Once the model provided a satisfactory representation of the wetland water levels for three years of monitoring data, set up was completed for the long-term simulation. This included inputting precipitation, temperature and evapotranspiration data provided by TRCA for 1991 – 2007 into the model. As groundwater levels were not available for this time period, the average values from the three years of data available were used, these groundwater patterns were repeated for each year.

A development scenario was then created in which 50% of the catchment area was diverted away from the wetland to simulate runoff being routed to a different outlet location. Given the current regulations protecting wetlands, this is often done in order to prevent large volumes of water from drowning the wetlands. The results of this flow diversion are shown on Figure 49 - Figure 51. Comparing the maximum water levels over the long-term scenario shows that the max water depth in the wetland drops from 0.553m to 0.520m while the average water level drops from 0.330m to 0.327m.

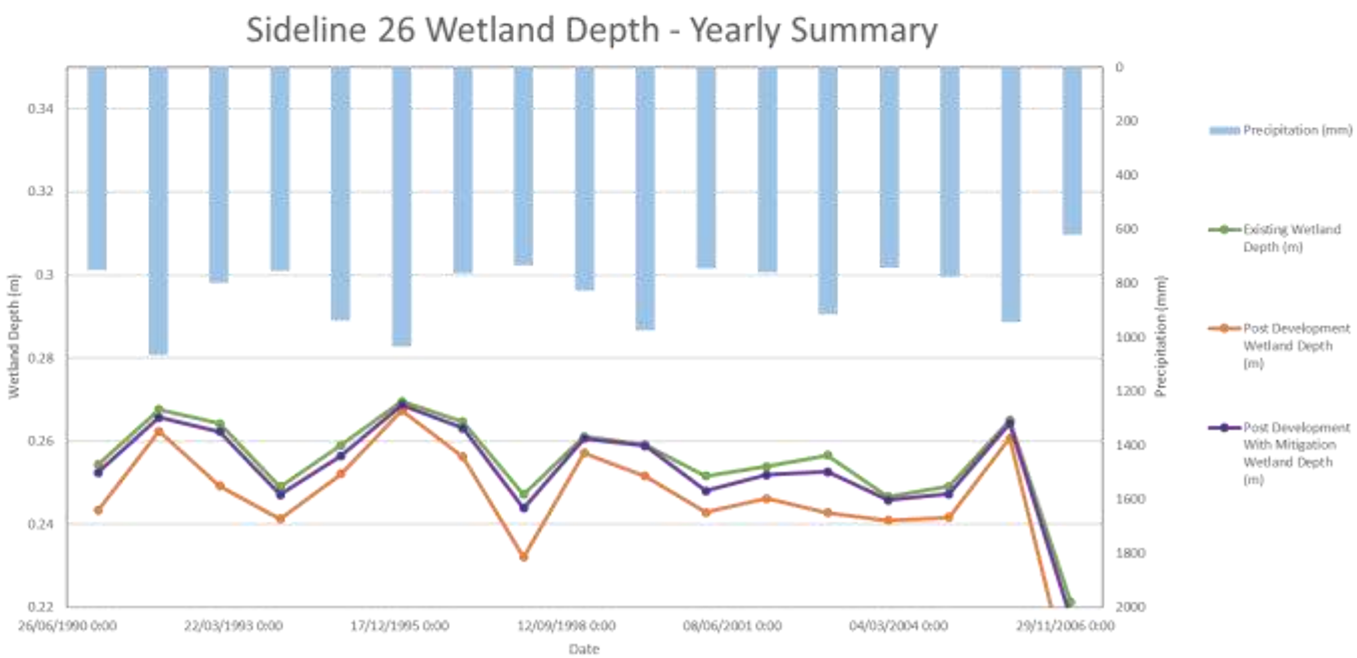


Figure 49: Average Annual Depth in Sideline 26 Wetland

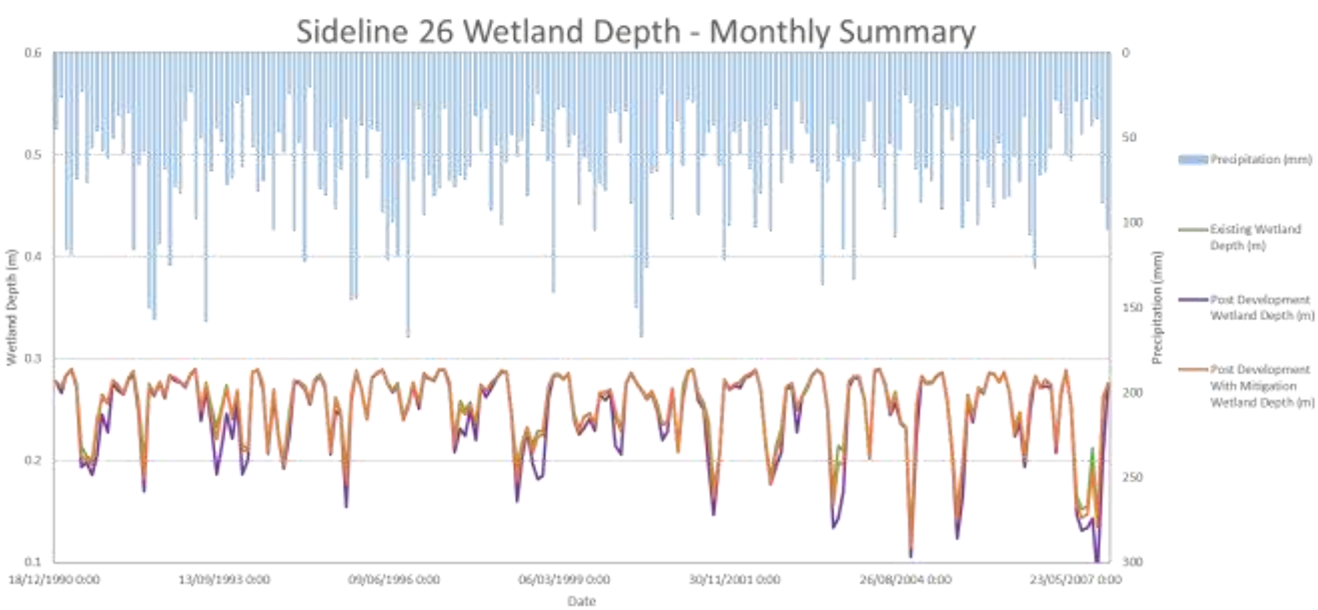


Figure 50: Average Monthly Depth in Sideline 26 Wetland

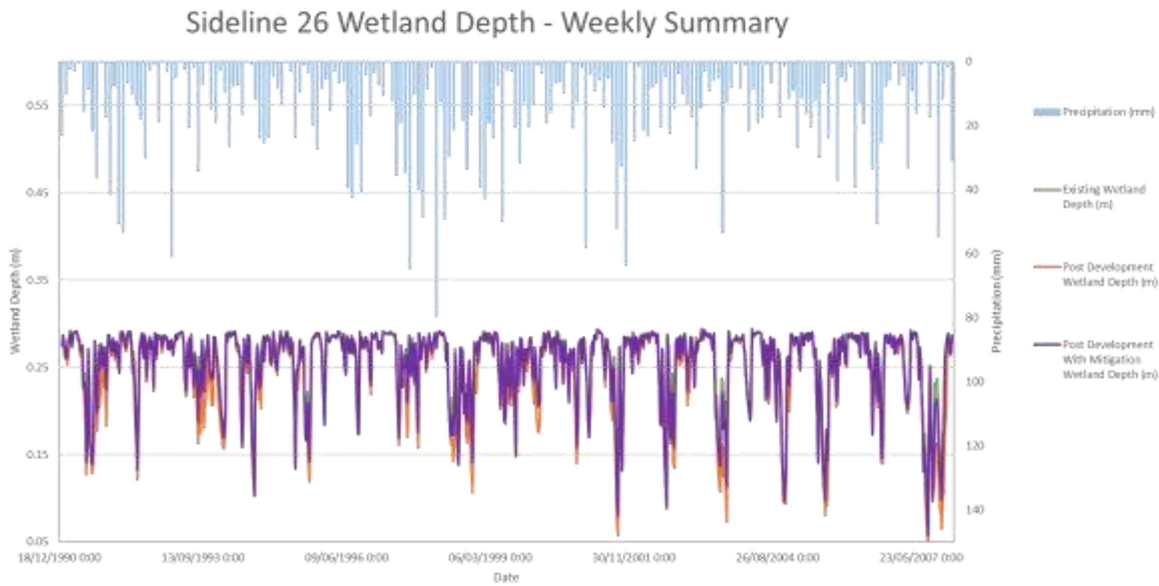


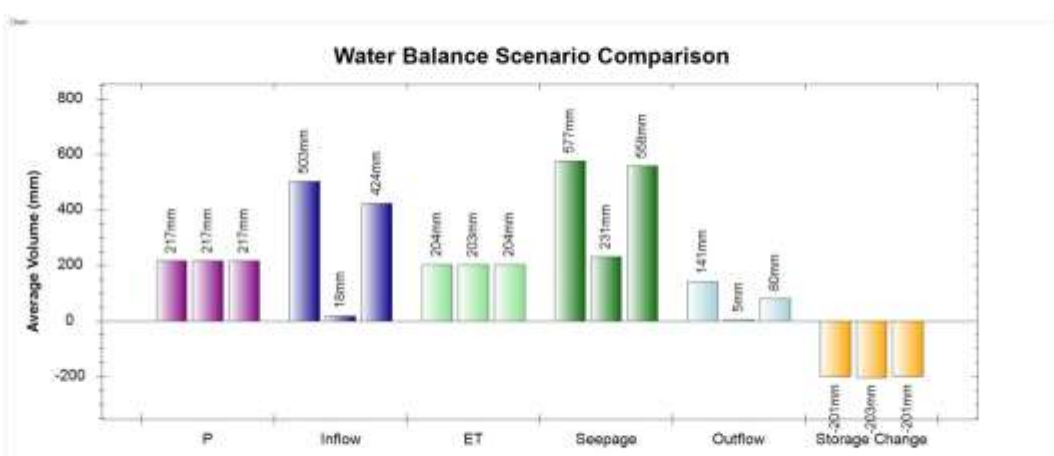
Figure 51: Average Weekly Depth in Sideline 26 Wetland

3.4.6 VO5: Long-term Simulation, Proposed Conditions with Mitigation

In order to simulate the mitigation scenario, a catchment was added to represent roof tops being directed to the wetland. A depression storage value of 10mm was used on the roof to catchment to mimic retention in a rain garden or bioretention cell upstream of the wetland, and a route reservoir was added to mimic the detention component of an LID. Using this methodology, the area of roofs and size of an upstream LID could be estimated in order to mitigate the impacts of the upstream development. The results of this mitigation are shown on Figure 49 - Figure 51. Comparing the maximum water levels over the long-term scenario shows that the maximum water depth in the wetland, which drop from 0.553m to 0.520m with development and no mitigation increase to 0.525m with mitigation. The average water level, which dropped from 0.330m to 0.327m in the scenario with no mitigation, is restored to 0.330m with mitigation.

Figure 52 summarizes the components of the wetland water balance on an annual, seasonal and monthly basis.

Figure 52: Sample water balance graph



3.4.7 VO5: Benefits, Challenges, Recommendations and References

Benefits

- Simple to use, generates defendable results. Having a command designed to represent a wetland makes modelling and calibration simpler than some other models, where different components are modeled separately (and potentially in multiple models).
- Having groundwater elevations as a model input simplifies building and calibrating the model. Although the impact of the wetland on the groundwater is not modeled, this model does use groundwater elevations to calculate soil saturation levels, changes in infiltration rates and groundwater seepage into the wetland.

Challenges

- As this is a hydrology model and does not model impact of the wetland on the local aquifer, it is only suitable for wetlands which do not have a large impact on the ground water. The model does not predict groundwater elevations and shows a water level of zero once the water level is below ground.
- Not having LIDs in the model made modelling mitigation a bit more challenging; however, VO developers intend to add LIDs functions to VO5 by the end of 2018.

Recommendations

- Discuss the use of this model with your local conservation authority prior to starting a water balance project as it is not suitable for use in wetlands which are primarily groundwater fed or for wetlands which may impact groundwater elevations. In most cases small wetlands will not have a noticeable impact on groundwater elevations as aquifers tend to have large catchments of which the wetland is only a small component.
- It is important when setting up a wetland model in VO that the groundwater, depth area curve and stage discharge curve are all generated relative to the lowest point in the wetland. If ground water elevations are not measured at the lowest point in the wetland, it may be necessary to adjust these elevations, in consultation with a hydrogeologist or geotechnical engineer, to represent groundwater levels at the lowest point in the wetland.

References

Visual OTTHYMO User Manual, Civica infrastructure Inc, August 2017 -
http://visualotthymo.com/downloads/v5.0_usermanual.pdf

Visual OTTHYMO Reference Manual, Civica infrastructure Inc, March 2017
http://visualotthymo.com/downloads/Reference%20Manual%20-%20VO5.pdf

3.5 Storm Water Management Model (SWMM)

3.5.1 SWMM: Background

First developed in 1971 by the United States Environmental Protection Agency (EPA), the Storm Water Management Model (SWMM) is a dynamic rainfall-runoff simulation model that allows for both single event and continuous (long-term) simulation of runoff quantity and quality. It is geared towards analysis of urban and urbanizing catchments. The current version (SWMM 5) provides an integrated modelling environment for editing the properties of subcatchments and flow routing networks, running hydrologic, hydraulic, and water quality simulations, and viewing simulation results. The runoff component of SWMM simulates generation of runoff and pollutant loads from various subcatchment areas, while the routing component simulates the transport of runoff and pollutants through both natural and engineered flow networks. Model capabilities are summarized below in Table 13.

Table 13: SWMM model features summary

Model Features	**SWMM**
Model Type	Physically-based lumped parameter
Simulation Type	Single-event/continuous
Precipitation	Multiple/single hyetograph
Snow Melt	Heat budget equation, areal depletion curves, and modified degree-day
Evapotranspiration	Evaporation from water stored at surface and in soil; PET input as timeseries or computed from temperature using Hargreaves method
Infiltration	Horton infiltration
	Modified Horton infiltration
	Green-Ampt infiltration
	Modified Green-Ampt infiltration
	Curve Number infiltration
Overland Flow	Nonlinear reservoir routing
Subsurface Soil Water Flow	Vertical exchanges within 2-zone groundwater layer (saturated/unsaturated)
Channel/Reservoir	1D dynamic wave approximation
	1D kinematic wave flow
Groundwater Flow	Vertical exchange within 2-zone groundwater layer; lateral exchange with drainage network nodes (but not between subcatchments)
GIS interface	Accept GIS format data including point/contour/polygon /polyline/ASCII

EPA-SWMM is provided free of charge and is available for download at https://www.epa.gov. Various proprietary graphical user interfaces have been developed using the SWMM 5 engine (e.g. PC-SWMM, XP-SWMM), and can facilitate the editing of subcatchment and flow network properties and the viewing and exporting of data, but the underlying fundamental representation of hydrologic processes remains the same. See Rossman (2015) for a detailed description of model representation of hydrologic processes.

3.5.2 SWMM: Model Setup, Existing Conditions

The SWMM engine (using the PC-SWMM graphical user interface) was used to model two different wetland catchments, both of which are to the north of Taunton Road in Pickering, Ontario. The sites are referred to as Sideline 22 and Sideline 26; detailed descriptions and of both sites are provided in sections 3.1.2, 3.2.2, 3.3.2, and 3.4.2, with accompanying figures.

The data used to determine the conceptual water balance and in model set-up is outlined in Table 14 below, along with the data source.

Table 14: SWMM data types and sources

Data Type	Data Sources
Topography	10-m DEM; sub-centimeter resolution field topographic/bathymetric survey of wetland basins used to derive stage-storage curves
Climate data	5-min precipitation and temperature from nearby Brock West Landfill station (~3.0 km from study sites)
Land use	TRCA land use data; hypothetical post-development land use and catchment parameters
Soil data	Data from existing geotechnical reports and hand-augured soil samples; slug test-derived hydraulic conductivity estimates
Channel	TRCA DEM-derived drainage lines
Groundwater	Static groundwater level measurements from consultant hydrogeological reports ; slug test-derived hydraulic conductivity estimates
Water Level Monitoring	1-hr surface water and groundwater level data from piezometers at multiple depths within wetland; data covers growing season of 2013 and 2014; 2013 data used to calibrate models and 2014 to validate

Prior to calibration and validation of the models, a conceptual water balance model for each site was created based on the water transfer mechanisms known to exist or suspected of being present at each site. Conceptual models considered data on wetland hydrogeomorphic and hydrogeological setting, known spillway elevations, and ecological indicators of hydrological conditions. The conceptual water balance models for the two sites consisted of the following terms:

a. Sideline 22: $P + RO + GW_{in} - ET - GW_{out,L} = \Delta S + residual$

b. Sideline 26:

i. Basin 1: $P + RO + GW_{in,L} - ET - GW/SW_{out\ (to\ Basin\ 2)} = \Delta S + residual$

ii. Basin 2: $P + RO + GW/SW_{in\ (from\ Basin\ 1)} - ET - GW_{out,V} - GW/SW_{out,L} - SW_{out} = \Delta S + residual$

where P is precipitation, RO is overland runoff, GW_{in} is groundwater inflow (both vertical and lateral components, unless specified by subscript), ET is evapotranspiration, GW_{out} is groundwater outflow (both vertical and lateral components, unless specified by subscript), SW_{out} is channelized surface water outflow, ΔS is the change in volumetric storage, and *residual* is the residual error term. Where surface water and groundwater terms are showed together in combination, it indicates that subsurface volumetric storage above the water table (i.e. interflow) was included together with overland flow.

After determining the terms of the wetland water balance equations for each, the following general approach was used in the calibration and validation process for the models under existing conditions:

1. Where possible, independently estimate known inputs, outputs, and storage changes along with their corresponding uncertainties;
2. Determine the terms of the water balance associated with the greatest amount of error based on analysis of wetland storage response monthly water balance analysis;
3. Evaluate the relative contribution of water transfer mechanisms and the temporal variability of these contributions to the water balance.

3.5.3 SWMM: Calibration, Existing Conditions

The simulation settings used for both the calibration and validation of the model are summarized in Table 15.

Table 15: SWMM simulation settings for calibration and validation

Climatology and simulation options	1-hr dry weather time step, 5-min wet-weather time step, 30-s routing time step; *ET* calculated using Hargreaves method and inputs of daily precipitation totals, maximum and minimum temperatures
Wetland parameterization	Wetland represented as dynamic storage feature; detailed stage-storage curve was defined to account for open water, bank storage, and subsurface storage; calibration focused on wetland storage response to precipitation events
Catchment and aquifer parameterization	Multiple upstream catchments defined for both wetlands based on shared land use and soil drainage properties; one aquifer unit defined for all upstream catchments for both wetlands; aquifer properties defined using combination of local and regional geological data
Groundwater interaction	Wetlands received groundwater flow from upstream aquifer units; for Sideline 26, observed vertical losses simulated using seepage parameters; for Sideline 22, wetland lateral losses to groundwater were simulated using a downstream catchment and aquifer unit
Sensitivity, calibration and validation	Parameter sensitivity analysis performed; calibration and validation assessed using both visual and statistical (e.g. Nash-Sutcliffe efficiency) measures

Monitored surface water and groundwater level data collected at both Sideline 22 and Sideline 26 in the growing seasons of 2013 and 2014 was used to calibrate the model. An iterative process was followed to simulate wetland storage dynamics, whereby water transfer mechanisms were added one at a time to an initial simple water balance equation to try and mimic wetland storage dynamics under both wet and dry conditions. The following summarizes the general process that was followed to calibrate the wetland hydrology models for a) Sideline 22 and b) Sideline 26:

a. Sideline 22
   i. Parameterize catchment and perform sensitivity analysis
   ii. Incorporate wetland and stage-storage curve
   iii. Compare simulation results to observed surface water levels (monitoring data)
   iv. Refine stage-storage curve to include subsurface (extend curve to reflect depth-dependent specific yield of soils)
   v. Compare simulation results to observed groundwater levels (monitoring data)
   vi. Incorporate groundwater inflow
   vii. Compare simulation results to observed groundwater levels (monitoring data)
   viii. Investigate options for simulating groundwater outflow (orifice loss versus DS catchment)
   ix. Calibrate and validate model for both groundwater outflow scenarios

b. Sideline 26
   i. Parameterize catchment and perform sensitivity analysis
   ii. Incorporate two wetland basins and stage-storage curve
   iii. Compare simulation results to observed surface water levels (monitoring data)
   iv. Refine stage-storage curve to include subsurface (extend curve to reflect depth-dependent specific yield of soils)
   v. Compare simulation results to observed groundwater levels (monitoring data)
   vi. Incorporate estimated groundwater inflow
   vii. Compare simulation results to observed groundwater levels (monitoring data)
   viii. Add spillover overland flow connection from Basin 1 to Basin 2
   ix. Compare simulation results to observed groundwater levels (monitoring data)
   x. Add subsurface outflow pathways from Basins 1 and 2
   xi. Calibrate and validate model

The stage storage curves for both wetlands were defined using a combination of high resolution topographic/bathymetric survey data and estimates of soil specific yield (S_y) to account for changes in volumetric storage occurring in the subsurface zone. Different specific yield values were used for Areas 1 and 2; initial estimates of the specific yield terms were derived from Gasca and Ross (2009). Figure 53 depicts the process that was used to determine ΔS (volumetric storage, i.e. the wetland hydroperiod) for the model calibration and validation.

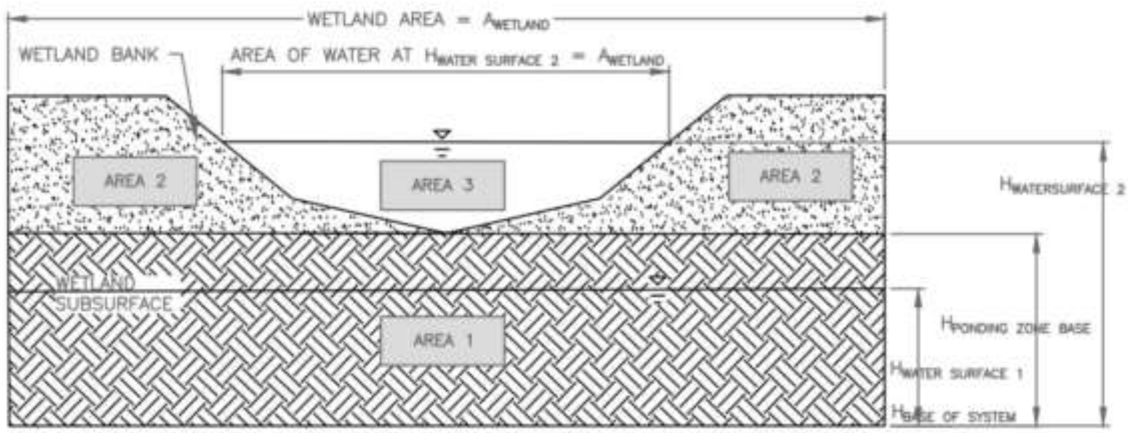


Figure 53: Calculation of total volumetric storage, incorporating specific yield (from Charbonneau, 2016)

The volumes for the respective reservoirs outlined in Figure 53 were calculated as follows:

$$V_{Area\ 1} = A_{wetland} \times (h_{water\ surface} - h_{base\ of\ system}) \times S_{y,subsurface}$$

$$V_{Area\ 2} = (A_{wetland} - A_{water\ surface}) \times (h_{water\ surface} - h_{base\ of\ ponding\ zone}) \times S_{y,banks}$$

$$V_{Area\ 3} = Surveyed\ wetland\ basin\ volume$$

$$\Delta S \begin{cases} \text{If water level < ponding zone base} = V_{Area\ 1} \\ \text{If water level > ponding zone base} = V_{Area\ 1} + V_{Area\ 2} + V_{Area\ 3} \end{cases}$$

An analysis of diurnal water level variations during several dry periods (periods with minimal 7-day antecedent rainfall during which no events >2 mm occurred) was used to isolate ET and vertical groundwater inflow fluxes following the method of McLaughlin and Cohen (2014). This method allowed the magnitude of these two terms to be estimated independently. For Sideline 26, owing to the relatively low conductivity soils within the catchment, it was assumed that there was no groundwater entering the wetland, and a small vertical outflow of groundwater from Basin 2 was identified through the monitored vertical hydraulic gradients. For Sideline 22, only vertical groundwater inflow was considered, while lateral groundwater outflow was identified as an important water transfer mechanism. Two methods were explored to replicate this water transfer mechanism in SWMM: 1) groundwater interactions within a downstream subcatchment aquifer unit, and; 2) outflow from the storage unit via an orifice. For the first method, an additional subcatchment with an aquifer unit associated with it was added to the model, and negative groundwater coefficients were added to the model to simulate groundwater outflow. For the second method, a circular orifice was added to the base of the wetland storage unit, and the coefficient and area were adjusted to attempt to replicate the lateral groundwater outflow.

The results of the model calibration are shown visually in Figure 54 and Figure 54 below; numerical results of the calibration as well as the validation of both models are shown in the subsequent section.

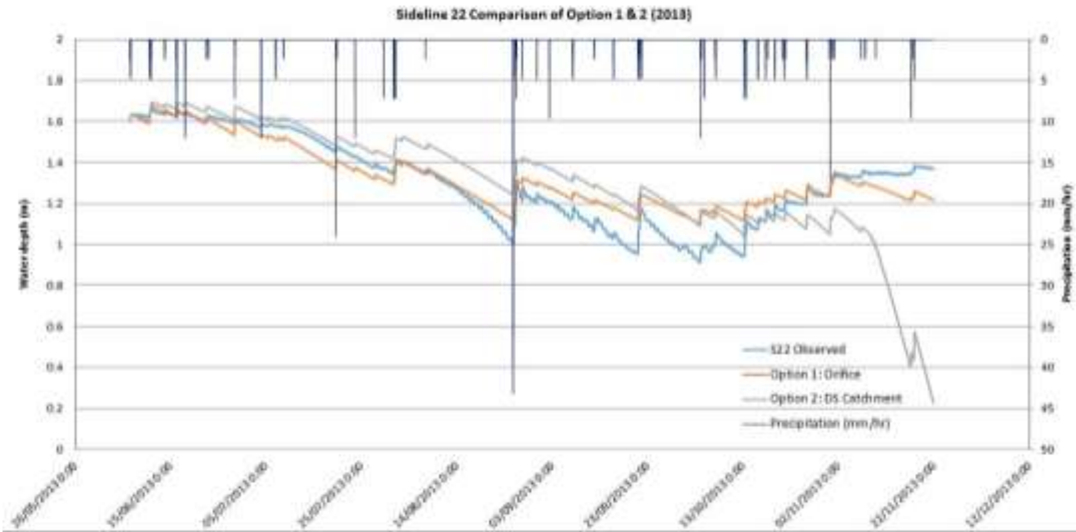


Figure 54: Results of calibration for Sideline 22, showing the representation of lateral groundwater outflow using both option 1 (orifice) and option 2 (catchment-aquifer unit), as described in text (from Charbonneau, 2016)

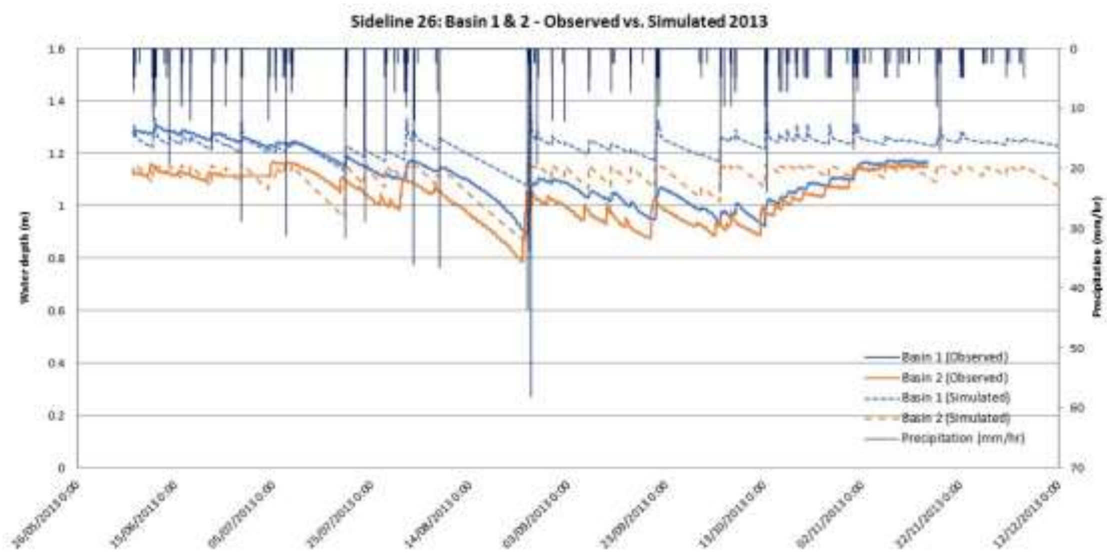


Figure 55: Results of calibration for Sideline 26, showing monitored and calibrated water levels for both Basin 1 and Basin 2 (from Charbonneau, 2016)

3.5.4 SWMM: Validation, Existing Conditions

Following calibration of the water balance models for Sideline 22 and Sideline 26 using monitoring data from the growing season of 2013, monitoring data for the year 2014 was used to validate the models. The results of the model performance for both the calibration and validation are shown in Table 16 and Table 17.

Table 16: Statistical performance measures for model calibration and validation for Sideline 22 (from Charbonneau, 2016)

Evaluation Functions	Value of Perfect Measure	Option 1: Orifice			Option 2: Downstream Catchment		
		2013 (189 days)	2013 (144 days)	2014 (246 days)	2013 (189 days)	2013 (110 days)	2014 (246 days)
Nash-Sutcliffe efficiency (NSE)	1	-0.037	0.862	-1.04	0.794	0.694	-1.01
Coefficient of determination	1	0.306	0.908	0.110	0.91	0.857	0.147
Standard error of estimate (SEE)	0	0.215	0.0804	0.418	0.127	0.126	0.142
Simple least squares (LSE)	0	190	17.8	940	53.3	55.4	109
Root mean square error (RMSE)	1	6.22	3.16	21.9	6.03	6.19	5.19

Table 17: Statistical performance measures for calibration and validation for Sideline 26 (from Charbonneau, 2016)

Evaluation Functions	Value of Perfect Measure	Basin 1		Basin 2	
		2013	2014	2013	2014
Nash-Sutcliffe efficiency (NSE)	1	0.502	-82.3	-11.2	-3.79
Coefficient of determination (R2)	1	0.12	0.01	0.03	0.06
Standard error of estimate (SEE)	0	0.362	0.291	0.312	0.231
Simple least squares (LSE)	0	538	461	398	291
Root mean square error (RMSE)	1	12.7	10.5	10.1	10

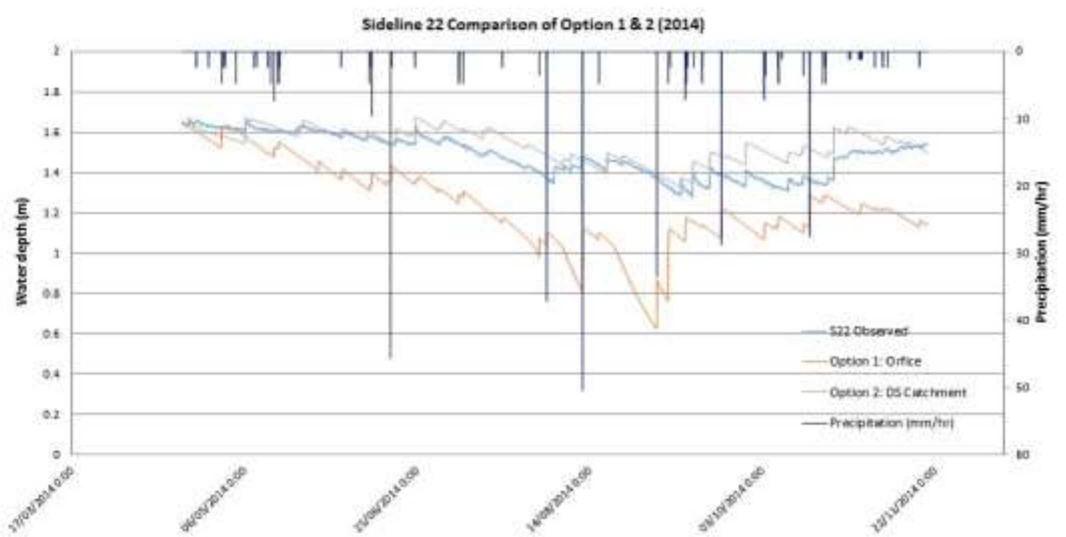


Figure 56: Results of validation for Sideline 22, showing difference between showing the representation of lateral groundwater outflow using both option 1 (orifice) and option 2 (catchment-aquifer unit) (from Charbonneau, 2016)

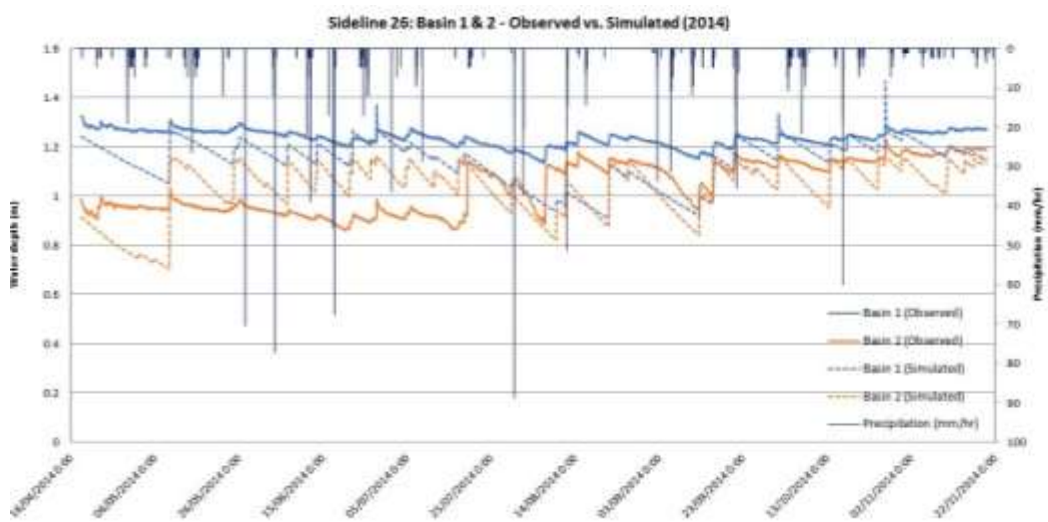


Figure 57: Results of validation for Sideline 26, showing monitored and calibrated water levels for both Basin 1 and Basin 2 (from Charbonneau, 2016)

For Sideline 26, the model showed a reasonable agreement between monitored and simulated wetland storage dynamics in both Basin 1 and Basin 2. The increase in storage in response to precipitation was occasionally overestimated in Basin 1, and a hypothesized subsurface flow path from Basin 1 to Basin 2 was not replicated but nonetheless the model represents wetland storage dynamics reasonably well.

At Sideline 22, there was a greater discrepancy between the modeled and monitored water levels, particularly in the late fall period. Lateral groundwater loss from the catchment needed to be simulated to account for the fact that no channelized surface water outflow existed at the site. Neither of the two methods used to simulate this water transfer mechanism (i.e., the downstream catchment-aquifer unit and circular orifice approaches, as described in Section 3.5.3) were fully satisfactory in replicating wetland storage dynamics, with the downstream catchment approach underestimating wetland water storage in 2013 while the orifice method underestimated storage in 2014. This shortcoming of the model speaks to the importance of using models that are capable of more explicitly representing groundwater-surface water interactions in settings characterized by a high degree of groundwater interaction such as the Sideline 22 wetland.

3.5.5 SWMM: Proposed Conditions without Mitigation

A post-development scenario was developed for Sideline 22 (only) by consulting preliminary draft subdivision plans for the area of the wetland catchment, which is zoned for residential development with some small commercial lots. The hypothetical development scenario was created based on the preliminary extent of development in the catchment and the proposed lot layout. To simulate the development, the degree of imperviousness in the upstream catchment area was increased from 3.5% to 50% and changing maximum flow path length to 30 m.

Table 18 shows the effect of development on each of the major terms in the water balance equation for Sideline 22. As would be expected for a large increase in the degree of catchment imperviousness, the proportion of water leaving the system as groundwater recharge decreases by nearly 50% (from 192.9 mm to 100.8 mm) while the proportion of precipitation entering the wetland as runoff increases from 12.9

mm to 187.0 mm. A relatively large decrease in total catchment evapotranspiration can also be observed (from 229.7 mm to 144.6 mm). Alterations to the wetland water balance of this magnitude clearly have the potential to lead to degradation or loss of wetland ecological functions as well as potential erosion issues, in the absence of a well-designed water balance mitigation strategy.

Table 18: Comparison of pre- to post-development water balance terms at Sideline 22 (from Charbonneau, 2016)

Sideline 22 Subcatchment 1	Pre-development	Post-Development (No Mitigation)
Surface		
Percent Impervious	3.5%	50%
Area (ha)	13.03	13.03
Surface Evaporation, E (mm)	2.5	40.8
Infiltration, I (mm)	420.1	204.6
Runoff, RO (mm)	12.9	187.0
Subsurface		
Evapotranspiration, ET (mm)	227.2	103.8
Groundwater Outflow, GW (mm)	11.5	9.0
Catchment Water Balance		
Rainfall (mm)	435.4	435.4
Groundwater recharge, GWR (mm)	192.9	100.8
Groundwater Outflow, GW (mm)	11.5	9.54
Total Evapotranspiration, E + ET (mm)	229.7	144.62
Runoff, RO (mm)	12.9	187.0

3.5.6 SWMM: Proposed Conditions with Mitigation

A number of scenarios were explored to determine the effect of different mitigation strategies. For the purposes of this review, the two scenarios that best demonstrated the capacity of SWMM to represent LID practices are reported here. These scenarios, referred to as Scenario 6 and Scenario 7, are described below. Both scenarios utilized bioretention cells to detain and infiltrate excess runoff from impervious surfaces. These cells are represented in SWMM as a three layer system (surface vegetated area, engineered soil, and storage layer), with an option to include an underdrain that was not used in this evaluation. The bioretention cells were sized to a 1-hr, 25 mm event. The parameters used to represent the bioretention cells are shown below in Table 19. An analysis of the sensitivity of total catchment infiltration, evapotranspiration, and runoff volume to the bioretention cell design parameters (soil depth, storage layer thickness, vegetation volume, berm height, cell area, and soil hydraulic conductivity) showed that only cell area had a significant effect on the volume of water infiltrated by the cells. As ponded water was rarely present on the cells across a wide range of settings, infiltration volume was seldom limiting, but rather it was the volume of runoff reaching the cells that controlled total infiltration volume.

Table 19: Parameters used in representation of LID practices (bioretention cells) (from Charbonneau, 2016)

Surface Layer	Value
Berm height (mm)	300
Vegetative volume (fraction)	0.10
Surface roughness (-)	0.0
Surface slope (%)	0.0
Soil Layer	**Value**
Thickness (mm)	200
Porosity (-)	0.40
Field capacity (-)	0.105
Wilting point (-)	0.047
Conductivity (mm/hr)	60
Conductivity slope (%)	5.0
Suction head (mm)	60
Storage Layer	**Value**
Thickness (mm)	200
Void ratio (voids/solids)	0.7
Seepage rate (mm/hr)	5.5
Clogging factor	0.0

For Scenario 6, 88% of the impervious area in the catchment (driveways, roofs, and portion of right-of-way) was treated by bioretention cells. From this treated runoff volume, 40% of the roof area runoff was diverted from the bioretention cells to a rainwater harvesting system, represented as a "rain barrel" in SWMM. This scenario represented the maximum extent of infiltration practices that could be used without exceeding the pre-development groundwater recharge volume. The bioretention cells were insufficient to mitigate the full excess runoff volume generated, and additional stormwater LIDs in the form of rainwater harvesting were thus required. However, it was noted that SWMM underestimates the volume lost to ET from bioretention cells, as ET cannot occur from the subsurface storage layers. This is a shortcoming of SWMM in long term continuous simulations of LID performance.

For Scenario 7, additional bioretention cell area was added such that 95% of impervious areas were treated. As in Scenario 6, 40% of the roof area runoff was diverted to a rainwater harvesting practice. Scenario 7 represented an "enhanced" recharge scenario, with groundwater recharge exceeding pre-development levels. The authors of this review note that such an option should only be considered in the context of an integrated urban water management plan where enhanced recharge is needed to mitigate factors such as water table drawdown due to external water takings or diversion. As SWMM is not capable of simulating dynamic interaction with groundwater, it would not be an appropriate tool to assess the potential consequences of an enhanced recharge program such as that in Scenario 7. Nonetheless, catchment runoff was reduced by >50% relative to Scenario 6, which reduced total catchment runoff to levels approaching but not matching pre-development conditions; the rainwater harvesting system mitigated the remaining unmitigated runoff.

The differences in the surface, subsurface, and total catchment water balance terms between the pre-development condition and Scenarios 6 and 7 are summarized in Table 20 below.

Table 20: Comparison of mitigation scenarios with pre-development water balance terms (from Charbonneau, 2016)

Sideline 22 Subcatchment 1	Pre-development	Scenario 6	Scenario 7
Surface			
Percent Impervious	3.5%	50%	50%
Area (ha)	13.03	13.03	13.03
Surface Evaporation, E (mm)	2.5	47.09	48.00
Surface Infiltration, I (mm)	420.1	328.0	365.0
Runoff, RO (mm)	12.9	65.5	65.5
Subsurface			
Subsurface Evaporation, ET (mm)	227.2	119.48	119.0
Groundwater Outflow, GW (mm)	11.5	10.0	11.6
Catchment Water Balance			
Rainfall (mm)	435.4	435.4	435.4
Groundwater Recharge, GWR (mm)	192.9	198.8	241.2
Total Evaporation, E + ET (mm)	229.7	166.6	167.0
Groundwater Outflow, GW (mm)	11.5	10.0	11.5
Runoff, RO (mm)	12.9	65.5	31.5

3.5.7 SWMM: Benefits, Challenges, Recommendations and References

Benefits:

- The SWMM model is capable of representing many important hydrological processes without requiring excessive input data or highly specialized expertise to operate.
- Representing wetlands as storage units allows for stage-storage and stage-discharge relationships to be defined, and for subsurface flow from the catchment to be transferred to the wetland; storage relationships can also be extended to include shallow subsurface storage.
- The representation in SWMM of LID practices as discrete features within the flow network with variable properties allows for a more realistic simulation of LIDs than simply changing the lumped parameters of the wetland catchment.

Challenges:

- Limitations in the representation of certain groundwater exchange pathways (e.g. lateral outflows from catchment outlet, groundwater mounding beneath LIDs) limit the validity of simulations of wetland storage dynamics where these processes constitute a large proportion of the overall water balance.
- The inability of SWMM to simulate ET from the soil layer of LIDs means that the ability of LIDs such as bioretention cells to mitigate excess runoff via evapotranspiration is likely underestimated in long-term simulations.

Recommendations:

- Wetland water balance modelling is an iterative process, and additional water transfer mechanisms should be added to an initial simplified water balance equation as the monitoring data and calibration process reveal their existence.

- It is critical to have multiple years of monitoring data to be able to isolate hydrological processes that are associated with wet or dry conditions or that vary seasonally; data should always be analyzed at multiple timescales (annual, seasonal, monthly, weekly, diurnal) to help isolate these processes.
- Independent estimates of certain water balance terms (e.g. ET, vertical groundwater inflow) can help to isolate other processes occurring simultaneously, and methods exist that can be applied to monitoring data for this purpose.
- Detailed topographic information can reduce the uncertainty in the above ground stage-storage relationship for wetland; site-specific information is needed reduce the error associated with the specific yield estimates below ground.

References:

Charbonneau , C. 2016. Hydrologic Analysis for the Protection of Wetlands in Urban Development. Master of Applied Science in Engineering Thesis, University of Guelph. Retrieved from https://atrium.lib.uoguelph.ca

Gasca, D., Ross, D. 2009. The use of wetland water balances to link hydrogeological processes to ecological effects. Hydrogeology Journal 17: 115-133. doi:10.1007/s10040-008-0407-x

McLaughlin, D.L., Cohen, M.J. 2014. Ecosystem specific yield for estimating evapotranspiration and groundwater exchange from diel surface water variation. Hydrological Processes 28: 1495-1506.

Rossman, L. 2015. Storm Water Management Model User's Manual Version 5.1 - manual. US EPA Office of Research and Development, Washington, DC, EPA/600/R-14/413 (NTIS EPA/600/R-14/413b).

United States Environmental Protection Agency. 2015. Storm Water Management Model. https://www.epa.gov/water-research/storm-water-management-model-swmm

Item 7.2

Section I – Items for Board of Directors Action

TO: Chair and Members of the Board of Directors
Friday, September 24, 2021 Meeting

FROM: Sameer Dhalla, Director, Development and Engineering Services

RE: **FINAL CARRUTHERS CREEK WATERSHED PLAN**

KEY ISSUE
To request approval of the Carruthers Creek Watershed Plan.

RECOMMENDATION

WHEREAS the development of the Carruthers Creek Watershed Plan was initiated in 2015 at the request of the Region of Durham;

AND WHEREAS the public review period of the draft Carruthers Creek Watershed Plan concluded on March 19, 2021;

AND WHEREAS Durham Regional Council endorsed the updated Carruthers Creek Watershed Plan on June 23, 2021;

THEREFORE, LET IT BE RESOLVED THAT the updated Carruthers Creek Watershed Plan be approved;

THAT TRCA staff be directed to communicate the final approval of the Carruthers Creek Watershed Plan to all partners and stakeholders;

AND FURTHER THAT staff be directed to commence work on implementing the Carruthers Creek Watershed Plan in collaboration with the Region of Durham, City of Pickering, and Town of Ajax.

BACKGROUND
Watershed planning provides a framework for establishing goals, objectives, and direction for the protection of water resources, the management of human activities, land, water, aquatic life, and resources within watersheds. It also provides an opportunity for the assessment of cumulative, cross-jurisdictional, and cross-watershed impacts.

Watershed plans are not land use plans, nor would approval of the watershed plan constitute a land use planning decision. However, as required by Provincial Plans, the data, scientific analyses, modelling, scenario evaluation, and management recommendations generated through a watershed planning process are to be used by municipalities to inform land use and infrastructure planning decisions.

The Carruthers Creek watershed is located within the City of Pickering and the Town of Ajax and is on the eastern edge of Toronto and Region Conservation Authority's (TRCA) jurisdiction. The watershed is relatively small, at approximately 3,840 hectares in size, ranging from two to three kilometres in width, and has a total length of 18 kilometres. The headwaters of Carruthers Creek form to the south of the Oak Ridges Moraine, in the city of Pickering, and the creek enters Lake Ontario at Carruthers Marsh in the Town of Ajax.

The watershed is mainly rural north of Highway 7 and is mainly urbanized south of Taunton Road. Between Highway 7 and Taunton Road, lands are characterized by a mix of rural, estate residential, recreational, and related uses, and are in the Protected Countryside designation of the provincial Greenbelt Plan. There are approximately 41,000 residents within the boundaries of the watershed.

The Carruthers Creek Watershed Plan (CCWP) update took place over two phases. Phase 1 was initiated in June 2015 and culminated in peer reviewed technical reports that characterize watershed conditions. Characterization Technical Reports are publicly posted on the Carruthers Creek webpage on TRCA's website and include topics of aquatic barriers, aquatic ecology, hydrogeology, terrestrial ecology, surface water quality, fluvial geomorphology, headwater drainage features, and surface water quantity. Phase 2 was initiated in December 2017 and included public consultation, further technical reports, watershed scenario analyses, and the development of management recommendations. The Scenario Analysis Technical Reports are publicly posted on the Carruthers Creek webpage on TRCA's website and include topics of hydrological assessment, fluvial geomorphic assessment, terrestrial impact assessment, aquatic impact assessment, soil water assessment modelling (water quality), urban forest assessment, stormwater management, and groundwater modelling. A draft CCWP was released for public review and comment on March 13, 2020.

As a result of the Covid-19 pandemic, in-person public consultations scheduled for April 30, 2020 were postponed. At its meeting on December 16, 2020, Regional Council authorized staff to reinitiate the public consultation process. In early 2021, public engagement resumed using online platforms. The final date for comments on the draft CCWP was March 19, 2021.

The watershed plan was designed to meet or exceed provincial requirements while satisfying policy 7.3.11 p) of the Regional Official Plan, which states,

> Where a comprehensive review of this Plan includes consideration of lands for Urban Area expansion within the City of Pickering east of the Pickering Airport lands, outside of the Greenbelt, the following additional matters will be assessed and evaluated at that time: . . .
>
> > ii. the preparation and completion of watershed plan update for the East Duffins and Carruthers Creek watersheds.

In accordance with this policy, the completion of the watershed plan will allow for the future consideration of potential development in northeast Pickering. It does not constitute a decision on whether the lands should be developed, since that is a matter that will be addressed through the Region’s Municipal Comprehensive Review (MCR) process. A small portion of the East Duffins watershed was included in the study area, given that only a small portion of that watershed is outside of the Greenbelt Plan and that substantial modelling has already been undertaken for the Seaton lands.

Previous Reports and Decisions
Since the commencement of this project, numerous reports have been prepared for Regional Planning and Economic Development Committee and Regional Council as outlined in the June 1, 2021 Report #2021-P-16 to the Region of Durham Planning and Economic Development Committee.

Additionally, the TRCA Board of Directors has regularly been updated at various points during the development of this watershed plan. Below is a summary of some of the key dates (from most recent to oldest) during which updates were provided as well as the original Board of Directors resolution to commence this work:

- September 27, 2019 – Annual update received
- June 22, 2018 – Annual update received
- October 27, 2017 – Report on completion of Phase 1 of the CCWP was received
- July 14, 2017 – Report on the installation of groundwater monitoring wells to gather data to support the CCWP
- October 28, 2016 – To clarify the process for completing the CCWP relative to the Authority's amended resolution providing comments on the review of the four provincial plans
- July 22, 2016 – Annual update received
- June 26, 2015 – Service agreement between TRCA and the Region of Durham to collaboratively develop a watershed plan for Carruthers Creek (See Resolution #A106/15 below)

At Board of Directors Meeting held on June 26, 2015, Resolution #A106/15 was approved in part as follows:

> *WHEREAS the Region of Durham has requested Toronto and Region Conservation Authority (TRCA) to complete a watershed plan update for Carruthers Creek watershed;*
>
> *THEREFORE, LET IT BE RESOLVED THAT TRCA work with the Region of Durham, and in consultation with the City of Pickering and Town of Ajax, to complete an integrated watershed plan for Carruthers Creek;*
>
> *THAT TRCA staff be directed to enter into a service agreement with the Region of Durham to complete the watershed plan; <…>*

Watershed Plan Overview

The final Watershed Plan (***Attachment 1***) is divided into nine sections. A brief summary of each section is provided below:

1. Introduction and Background: provides an overview of the rationale and policy basis for watershed planning, the local context and considerations, and key partners and stakeholders.
2. Water Resources and Natural Heritage Systems: describes the key components of the Water Resource System (WRS) and Natural Heritage System (NHS), and how each system was mapped.
3. Existing Watershed Conditions: describes the current watershed conditions based on technical evaluations undertaken in Phase 1 of the study. Four key issue areas, being the WRS, the NHS, Water Quality and Natural Hazards (including flooding) are described and rated against benchmark indicators.
4. Future Watershed Conditions: describes the three future scenarios that were modelled to predict the response of the watershed to future land use change, the results of the modelling analyses, and the implications of these scenarios.
5. Management Framework: outlines what needs to be done to protect, enhance, and restore the watershed's health. The management framework includes 35 recommendations divided into three goal areas of: Land Use, WRS, and the NHS. A separate sub-section (5.4) details the management recommendations that would apply, should a future Settlement Area Boundary Expansion be allowed within northeast Pickering.

6. Monitoring and Evaluation: details the indicators, frequency, and methods in which monitoring should occur. The performance of the Watershed Plan implementation will need to be evaluated on an ongoing basis.
7. Maps, Glossary, and References: These three sections (sections 7, 8, and 9) contain supporting resources in the form of maps, a glossary of terms, and references.

Engagement Approach
Since project initiation, the CCWP has been a collaborative process with significant stakeholder and public engagement. Below is a summary of the engagement activities that took place over the course of the project:

I. Dedicated Project Website: Over 2,400 visits
II. Project information postcards: Over 2,000 distributed
III. Online survey: Over 70 participants
IV. Project specific email: Continuously maintained and monitored since October 2017
V. Popup displays at public events: 7 events
VI. Stakeholder Workshops (environmental non-government organizations, golf courses, etc.): Hosted 3 workshops
VII. Update Presentations to Municipal Committees of Council: Durham 2, Ajax 3, and Pickering 2
VIII. Public Open Houses: 4 (in person on October 8, 2019 and October 10, 2019; virtual on February 1, 2021 and February 4, 2021)
IX. TRCA, Ajax, Pickering and TRCA staff-to-staff meetings: 8
X. Presentations to advisory committees (Durham Agricultural Advisory Committee, Durham Environmental Advisory Committee, Ajax Environmental Advisory Committee, etc.): 6
XI. Commissioner's Reports providing project updates to Durham Planning and Economic Development Committee / Committee of the Whole and Council with circulation to Ajax and Pickering: 12
XII. Submissions and comments received on the draft Carruthers Creek Watershed Plan Update in 2020/2021: 27

In addition to the above, over the course of the spring and summer of 2020, the Region of Durham received 182 similar emails, each containing identical language, indicating that development should not be permitted in the headwaters. These submissions were also forwarded to TRCA for consideration, with a standardized response clarifying the role of watershed planning within Ontario's land use planning system. All individuals that made a submission were also invited to subscribe as an interested party, so that they could be notified of future project updates and engagement opportunities.

Public Review of Draft CCWP
The opportunity to review and comment on the draft CCWP remained open for over a year since its initial release on March 13, 2020, until March 19, 2021. During this time, a total of 27 submissions were received. Each comment has been reviewed and considered by TRCA staff and also shared and reviewed with staff from the Region of Durham, City of Pickering, and Town of Ajax. Where appropriate, the CCWP has been updated. A summary of feedback received, responses, and how the CCWP has been updated can be found in ***Attachment 2***.

Several themes emerged from the comments received on the draft CCWP, which are discussed below. More details are provided in ***Attachment 2***.

Scenario Modelling

Several comments were received regarding the three future scenarios included in the CCWP. These comments included preferences on which scenario should be implemented and requests for additional scenarios to be evaluated. In response, TRCA explained that scenario modelling is a tool used to evaluate how a watershed may react under different future land use conditions. It is not meant to analyze the full spectrum of potential future land uses that may occur, nor is it intended to represent any particular development or special interest that may exist. Additionally, it was explained that the scenarios do not assume specific mitigation measures that may be proposed by any particular land use interest. Instead, the management framework in the CCWP accounts for several potential land use scenarios and identifies measures to protect, enhance, and restore watershed health.

Language regarding the purpose of scenario analysis was included in the draft CCWP but has been further clarified in the final CCWP.

The three future management scenarios modelled as part of the CCWP are:

- Scenario 1 assumed the "build out" of the watershed as permitted by current Official Plans to the year 2031.
- Scenario 2 assumed the same "build out" as Scenario 1, but with an enhanced Natural Heritage System throughout the watershed.
- Scenario 3 assumed urbanization of northeast Pickering with the same enhanced Natural Heritage System as shown in Scenario 2.

Potential Settlement Area Boundary Expansion

Comments were received both for and against a potential Settlement Area Boundary Expansion in northeast Pickering which is part of the headwaters of Carruthers Creek outside of the Greenbelt.

The CCWP explains that watershed plans do not constitute a land use planning decision but are intended to inform land use and infrastructure planning decisions. The CCWP includes management recommendations on future studies and requirements associated with the potential Settlement Area Boundary Expansion in the headwaters of Carruthers Creek. As part of the record of responses on submissions (***Attachment 2***), the Region of Durham explained the MCR process and how that will determine if a Settlement Area Boundary Expansion is needed.

The Region of Durham is currently undertaking their Land Needs Assessment (LNA) to comprehensively assess the Region's urban structure, its intensification potential, designated greenfield areas, and future urban land needs to accommodate the province's population and employment forecasts under the Growth Plan. Regional staff will report to Planning and Economic Development Committee on the results of the LNA when the analysis is completed. Should the LNA determine that additional urban land is required to accommodate the province's forecasts, and should Council recommend that it is appropriate to allow development within this area, then a recommendation to that effect would be provided as part of the Region's position on the Regional Official Plan. The Minister of Municipal Affairs would then render their decision. If development is permitted, detailed mitigation strategies, community design elements and/or other features to address potential watershed impacts would be developed during the detailed planning stages, but only after the scope of any potential land use change has been determined.

Existing and Future Flooding Issues

Throughout the development of this watershed plan, concerns related to existing flooding in the lower Carruthers (Town of Ajax) have been expressed by members of the public and other stakeholders. Additionally, concerns have been expressed with potential increases to flood risk associated with urban development in the headwaters.

Scenario modelling confirmed that urbanization in northeast Pickering, without additional mitigation or flood controls, will increase peak flows in the lower reaches of the watershed. The predicted increased rate of peak flows is based on broad assumptions about future urban land use and would be subject to refinement if a more detailed land use plan and the extent of urban development is determined in the future. Specific mitigation measures, designs, and other solutions would be detailed through subsequent planning studies and Environmental Assessment processes.

Natural Heritage System

As part of the CCWP, an enhanced Natural Heritage System (NHS) is recommended based on existing and potential natural cover needed to maintain long-term ecosystem resilience and sustainability. A number of comments were received indicating agreement and support for the implementation of the enhanced NHS identified in the CCWP. However, a number of detailed submissions were received outlining concerns with how the enhanced NHS has been identified and treated in the management recommendations. Additionally, comments were received asking how the Region of Durham will implement the enhanced NHS through the MCR and as part of any future Regional Official Plan.

Regional planning staff are considering how to appropriately implement NHSs, including the recognition of enhancement areas through the MCR process. It is acknowledged that the policy treatment for enhancement areas could be different than existing natural cover areas. It is also recognized that the exact boundaries and delineation of the enhanced NHS recommended in the CCWP could be refined during the implementation process for regional and local Official Plans, provided that an analysis demonstrates consistency with the goals and objectives of the CCWP.

The relevant management recommendations in the CCWP were updated to outline this general approach at the regional and local municipal level.

Regional Council Endorsement

On June 1, 2021, Region of Durham and TRCA staff presented on the updated CCWP to Regional Planning and Economic Development Committee. An overview of the public review period and changes to the draft Plan was presented and provided in materials submitted to Committee.

In addition to the presentation from Region of Durham and TRCA staff there were five delegations and 26 correspondence items submitted to Committee regarding the CCWP.

Delegations were made by:

- Phil Pothen, Ontario Environment Program Manager, Environmental Defence
- Andrew McCammon, Executive Director, Ontario Headwaters Institute
- Helen Brenner, Durham resident
- Aidan Dahlin Nolan, Ajax resident

- Mark Flowers, North East Pickering Landowners Group Inc.

More information on the delegations, correspondence, and presentation by staff are available in the Region of Durham June 1, 2021 Planning and Economic Development Committee Minutes. In the report to Committee, it was recommended to Council that the CCWP be endorsed, which was carried by Committee.

Durham Regional Council met endorsed the CCWP at its' June 23, 2021 meeting.

RATIONALE
With the conclusion of the public review period of the draft CCWP it is now appropriate to finalize and approve the watershed plan. This multi-year collaborative process has resulted in a CCWP that provides a strong basis for the protection and enhancement of the watershed. The CCWP can be used to inform future land use planning processes by the Region of Durham and local municipalities.

With endorsement of the CCWP by Durham Regional Council on June 23, 2021, it is recommended that the TRCA Board of Directors approve the CCWP.

Relationship to Building the Living City, the TRCA 2013-2022 Strategic Plan
This report supports the following strategies set forth in the TRCA 2013-2022 Strategic Plan:
Strategy 2 – Manage our regional water resources for current and future generations
Strategy 4 – Create complete communities that integrate nature and the built environment

FINANCIAL DETAILS
The CCWP is funded by the Region of Durham through a service agreement with TRCA for a total budget of $1,089,431.

DETAILS OF WORK TO BE DONE
TRCA will communicate the approval of the CCWP to partners, stakeholders, and residents.

In collaboration with the Region of Durham, City of Pickering, and Town of Ajax, TRCA will initiate implementation planning of the CCWP. In collaboration with our municipal partners, TRCA will consider the establishment of a stakeholder advisory committee specific to Carruthers Creek to support implementation.

Report prepared by: Tony Morris, Senior Project Manager, Watershed Planning and Reporting, extension 5651
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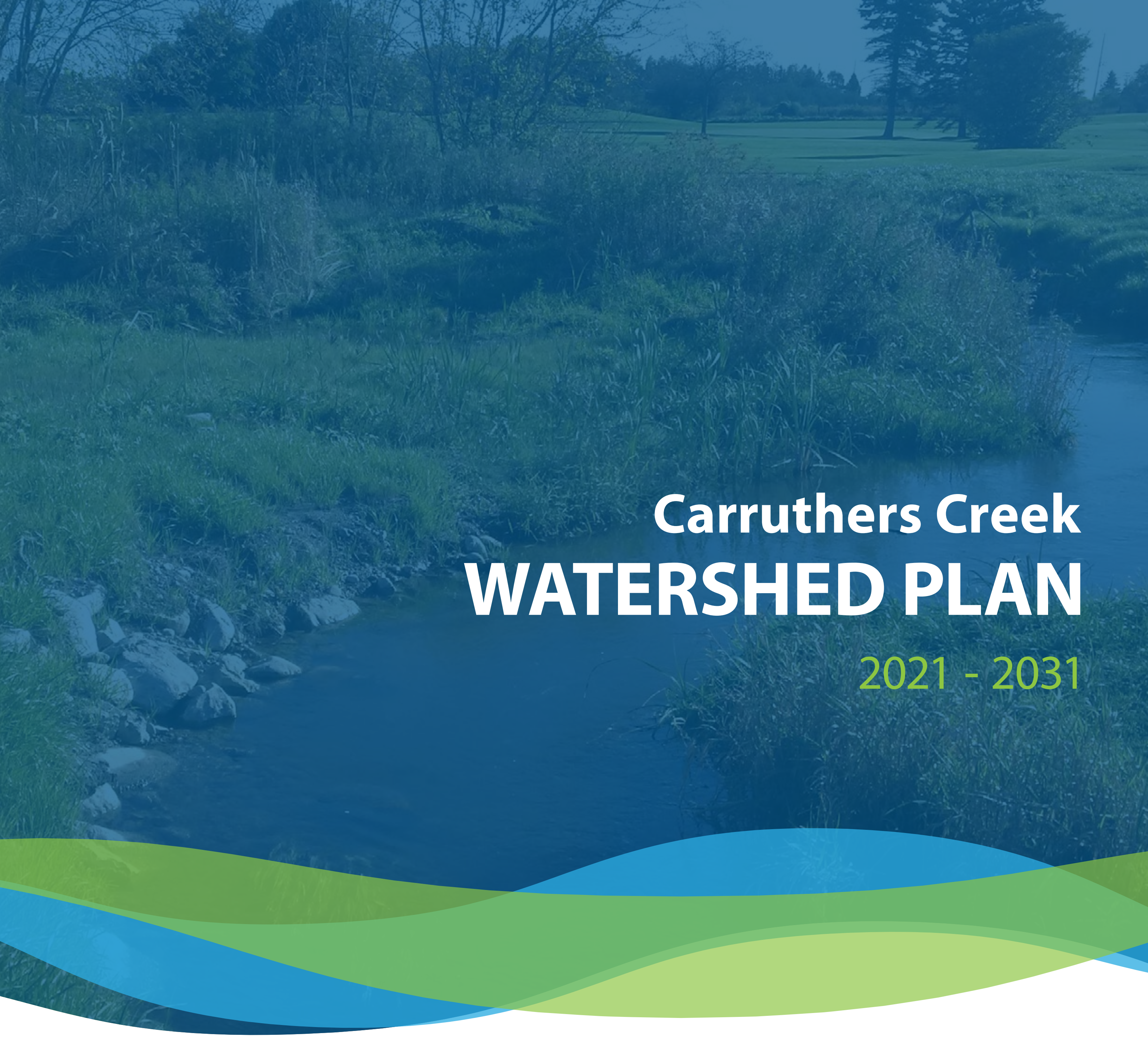
For Information contact: Tony Morris, extension 5651
Emails: tony.morris@trca.ca
Date: August 4, 2021
Attachments: 2

Attachment 1: Final Carruthers Creek Watershed Plan
Attachment 2: Comment Submissions Summary: Public Review of Draft Carruthers Creek Watershed Plan (May 2021)



Carruthers Creek
WATERSHED PLAN
2021 - 2031

Developed in collaboration with
the **Town of Ajax** and **City of Pickering**

DURHAM REGION

Toronto and Region Conservation Authority

Executive Summary

A watershed is an area that is drained by a river and its tributaries. Healthy watersheds provide numerous ecosystem services: from sustaining drinking water, supporting biodiversity, reducing flood and erosion hazards, protecting the quality and quantity of water, and replenishing aquifers. Due to the importance of healthy watersheds, they merit collaborative efforts to ensure their long-term sustainability.

The purpose of a watershed plan is to understand the current conditions of the watershed, and identify measures to protect, enhance, and restore the health of the watershed. Watershed planning integrates natural systems into land use and infrastructure decision-making by identifying natural features to protect and by recommending how to mitigate impacts from land use and infrastructure development on natural systems. Ontario's provincial planning framework recognizes that watershed planning is important to informing land use and infrastructure planning decisions.

The development of this watershed plan has been a collaborative effort between the Toronto and Region Conservation Authority (TRCA), the Region of Durham, the Town of Ajax, and the City of Pickering. Additional stakeholders and members of the public have been involved throughout the watershed planning process.

Carruthers Creek is a small watershed that crosses rural and urban lands, including portions of the provincial Greenbelt, before entering Lake Ontario. Urbanization and the impacts of climate change will continue to stress the health and resiliency of the watershed. Watershed planning is a means to identify opportunities to mitigate and adapt to potential changes in watershed health arising from land use and infrastructure development patterns.

The development of the Carruthers Creek Watershed Plan was a multi-year process that consisted of:

1. Watershed characterization, which involves the identification of current conditions in the watershed.

   The key issues with Carruthers Creek were identified to be:

   - The aquatic ecosystem is sensitive and near the level of land use development it can sustain long-term (without additional and improved mitigation).
   - There is not enough natural cover, or good quality habitat, needed to maintain ecosystem resilience (i.e. capacity to respond to change) due to changing land use patterns and climate change.
   - Water quality is impaired (i.e. degraded), requiring improvements to stormwater management.
   - The flow of water through the watershed is out of balance from natural conditions resulting in flooding and erosion issues.

2. Understanding future conditions through the analysis of potential land use scenarios. Three potential future scenarios were compared to 2015 land use conditions as part of the Carruthers Creek watershed planning process.

   - **Scenario 1 (+OP)** – assumes all lands south of the Greenbelt are developed as planned in approved Official Plans up to the year 2031.
   - **Scenario 2 (+NHS)** – assumes the same development as scenario 1 but includes the proposed enhanced Natural Heritage System (includes natural features and areas, such as forests, meadows, wetlands, and potential natural cover enhancement areas).
   - **Scenario 3 (+Potential Urban)** – assumes post-2031 development in the headwaters of Carruthers Creek outside the proposed enhanced Natural Heritage System.

   These three potential future scenarios help determine how the watershed would react to these potential land use changes, which can help inform future land use and infrastructure planning decisions. In other words, would these potential changes have a positive, neutral, or negative effect on the health of the Carruthers Creek watershed? Scenario analysis does not result in decisions about the type and configuration of land uses. Instead, scenario analysis helps to inform decisions through the municipal planning process (e.g. Official Plans, secondary plans).

3 The development of a management framework to provide recommendations on how to protect, enhance, and restore the watershed. The management framework consists of goals, objectives, indicators, and management recommendations. This management framework is designed to address existing issues in the watershed and mitigate impacts from potential future land uses, while recommending appropriate actions to protect, enhance, and restore the watershed. Decisions on the configuration of future growth and land use throughout the watershed are the purview of the applicable municipality (e.g. Region of Durham for decisions such as settlement area boundary expansions and local municipalities for site-specific decisions). The management framework is focused on:

- Achieving more sustainable land use and infrastructure development patterns through the use of low impact development and green infrastructure policies, improved stormwater management, managing the risks of flooding and erosion, and implementing agricultural best management practices.
- Protecting, enhancing, and restoring the Water Resource System and improving aquatic habitat connectivity.
- Protecting, enhancing, and restoring the Natural Heritage System and increasing urban forest cover.

4 A monitoring and evaluation program to track implementation progress and ensure mechanisms are in place to adjust approaches as needed. The indicators identified as part of the management framework will help determine if actions taken in the watershed are having the desired benefit. Adaptive management will be used to adjust the management framework as needed.

Through the implementation of the Carruthers Creek Watershed Plan, TRCA and its municipal partners can improve the health of the watershed and ensure integrated long-term planning for land use and infrastructure decision-making. Protecting, enhancing, and restoring the natural systems within the watershed; accompanied by sustainable land use and infrastructure planning of redevelopments and future growth is essential for a healthy Carruthers Creek watershed.

WHAT IS A WATERSHED?

An area that is drained by a river and its tributaries. Wherever you are right now, you are in a watershed.

WATERSHEDS DELIVER IMPORTANT BENEFITS

Human – provide safe drinking water and food, and help to reduce flooding and erosion.

Economic – produce energy, and supply water for agriculture, industry and homes.

Environment – promote a healthy water cycle, and provide vital habitat for wildlife and plants.

What is the Natural Heritage System?

Consists of natural features and areas, including wetlands, forests, meadows and valleylands, that are needed to maintain biodiversity and healthy ecosystems.

What is the Water Resource System?

Consists of groundwater and surface water features and areas, including streams, lakes, groundwater recharge areas and springs, needed to sustain healthy aquatic and terrestrial ecosystems, and human water supply.

What causes Flooding?

Rivers naturally flood with heavy rain or snowmelt, but flooding can become a problem when buildings and other structures are placed in flood plains. Climate change and urbanization can make flooding worse.

How can salt impact a watershed?

Chlorides can contaminate drinking water and negatively affect the health of aquatic species.

What is stormwater?

Rain and melting snow rushes off roofs, sidewalks and parking lots into pipes and pours into streams and lakes. Without proper stormwater control and treatment, flooding and erosion can increase, waterways can become polluted and local ecosystems can be damaged.

How can agriculture impact a watershed?

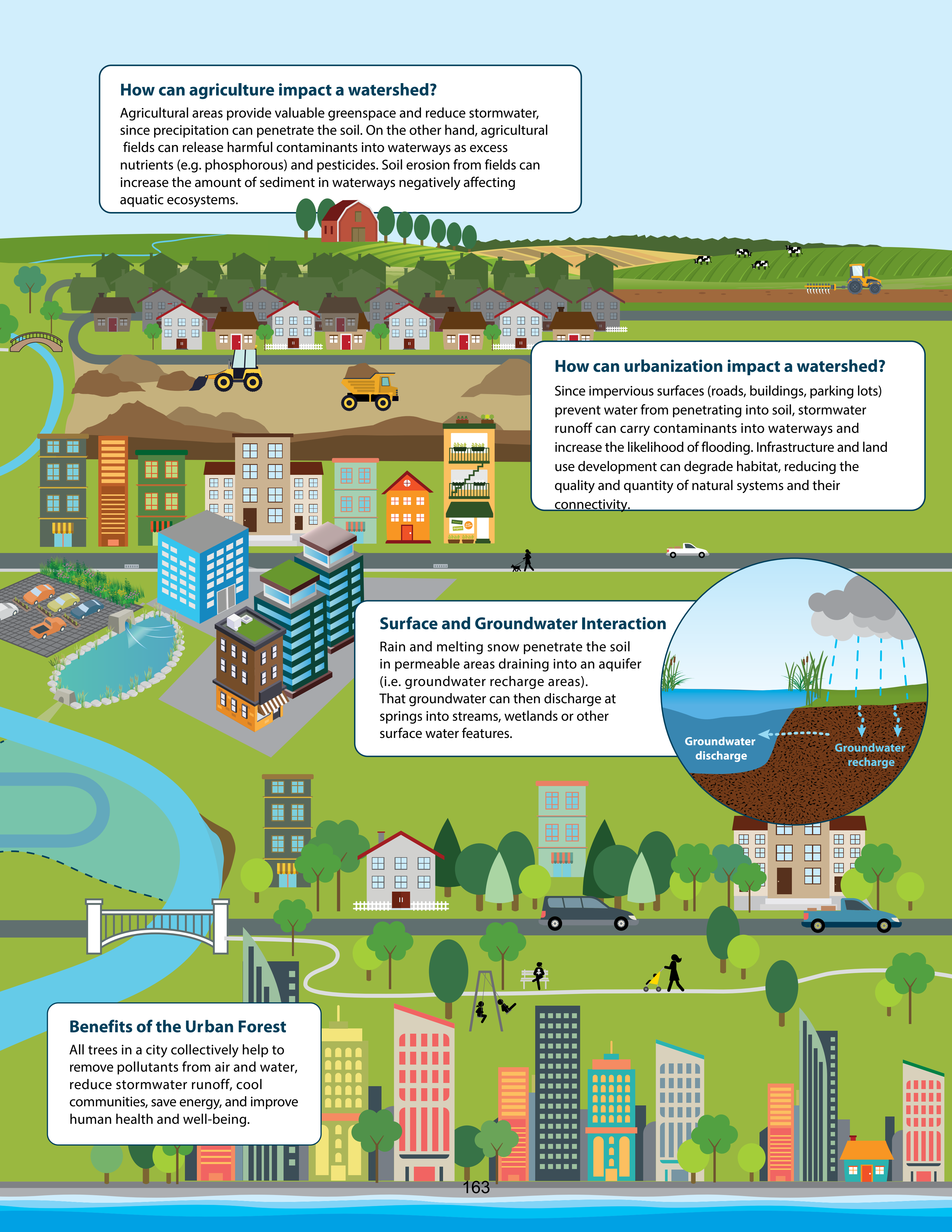
Agricultural areas provide valuable greenspace and reduce stormwater, since precipitation can penetrate the soil. On the other hand, agricultural fields can release harmful contaminants into waterways as excess nutrients (e.g. phosphorous) and pesticides. Soil erosion from fields can increase the amount of sediment in waterways negatively affecting aquatic ecosystems.

How can urbanization impact a watershed?

Since impervious surfaces (roads, buildings, parking lots) prevent water from penetrating into soil, stormwater runoff can carry contaminants into waterways and increase the likelihood of flooding. Infrastructure and land use development can degrade habitat, reducing the quality and quantity of natural systems and their connectivity.

Surface and Groundwater Interaction

Rain and melting snow penetrate the soil in permeable areas draining into an aquifer (i.e. groundwater recharge areas). That groundwater can then discharge at springs into streams, wetlands or other surface water features.



Benefits of the Urban Forest

All trees in a city collectively help to remove pollutants from air and water, reduce stormwater runoff, cool communities, save energy, and improve human health and well-being.

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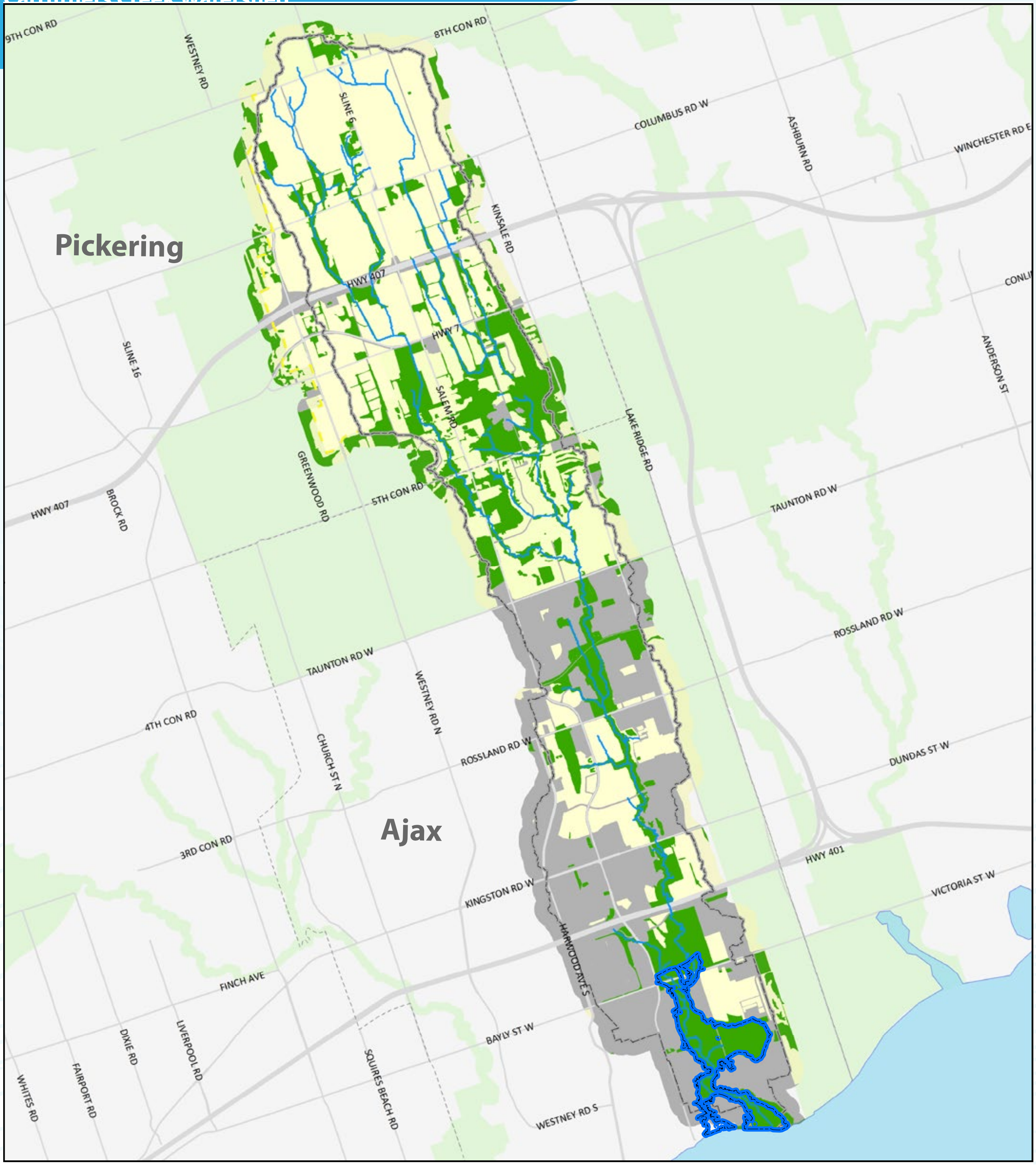
ACRONYMS

ANSI	Areas of Natural and Scientific Interest
CCME	Canadian Council of Ministers of the Environment
CTC	Credit Valley, Toronto and Region and Central Lake Ontario
DFO	Department of Fisheries and Oceans
ESGRAs	Ecologically Significant Groundwater Recharge Areas
FBI	Family Biotic Index
FVC	Flood Vulnerable Cluster
GIS	Geographic Information System
Growth Plan	Growth Plan for the Greater Golden Horseshoe, 2019
GTA	Greater Toronto Area
IBI	Index of Biotic Integrity
IRP	Integrated Restoration Prioritization
LAM	Landscape Analysis Model
MECP	Ministry of the Environment, Conservation and Parks
MNRF	Ministry of Natural Resources and Forestry
NHS	Natural Heritage System
PPS	Provincial Policy Statement
PWQO	Provincial Water Quality Objectives
ROP	Regional Official Plan
TRCA	Toronto and Region Conservation Authority
TSS	Total Suspended Solids
WRS	Water Resource System

Indigenous Land Acknowledgement

As we strive to develop a comprehensive watershed plan for the Carruthers Creek watershed, Toronto and Region Conservation Authority (TRCA) acknowledges that this watershed planning was undertaken within the traditional territory and treaty lands of the Anishinaabeg of the Williams Treaty First Nations, and the traditional territory of the Huron-Wendat Nation. As stewards of land and water resources within the Greater Toronto Area (GTA), TRCA appreciates and recognizes the history and diversity of the land, as well as our shared values and interests and is respectful of working in this territory.

FIGURE 2:
Carruthers Creek Watershed



Toronto and Region Conservation Authority

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Date: September 2019
Created by: TRCA Information Services/Information Technologies
Disclaimer:
The Data used to create this map was compiled from a variety sources and dates. The TRCA takes no responsibility for errors or omissions in the data and retains the right to make changes and corrections at anytime without notice. For further information about the data on this map, please contact the TRCA GIS Department. (416) 661-6600.

Carruthers Creek Watershed Plan: 2015 Land Use Conditions

0 0.5 1 2 3 KM

- Municipal Boundary
- Watercourse

Land Use

- Natural
- Rural
- Urban
- Flood Vulnerable Cluster
- Greenbelt Boundary
- Carruthers Creek Watershed Boundary
- Carruthers Creek Watershed Plan Study Area

1. Introduction and Background

Carruthers Creek is a small, yet important watershed that crosses rural and urban areas before entering Lake Ontario. This watershed plan represents a collaborative effort to determine the current state of the watershed, assess potential future land use scenarios, and determine an appropriate management framework to ensure the long-term sustainability and resiliency of the watershed.

See **Figure 2** for a map of the Carruthers Creek watershed and its land use conditions as of 2015. This watershed plan has a ten-year time frame. However, regular monitoring and evaluation, including adaptive management, will ensure that the watershed plan is updated, or refined, as needed on an ongoing basis.

Vision for the Carruthers Creek watershed:

Carruthers Creek watershed is a healthy and resilient natural system that is managed through partnerships to balance resource protection with human activity. Sound science and best management practices will protect and restore ecosystem functions, protect watershed residents from natural hazards like flooding, and maintain our natural heritage and water resources for present and future generations.

1.1 RATIONALE AND POLICY BASIS

Watershed planning is important because it helps to understand the current conditions of the watershed (i.e. watershed characterization), and identify measures to protect, enhance, and restore the health of a watershed. Watershed plans provide a comprehensive understanding of the ecological forms and functions of the various features and areas that comprise the water resource and natural heritage systems. Additionally, watershed planning helps to inform how land use and infrastructure planning influence and affect the natural ecology of the watershed.

This subsection will explain the provincial policy basis for watershed planning and the roles of municipalities and TRCA in implementing that policy framework.

Provincial Watershed Planning Policy Basis

Ontario's planning policy framework recognizes the importance of watershed planning to inform land use and infrastructure decision-making. The key policy driver for watershed planning is applicable provincial policy direction in the Provincial Policy Statement, 2020 (PPS) and provincial plans such as the Growth Plan for the Greater Golden Horseshoe, 2020 (Growth Plan) and the Greenbelt Plan, 2017 (Greenbelt Plan)[1].

PPS policies encourage a coordinated approach to planning that recognizes the watershed as the ecologically meaningful scale for integrated and long-term planning. The PPS also directs the protection, improvement or restoration of the quality and quantity of water by minimizing potential negative impacts. Growth Plan and Greenbelt Plan policies require watershed planning to be undertaken to support the protection, enhancement or restoration of the quality and quantity of water within a watershed[2].

Furthermore, watershed planning is to be used to identify the Water Resource System (WRS), inform decisions on allocation of growth and planning for water, wastewater, and stormwater infrastructure[3].

Provincial policies also recognize the importance of protecting, enhancing, and restoring the Natural Heritage System (NHS) to maintain long-term ecological and hydrologic functions of the features and areas[4], and demonstrating that there will be no negative impacts from development and site alteration. The integrated nature and importance of the natural heritage and water resource systems is discussed in greater detail in **Section 2**.

[1]There are other geographically specific provincial plans that do not apply to the Carruthers Creek watershed (e.g. Lake Simcoe Protection Plan, Oak Ridges Moraine Conservation Plan and Niagara Escarpment Plan).

[2]Growth Plan policy 4.2.1.1 and Greenbelt Plan policy 3.2.3.2.

[3]Growth Plan policy 4.2.1.3 and Greenbelt Plan policies 3.2.3.3 and 3.2.3.4.

[4]Natural Heritage System policies for the Growth Plan are 4.2.2 and the Greenbelt Plan are 3.2.2.

Municipalities are required to conform to the PPS and applicable provincial plans through the municipal planning process and when updating their Official Plans. This Carruthers Creek Watershed Plan identifies management recommendations necessary to demonstrate conformity with provincial policies related to watershed planning. By implementing the recommendations included in this watershed plan, municipalities will be able to demonstrate how the features and areas that comprise the natural heritage and water resource systems, as well as water quality and quantity, will be protected, enhanced, and restored.

Ontario's *Clean Water Act, 2006* is designed to protect existing and future sources of drinking water. Under the *Clean Water Act, 2006*, source protection plans were developed by source protection committees representing municipal, Indigenous, public, and business interests. The Credit Valley – Toronto and Region – Central Lake Ontario (CTC) Source Protection Plan applies in the Carruthers Creek watershed. The CTC Source Protection Plan is a strategy and suite of policies developed by residents, businesses, and the municipalities, which outlines how water quality and quantity for municipal drinking water systems, not including private well owners, will be protected. The CTC Source Protection Plan includes its own set of policies and compliance mechanisms, in accordance with the *Clean Water Act, 2006*, that are not repeated in this watershed plan. The management recommendations identified in this watershed plan complement the requirements of the applicable source protection plan by including the need to protect water resources, which will support safe drinking water regardless of source (i.e. municipal and private systems).

Reducing Natural Cover Losses in the Carruthers Creek Watershed

There have been losses and impacts to natural cover in the watershed, including parts of the Greenbelt. These changes have continued since the enactment of the *Greenbelt Act, 2005*

POLICY FRAMEWORK

As discussed in this section, the Greenbelt Plan is one part of Ontario's land use planning framework. One vital policy tool for maintaining natural cover in both the Growth Plan and the Greenbelt Plan is the NHS policies. Once a NHS is designated in a municipal Official Plan, any development or site alteration must meet certain policy requirements in the applicable provincial plan.

Observed land use changes within the Carruthers Creek portion of the Greenbelt include fill sites, road widenings, land clearing on existing lots, farming and non-farm business operations, and vehicle and other storage.

MOVING FORWARD

This watershed plan identifies recommendations to strengthen municipal policies to protect the NHS, in accordance with provincial policy, and identifies opportunities for restoration programs.

If community members are concerned about any development, large scale tree cutting or fill activities, please contact your local municipality, Region of Durham, or conservation authority for assistance.

Ontario's provincial planning policies recognize the importance of the Great Lakes[5]. Carruthers Creek flows into Lake Ontario. The series of Great Lakes agreements, legislation and policies set binational, national, and provincial commitments to protect and restore the Great Lakes. This watershed plan is intended to improve the conditions within the Carruthers Creek watershed, thereby reducing negative impacts to Lake Ontario from this single watershed.

Role of Municipalities

Within the Greater Golden Horseshoe, most municipalities in Ontario are organized into two-tier systems. Upper-tier municipalities, such as the Region of Durham, are comprised of several lower-tier municipalities. The role of regional government is to address issues and concerns that apply to broader geographic areas, crossing the borders of lower-tier municipalities.

For land use planning, regional government's primary planning tool is a Regional Official Plan (ROP). The ROP implements the requirements of any relevant provincial legislation, provincial plans, and the PPS. Area municipalities develop their own, more detailed Official Plans (and may include more detailed secondary plans, Part II Plans, or tertiary plans as the case may be), as well as implementing zoning by-laws. While the ROP is required to implement provincial policy, area municipal planning tools are required to conform with both regional and provincial policy.

Municipalities are granted decision-making powers through the *Municipal Act* and *Planning Act*. Watershed planning helps municipalities to make informed decisions on where and how to grow, while identifying opportunities to improve natural watershed conditions (e.g. restoration opportunities).

Role of TRCA

Conservation authorities were established and granted responsibilities under the *Conservation Authorities Act*. Conservation authorities play an important role in land use planning and environmental protection processes in partnership with municipalities, but are not the decision-makers in land use and infrastructure planning. Conservation authorities deliver programs and services related to natural hazard protection and management (i.e. flooding), conservation and management of conservation authority lands, drinking water source protection (as prescribed under the *Clean Water Act, 2006*), and conserving natural resources. Through its watershed expertise, TRCA, in partnership with the Region of Durham, Town of Ajax, and City of Pickering, has developed this watershed plan to help inform land use and infrastructure planning decisions.

[5]The PPS identifies the importance of considering the priorities identified in various agreements related to the protection or restoration of the Great Lakes – St. Lawrence River Basin. The Growth Plan and Greenbelt Plan require the consideration of the Great Lakes Strategy and the Great Lakes Protection Act, 2015, and any applicable Great Lakes agreements as part of watershed planning.

1.2 LOCAL CONTEXT AND CONSIDERATIONS

Carruthers Creek is a relatively small watershed with a drainage area of approximately 38 km^2, ranging from 2-3 km in width and 18 km in length, and occurs within the South Slope and glacial Lake Iroquois physiographic regions. It is the easternmost watershed in TRCA's jurisdiction and is bordered by the Duffins Creek watershed to the west and the Lynde Creek watershed in the east. The watershed has approximately 41,000 residents and is located entirely within the Region of Durham. Carruthers Creek's headwaters form to the south of the Oak Ridges Moraine, in the City of Pickering, and the creek enters Lake Ontario in the Town of Ajax. The watershed is mainly rural north of Highway 7 and urbanized south of Taunton Road to the lakeshore. From Highway 7 south to Taunton Road, most lands are in the protected countryside designation of the provincial Greenbelt Plan.

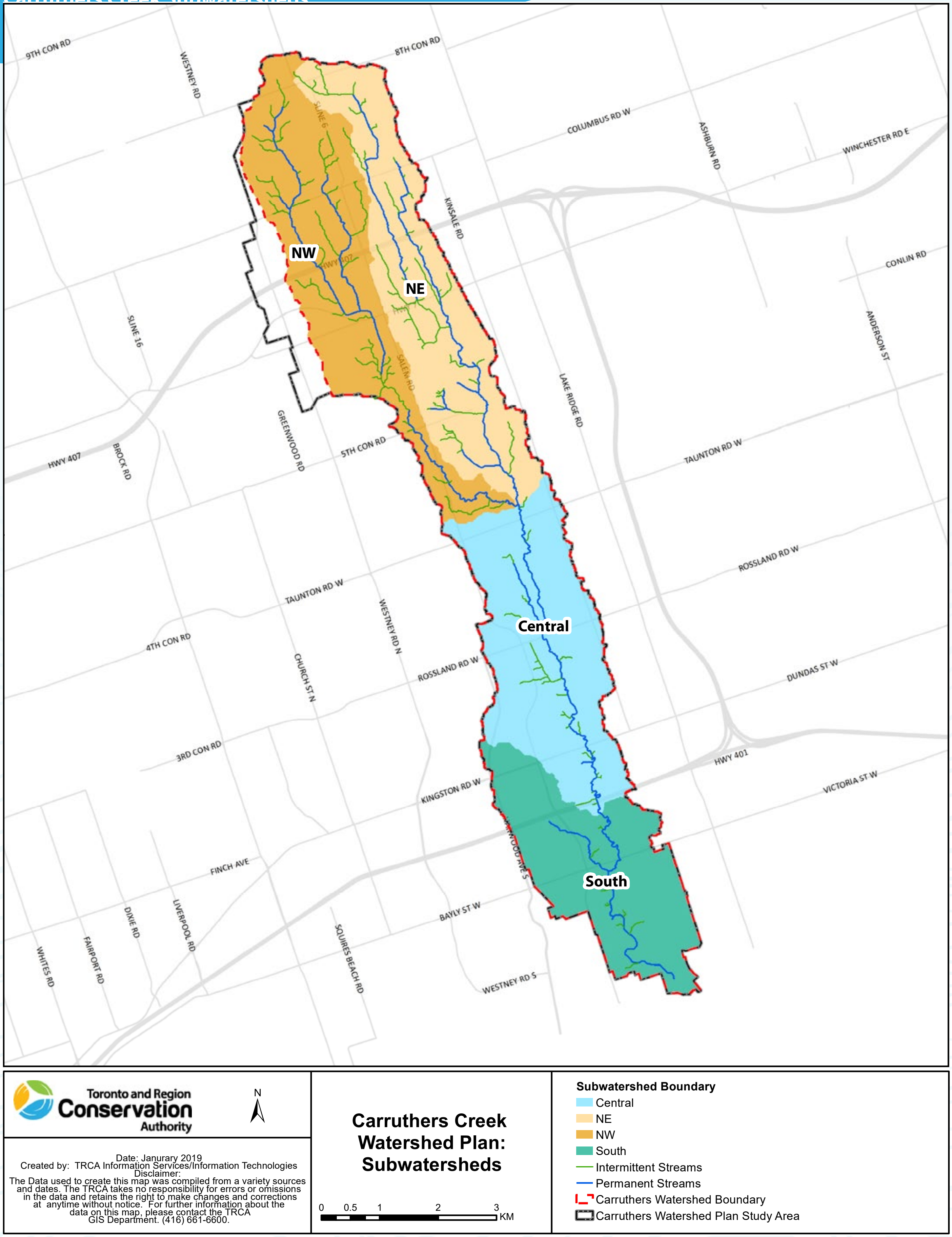
Carruthers Creek watershed consists of four subwatersheds, for the purposes of this watershed plan. Subwatersheds are defined as areas drained by a tributary, or portion of the stream, and are a more geographically specific scale than watersheds. Some of the technical analyses conducted as part of this watershed planning process used the four subwatersheds identified in **Figure 3** to evaluate the conditions of the watershed from a more refined geographic location.

The previous 2003 Duffins and Carruthers Creek Watershed Plan evaluated existing watershed conditions and identified recommendations to protect, restore, and enhance the natural systems and water quality of Carruthers Creek. The issues identified in the 2003 plan are still prevalent in the Carruthers Creek watershed, such as the need to protect and restore natural areas, improve stormwater management, and address water quality concerns. Since 2003, the Carruthers Creek watershed has undergone significant changes associated with urbanization and the impacts of climate change (See **Section 3**) for more information. Since many of the issues identified in the previous watershed plan are still occurring, an updated watershed plan using the latest advancements in watershed science, monitoring programs, and computer modelling was necessary.

Periodic reviews of watershed plans are an integral component of the watershed planning process and allow for adaptive management to incorporate new scientific approaches and to address emerging initiatives. This watershed plan update is also more reflective of current provincial policies around watershed planning, which have evolved since the 2003 plan. At the request of the Region of Durham, a small section of lands in the East Duffins Creek subwatershed, which are immediately adjacent to Carruthers Creek watershed and outside of the provincial Greenbelt, were included in the study area to provide a more complete analysis of lands in the area. However, only watershed planning processes that occur at the regional, rather than the watershed scale, were assessed (i.e. NHS planning and groundwater modelling), as these processes extend beyond the watershed boundary.

FIGURE 3:

Carruthers Creek Subwatersheds



The development of this Carruthers Creek Watershed Plan was a multi-year process completed in the following sequence:

- Field work on existing watershed conditions **(2015-2016)**
- Watershed characterization technical reports completed **(2017)** – See **Section 3** for the results of watershed characterization
- Potential future scenarios modelling and analysis undertaken **(2018)**
- Scenario analysis technical reports completed **(2019)** – See **Section 4** for information on the potential future scenarios and results
- Water Resource and Natural Heritage Systems identified **(2019)** – See **Section 2** for more information on these systems
- Management framework for Carruthers Creek developed **(2019)** – See **Section 5** for the Carruthers Creek management framework
- Draft Carruthers Creek Watershed Plan released for public review (**2020**)

1.3 PARTNERS AND STAKEHOLDERS

In 2015, the Region of Durham engaged TRCA to develop a watershed plan for Carruthers Creek. The key partners involved in the process to develop this watershed plan are TRCA, the Region of Durham, the Town of Ajax, and the City of Pickering.

Throughout the multi-year process discussed in **Subsection 1.2**, TRCA engaged the Mississaugas of Scugog Island, stakeholders, and the public to raise awareness of the watershed, planning process and solicit feedback on components of this watershed plan. Stakeholders engaged include watershed residents, landowners, farmers, developers, golf course operators, and environmental non-governmental organizations.

Stakeholders were engaged at various points during this watershed planning process, as follows:

LATE 2015 – LATE 2017

Promoted and raised awareness of the watershed planning process for Carruthers Creek through reports and presentations to Councils and Committees of the Region of Durham, Town of Ajax, and City of Pickering.

LATE 2017 – EARLY 2019

Continued to raise awareness of the watershed planning process for Carruthers Creek and gathered feedback from the public on a vision for the watershed plan. This was completed by launching an interactive website and hosting information booths at various events across the watershed.

MID 2019 – LATE 2019

Gathered feedback on the draft management framework for the Carruthers Creek Watershed Plan from partners and stakeholders. Two public open houses were held in October 2019.

EARLY 2020 - MID 2021

The draft Carruthers Creek Watershed Plan was released for public review in March 2020. Two virtual open houses were held in February 2021. The public review comment period closed March 19, 2021.

Feedback received from partners and stakeholders was invaluable in the development of this watershed plan. The Carruthers Creek Watershed Plan reflects the diversity of issues and concerns raised throughout the planning process and represents a realistic and manageable plan to improve the overall health of the Carruthers Creek watershed.

All the partners and stakeholders engaged as part of this process play a key role in the effective implementation of the management recommendations identified in **Section 5**.

2. Water Resource and Natural Heritage Systems

The aquatic and terrestrial features and areas that maintain the ecological integrity of a watershed consist of two integrated systems, the WRS and NHS. Together, these two systems provide essential ecosystem services, including water storage and filtration, cleaner air, support to biodiversity and habitats, carbon storage, as well as resiliency to climate change. Maintaining extensive, connected and high-quality ecological and hydrological features and areas of both systems is essential for the long-term health and sustainability of Carruthers Creek, as shown in **Figure 1**.

As mentioned in **Subsection 1.1**, identifying and protecting both systems is a key policy requirement in the Growth Plan and Greenbelt Plan.

The features and areas that comprise both systems are explained in **Table 1** below.

TABLE 1:
Description of the Water Resource System and Natural Heritage System

Water Resource System	Natural Heritage System
A system consisting of groundwater features and areas and surface water features (including shoreline areas), and hydrologic functions, which provide the water resources necessary to sustain healthy aquatic and terrestrial ecosystems and human water consumption.	A system made up of natural heritage features and areas, and linkages identified to provide connectivity (at the regional or site level) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species, and ecosystems.
The WRS consists of: **Key Hydrologic Areas** • Significant Groundwater Recharge Areas (including Ecologically Significant Groundwater Recharge Areas) • Highly Vulnerable Aquifers • Significant Surface Water Contribution Areas **Key Hydrologic Features** • Permanent Streams • Intermittent Streams • Inland Lakes and their Littoral Zones • Seepage Areas and Springs • Wetlands*	The NHS consists of: • Significant Wetlands* • Significant Coastal Wetlands • Other Coastal Wetlands in Ecoregions 5E, 6E and 7E • Fish habitat* • Significant Woodlands • Significant Valleylands in Ecoregions 6E and 7E (excluding islands in Lake Huron and the St. Mary's River) • Habitat of Endangered Species and Threatened Species • Significant Wildlife Habitat • Significant Areas of Natural and Scientific Interest (ANSIs) • Sand barrens, savannahs, tallgrass prairies and alvars • Federal or provincial parks, and conservation reserves

***Notes:**

Wetlands are important features in both systems. For the purposes of mapping in **Section 7**, wetlands are shown separately in **Map 1A** for the WRS and included as natural cover in **Map 2** for the NHS. Fish habitat in the NHS overlaps with features and areas in the WRS.

The majority of these terms are defined in the Growth Plan, 2020. Some, but not all definitions, have been included in the Glossary (**Section 8**) of this watershed plan.

Not all of the NHS features or areas identified in this table are part of the proposed enhanced NHS for Carruthers Creek, since some of these features do not exist in this watershed (e.g. sand barrens, savannahs, etc.), or are not distinguished specifically from natural cover areas (e.g. significant woodlands and significant wildlife habitat).

Due to the importance of both systems, the protection, enhancement, and restoration of the WRS and NHS are goals of this watershed plan (**Section 5**).

See **Section 7** for maps of the WRS and the recommended NHS.

How the WRS was delineated?

The key hydrologic areas and key hydrologic features that comprise the WRS were delineated using various techniques and methodologies.

Highly Vulnerable Aquifers and Significant Groundwater Recharge Areas were determined through Technical Rules established under the *Clean Water Act, 2006* for the purposes of regional source water protection planning. Ecologically Significant Groundwater Recharge Areas (ESGRAs) were determined using a model developed by the Oak Ridges Moraine Groundwater Program to optimize the protection of groundwater dependent ecosystems. The model results for ESGRAs were assessed to minimize the land area covered by these key hydrologic areas while maintaining a high degree of hydrological function protection for these ecosystems. Significant Surface Water Contribution Areas include many of the intermittent streams in the headwaters (northern portion) of Carruthers Creek.

Each of the five key hydrologic features were delineated using a combination of satellite imagery, ArcHydro GIS, and field site verification.

The WRS provides habitat for aquatic life (e.g. fish). The conditions of aquatic habitat in Carruthers Creek were assessed as part of this watershed planning process.

How the NHS was delineated?

The components of the NHS were delineated using a robust methodology that incorporated ecological models (e.g. Landscape Analysis Model), information from satellite imagery, monitoring data, field site verification, and expert based knowledge.

The components of the NHS were identified for their ecological value as existing and potential natural cover (i.e. areas targeted for restoration and enhancement), to:

- Increase natural cover (e.g. forests, wetlands, meadows, etc.) quantity and quality by improving habitat size, shape, and connectivity in and around existing natural areas, as well as in areas for potential restoration
- Protect and restore species and vegetation communities by incorporating diverse habitat types, mitigating the impacts of urban development, and improving the ecological connectivity across the watershed
- Incorporate natural system vulnerabilities to climate change in planning processes to build a more resilient NHS

Protecting the WRS and NHS

As mentioned in **Subsection 1.2**, provincial policies recognize the importance of protecting the WRS and NHS. Municipalities are required to demonstrate how these systems will be protected. Through its technical and scientific expertise, TRCA delineated both systems as part of this watershed planning process.

For the recommended NHS, the areas identified as potential natural cover (enhancement areas) should be restored to maintain the long-term resiliency and sustainability of terrestrial ecosystems, in addition to protecting the existing natural cover. TRCA's *Terrestrial Natural Heritage System Strategy* has a minimum target of 30% natural cover across the entire jurisdiction, while recognizing there will be variability among TRCA's nine watersheds due to existing land uses. The Carruthers Creek watershed is currently below that target (see **Subsection 3.3** for more information).

The management framework (**Section 5**) of this watershed plan, recognizes that land use and/or infrastructure decisions may impact, or occur, within the WRS or NHS, and establishes recommendations to avoid these features and areas, mitigate impacts, or when impacts are unavoidable, provide for ecosystem compensation. Municipalities are responsible for designating a NHS that is consistent with provincial policies and informed by the goals and objectives of this watershed plan.

3. Existing Watershed Conditions

Watershed characterization is a vital part of watershed planning, which helps to determine the current conditions of the watershed. As part of this watershed plan, TRCA produced technical reports on different components of the watershed, which are summarized in this section.

3.1 CONTEXT AND BACKGROUND

Since the previous watershed plan is from 2003, the existing conditions of the watershed were evaluated using more recent data and science. TRCA produced eight peer-reviewed technical reports as part of watershed characterization. These technical reports helped determine the current state of the watershed, as discussed in **Subsection 3.3**

Watershed characterization includes the following topics (see full technical reports listed in **Section 9**):

Aquatic Crossing and Barrier Assessment

Involved the assessment of existing structures in Carruthers Creek that represent barriers to fish passage, such as perched culverts and online ponds.

Aquatic Habitat and Community Characterization

Involved the assessment of aquatic habitat conditions, stream temperature, fish community richness and composition, and benthic invertebrate richness and composition.

Fluvial Geomorphology

Involved the assessment of the creek's flow and sediment movement processes, drainage patterns, and potential erosion risks.

Headwater Drainage Features

Involved the assessment of small streams in the upper portions of the watershed that may not flow year-round (i.e. intermittent and ephemeral). These features provide hydrologic and ecological functions to maintain downstream watershed conditions.

Hydrogeology

Involved the assessment of groundwater conditions within the watershed, such as groundwater recharge and discharge, and groundwater flow and quality.

Surface Water Quality Characterization

Involved the assessment of current and past water quality conditions to determine trends and factors influencing water quality.

Terrestrial Natural Heritage

Involved the assessment of natural cover, terrestrial habitat, and species across the watershed.

Water Quantity Characterization

Involved the assessment of the volume, velocity, spatial distribution, and timing of water moving through the stream network (i.e. streamflow).

3.2 HISTORICAL AND CURRENT LAND USES

Ongoing urbanization in the GTA continues to convert natural and agricultural lands to other uses. This is true in the Carruthers Creek watershed as well. In 1999, the watershed consisted of 28% natural cover, 53% agricultural lands, and 12% urban area[6]. As of 2015, natural cover had dropped to 25% and agricultural lands to 34%. Urban land use increased to approximately 37% during that time period. See **Figure 2** for a map of 2015 land use conditions. This historical context is important for characterizing the current conditions of the watershed as it helps to understand the rate of change within the watershed and provides a useful benchmark for comparison.

3.3 CURRENT STATE OF THE WATERSHED

Based on the technical assessments conducted as part of watershed characterization (discussed in **Subsection 3.1**), there are four key issues in Carruthers Creek:

1 **WATER RESOURCE SYSTEM:** the aquatic ecosystem is sensitive and near the level of land use development it can sustain long-term (without additional and improved mitigation).

The current state of the WRS includes assessments of headwater drainage features, fish communities, in-stream barriers to fish movement and groundwater recharge areas, which support discharge to aquatic habitats.

The analysis of the small stream features north of Highway 7 (i.e. headwater drainage features), showed that 67% of the features have been altered (i.e. reducing hydrologic connectivity and increasing surface runoff) in some way by human activities, primarily through tile drainage.

Tile Drainage

Tile drainage is a common and important land management practice in many agricultural parts of Ontario. Tile drains are corrugated plastic tubing, clay or concrete drains installed beneath the surface of fields to drain excess water from the crop root zone.

Working with the agricultural community is important to identify opportunities to mitigate the potential impacts of tile drainage.

Consult the Ontario Ministry of Agriculture, Food and Rural Affairs, or the Ontario Soil and Crop Improvement Association for more information.

[6]Additional land use categories such as water, recreational, golf courses, cemeteries, and hydro corridors make up the remaining percentages not included in the categories of natural, agricultural, and urban land uses.

Currently, the fish communities within the watershed are dominated by cool-water native species. Redside Dace, an endangered species, is currently found within the watershed.

Urbanization results in impervious land cover (i.e. pavement, or areas where water cannot penetrate the ground). Imperviousness can increase the severity and duration of peak flows during storm events, cause erosion and sedimentation, and increase stream temperatures, which impacts aquatic habitat for all species. Some areas of the watershed are impacted by poor water quality, which negatively impacts the aquatic ecosystem (see key issue number three, water quality for more information).

Existing in-stream barriers to fish movement associated with development and infrastructure adversely impacts the aquatic system in Carruthers Creek by limiting access to feeding and spawning areas, increasing water temperature, and affecting sediment transport. In-stream structures that act as barriers to fish passage include dams, weirs, road and rail crossings, and some culverts.

From a groundwater perspective, there are three aquifer systems present in the watershed. These aquifer systems include the Oak Ridges Moraine / Mackinaw Interstadial, Thorncliffe, and Scarborough aquifer complexes. Long-term groundwater quality information for specific sites within the Carruthers Creek watershed are unavailable, but there have been a number of studies conducted in adjacent watersheds to provide an indication of background groundwater quality. The available information from Duffins Creek and Rouge River indicate elevated levels of nitrates and chlorides in groundwater attributed to road salts and fertilizer use. Healthy groundwater systems are essential for safe drinking water (e.g. particularly from rural private wells), commercial agricultural activities, and to support aquatic ecosystems.

2 **NATURAL HERITAGE SYSTEM:** there is not enough natural cover, or good quality habitat, needed to maintain ecosystem resilience (i.e. capacity to respond to change) due to changing land use patterns and climate change.

As of 2015, approximately 25% of the watershed consisted of natural cover. Approximately 9% of that natural cover is forest, 7% wetland, 4% successional (transitioning to forest), and 3% meadow [7]. Current habitat conditions are overall poor in terms of patch size, shape, and influences from surrounding land uses.

In addition to this assessment of natural cover within the watershed, TRCA also conducted terrestrial inventories of plants and animals. These inventories found 845 vascular plant species, of which only 57% are native species. These results indicate a significant presence of invasive species, such as dog-strangling vine, garlic mustard, and common buckthorn. The inventory also identified 153 flora species of regional conservation concern including four species that have not been found anywhere else in TRCA's jurisdiction. Inventories documented a total of 133 breeding vertebrate fauna species over the past decade comprised of 106 breeding birds, 18 mammals, and 9 herpetofauna (i.e. reptiles and amphibians).

The urban forest within the Carruthers Creek watershed contains 94 types of woody plant species, with over 270 varieties. Maples make up the most common type of tree within the watershed. In 2017, approximately 23% of the watershed consisted of tree and shrub canopy.

[7] The remaining natural cover percentages are around, or less than, one percent, consisting of water, hydro corridors, and beach/bluff.

Difference between urban forest and natural cover

The term **urban forest** is used to describe the trees and woody shrubs located on all private and public property within a watershed, including urbanized spaces (e.g. along roads) and in forests. The percentage of urban forest within a watershed is determined by the area covered by the canopies of all trees and shrubs.

Natural cover, expressed in hectares, or as a percentage of the overall watershed area, is the area of the watershed covered by natural habitats including forests, meadows, and wetlands.

Natural cover includes habitats with varying degrees of trees and shrubs. Meadows for example are open habitats that do not contain trees. Although meadows, and other non-treed habitats, are natural cover, they are not part of the urban forest. Similarly, the urban forest includes trees located within built portions of the watershed, outside of natural habitats. For these reasons, the amount of natural cover and the amount of urban forest in a watershed will not be equal as is the case of the Carruthers Creek watershed.

See **Figure 4** for a visual representation of this explanation.

3 WATER QUALITY: is impaired within the watershed, requiring improvements to stormwater management.

The headwaters of Carruthers Creek contain elevated concentrations of total phosphorus, phosphate, total ammonia, *E. coli*, total suspended solids (TSS), turbidity, and some trace metals. These elevated concentrations in the headwaters were likely influenced by agricultural practices and the construction of Highway 407. Just upstream of urban development, concentrations were reduced for most parameters, except chloride. Chloride levels regularly exceeded the threshold for the protection of aquatic life in the reaches of Carruthers Creek with urban influences. Additionally, increased concentrations of total ammonia, nitrite, phosphate, turbidity, and trace metals are often observed downstream of the urban area. As expected, the concentrations of many water quality parameters were elevated during high flow conditions that occur during storm runoff and wet weather.

Prior to the 1980s, stormwater management focused solely on flood control (stormwater quantity). Modern stormwater management provides a higher level of protection for the environment, property, and residents by incorporating mitigation provisions for water quality, erosion, and water balance in addition to water quantity control. The Carruthers Creek watershed has various levels of stormwater control that are indicative of the age of development and the prevailing stormwater management practices at the time.

4 NATURAL HAZARDS: the flow of water through the watershed is out of balance and there are flooding and erosion issues.

Urbanization converts formerly pervious surfaces (e.g. forests, meadows, agricultural lands) to impervious surfaces (e.g. roads, parking lots, rooftops). From 1999 to present day, the increase in urban cover has greatly altered the natural water balance. In addition, existing agricultural lands located in the headwaters of the watershed are extensively tile drained. Several sites with erosion issues were identified as part of the fluvial geomorphic assessment.

During storm events, the increase in surface runoff associated with impervious surfaces can result in excessive riverine flooding and stream erosion. Currently, a Flood Vulnerable Cluster (FVC) exists in the lower part of the Carruthers Creek watershed in the Town of Ajax (see **Figure 2** or **5** for the location of this FVC). There have been both historical and recent flooding events in the Carruthers Creek watershed due to extreme precipitation events.

These four key issues provide the basis for the management framework of this watershed plan, discussed in **Section 5**.

Table 2 summarizes benchmarks for the four key watershed issues previously discussed. The benchmarks are important reference points for understanding how watershed conditions can change over time to evaluate success of this watershed plan. **Table 2** also identifies guidelines (or rating scales) to show the ideal state of that particular watershed component. The guidelines (or rating scales) are informed by relevant TRCA strategies, provincial or federal guidance, and established conservation science. The scenario analysis, described in **Subsection 4.3**, summarizes how the watershed will respond to potential future scenarios in comparison to the benchmarks. **Section 6** uses indicators to evaluate the success of implementation through a watershed monitoring program. The indicators identified in **Section 6** will track watershed conditions relative to the benchmarks discussed in **Table 2**. Where a monitoring station is referenced in **Table 2**, see **Figure 7** for the location of that monitoring station within the watershed.

TABLE 2:
Current Watershed Conditions Benchmarks

<table>
<tr><th>Key Watershed Issues</th><th>Sub-Issue</th><th>Benchmarks</th><th>Guideline or Rating Scale (if applicable)</th></tr>
<tr><td rowspan="5">WATER RESOURCE SYSTEM</td><td>Aquatic Health</td><td>Family Biotic Index (FBI)[8]– rating of fairly poor and poor across Carruthers Creek:
Poor = 6.59 (Average from 2013 – 2017 at monitoring station Aquatic 1)
Fairly poor = 6.19 (Average from 2013 - 2017 at monitoring station Aquatic 2)
Fairly poor = 6.07 (Average from 2013 - 2017 at monitoring station Aquatic 3)
Index of Biotic Integrity (IBI)[9]:
Rating of poor at three sites (2015)
Rating of fair at two sites (2015)
Rating of good at six sites (2015)</td><td>Rating scale for FBI:<table><tr><th>Value</th><th>Rating</th></tr><tr><td>0 – 3.75</td><td>Excellent</td></tr><tr><td>3.76 – 4.25</td><td>Very good</td></tr><tr><td>4.26 – 5.00</td><td>Good</td></tr><tr><td>5.01 – 5.75</td><td>Fair</td></tr><tr><td>5.76 – 6.50</td><td>Fairly poor</td></tr><tr><td>6.51 – 7.25</td><td>Poor</td></tr><tr><td>7.26 – 10</td><td>Very poor</td></tr></table>Rating scale for IBI:<table><tr><th>Value</th><th>Rating</th></tr><tr><td>≥ 38</td><td>Very good</td></tr><tr><td>28 – 37.9</td><td>Good</td></tr><tr><td>20 – 27.9</td><td>Fair</td></tr><tr><td>≤20</td><td>Poor</td></tr></table></td></tr>
<tr><td>Riparian corridor (30 m buffer around streams)</td><td>Within the riparian corridor natural cover is 49%</td><td>75% of stream length is naturally vegetated</td></tr>
<tr><td>Streamflow (surface water)</td><td>Carruthers Creek at Achilles Road had an average total volume of 1.14 x 10^7 m^3 over the 2008 – 2016 period. This corresponds to a discharge rate of 0.360 m^3/s when averaged on an annual basis</td><td>Not applicable (should not vary significantly from natural fluctuations year to year)</td></tr>
<tr><td>Groundwater Recharge</td><td>Average recharge rate is estimated at 118 mm/year</td><td>Not applicable (should not decrease significantly from natural rates)</td></tr>
<tr><td>Groundwater Discharge</td><td>Average discharge rate is estimated at 130 mm/year</td><td>Not applicable (should not decrease significantly from natural rates)</td></tr>
</table>

[8]The Family Biotic Index is often used to assess the quality of water in rivers and is a scale for showing the quality of an environment by indicating the types of organisms present in it.

[9]The Index of Biotic Integrity measures a chosen set of metrics (in this case number of fish species, presence of sensitive fish species, abundance and food chain classifications) to assign a rating of very good to poor.

<table>
<tr><th>Key Watershed Issues</th><th>Sub-Issue</th><th>Benchmarks</th><th>Guideline or Rating Scale (if applicable)</th></tr>
<tr><td rowspan="5">NATURAL HERITAGE SYSTEM</td><td>Natural cover</td><td>Approximately 25% total natural cover, consisting of 9% forest, 7% wetland, 4% successional (transitioning to forest), and 3% meadow</td><td>Minimum 30% natural cover.
TRCA recommended NHS for Carruthers Creek: 36% natural cover; 16% forest, 7% wetland, 13% other (primarily successional forest and meadow)</td></tr>
<tr><td>Habitat quality</td><td>Evaluated using Landscape Analysis Model (LAM), which assigns a score based on total number of habitat patches, patch size, patch shape, and influences from surrounding land uses. Overall patch quality in the Carruthers Creek watershed was found to be ‘poor’</td><td>Rating scale:<table><tr><th>Patch Score</th><th>Quality Condition</th></tr><tr><td>13 – 15</td><td>Excellent</td></tr><tr><td>11 – 12</td><td>Good</td></tr><tr><td>9 – 10</td><td>Fair</td></tr><tr><td>6 – 8</td><td>Poor</td></tr><tr><td>0 – 5</td><td>Very poor</td></tr></table></td></tr>
<tr><td>Animal (i.e. fauna) species of concern</td><td>North of Taunton Road = 39
South of Taunton Road = 56</td><td>Not applicable (ideally maintained or improved)</td></tr>
<tr><td>Number and area of sensitive vegetation communities</td><td>Entire watershed number = 43
Area = approximately 54 hectares</td><td>Not applicable (ideally maintained or improved)</td></tr>
<tr><td>Tree and Shrub Canopy (urban forest)</td><td>Approximately 23% tree and shrub canopy for the entire watershed (2017)</td><td>Not applicable (targets to be established through management recommendation 3.3.2)</td></tr>
<tr><td rowspan="2">WATER QUALITY (SURFACE)
Water quality benchmarks are based on average concentration of 17 water quality samples collected monthly from June 2015 to May 2016.</td><td>Chlorides</td><td>• 183 mg/L at monitoring station Water Quality 1
• 72 mg/L at monitoring station Water Quality 2
• 35 mg/L at a no longer active monitoring station that was located west of Salem Road at Hwy 7</td><td>The long-term water quality guideline for the protection of aquatic life (CCME) for chlorides is 120 mg/L</td></tr>
<tr><td>Total suspended solids</td><td>• 20 mg/L at monitoring station Water Quality 1
• 11 mg/L at monitoring station Water Quality 2
• 59 mg/L at a no longer active monitoring station that was located west of Salem Road at Hwy 7</td><td>CCME water quality guideline for TSS is based on increases over background levels. Monitoring results show large fluctuations in TSS in Carruthers Creek.</td></tr>
</table>

Key Watershed Issues	Sub-Issue	Benchmarks	Guideline or Rating Scale (if applicable)
WATER QUALITY (SURFACE) cont'd	*E. coli*	• 706 CFU/100 ml at monitoring station Water Quality 1 • 517 CFU/100 ml at monitoring station Water Quality 2 • 475 CFU/100 ml at a no longer active monitoring station that was located west of Salem Road at Hwy 7	CFU – Colony Forming Units. Provincial Water Quality Objective (PWQO) for E. coli is 100 CFU/100 ml. Averages for Carruthers Creek exceed this guideline
	Total phosphorus	• 0.044 mg/L at monitoring station Water Quality 1 • 0.031 mg/L at monitoring station Water Quality 2 • 0.091 mg/L at a no longer active monitoring station that was located west of Salem Road at Hwy 7	PWQO to avoid excessive plant growth in river and stream concentrations below 0.03 mg/L. Averages for Carruthers Creek exceed this guideline
	Stormwater management[10]	As of 2003, approximately 64% of the developed portion of the watershed has stormwater controls that meet TRCA criteria. Of the remaining percentages, 29% have no stormwater controls and 7% have water quantity control only	Established by municipalities, in collaboration with TRCA, through stormwater master planning and secondary planning
NATURAL HAZARDS	Peak flows (flooding)	Regional Storm (i.e. Hurricane Hazel) • 71.61 m^3/s at Taunton Road • 140.52 m^3/s at Shoal Point Road 5-year Storm (i.e. 1 in 5 probability of flow being exceeded in any one year) • 7.27 m^3/s at Taunton Road • 11.00 m^3/s at Shoal Point Road	Not applicable (peak flows should not increase)
	Flood vulnerable roads and structures	Metres of impassable road length affected: • Average annual = 91 m • Regulatory flood event = 2,532 m Number of households affected: • Average annual = 1 • Regulatory flood event = 89	Not applicable (ideally a reduction in vulnerable roads and structures)

Notes: See **Section 6** for map and description of monitoring station locations referenced in this table. Other surface water quality parameters were characterized as part of TRCA's technical analysis, but only parameters of concern are included in this table.

[10]For the purposes of determining the current state of the watershed, stormwater management has been grouped with water quality. However, inadequate stormwater management can also increase the frequency and duration of flooding (i.e. natural hazards) and impact aquatic habitat (i.e. WRS).

4. Future Watershed Conditions

An important part of watershed planning is assessing future conditions based on potential future land use scenarios. The results of watershed characterization discussed in **Section 3** were used to inform the potential future land use scenarios discussed in this section. TRCA produced peer-reviewed technical reports on different components of the watershed as part of scenario analysis, which are referenced in **Section 9**.

4.1 FUTURE STRESSORS

To determine what land use scenarios to assess requires identifying potential future stressors on a watershed. For Carruthers Creek, urbanization continues to drive land use change, converting natural and agricultural areas to residential, commercial, and industrial lands. This urbanization impacts the health of a watershed largely through the loss of natural cover and increase in impermeable surfaces, which alter the hydrologic regime. Despite some positive watershed management efforts to date in Carruthers Creek, the watershed exhibits signs of stress due to the impacts of urbanization and climate change. By 2051, the population of the Region of Durham is expected to nearly double from 682,000 to 1.3 million. Some of that growth will certainly be in the Carruthers Creek watershed.

Climate change is expected to increase precipitation, annual average temperatures and the frequency of extreme weather events, which will impact watersheds within the Region of Durham. Some of the implications of a changing climate include localized flooding, violent storm damage, changes to ecosystem composition, and changes to agricultural conditions and production.

These stressors were evaluated as part of assessing future watershed conditions. The management framework in **Section 5** of this watershed plan recognizes these stressors by identifying recommendations to mitigate potential future watershed impacts.

4.2 FUTURE SCENARIOS

An effective way to assess how a watershed will respond to potential future change is to develop, analyze, and compare several alternate scenarios, each reflecting a different composition of possible land use conditions. In this way, land use scenario analysis is used as a tool to compare how possible future land uses might add to existing pressures on the natural system, and how these pressures might affect watershed health. Land use scenario analysis is a technical exercise that is typically undertaken when developing watershed plans to ensure management recommendations are based on the best available science. The results help guide the development of management recommendations and support municipalities in land use and infrastructure planning decision-making.

Climate Change

Climate change was incorporated into the scenario analysis for various technical components of this watershed planning process, where possible. For example, the terrestrial impact assessment completed as part of the NHS planning specifically incorporated climate change vulnerabilities as one of its criteria for determining priority NHS sites. The impacts of future climate change were factored into potential stresses on the aquatic system as part of that technical assessment. Additionally, hydrologic modelling completed as part of this watershed planning process incorporates storm events considered to be more frequent under climate change scenarios.

The management framework recognizes the importance of climate change by prioritizing the protection of the WRS and NHS, which can, if properly protected and restored, improve climate adaptation and increase ecosystem resilience. The use of green infrastructure and low impact development combined with improvements to stormwater infrastructure are also important management recommendations to adapt to a changing climate.

TRCA, the Region of Durham, Town of Ajax, and City of Pickering all recognize the challenge of climate change and have various strategies and action plans to address this challenge, in addition to the recommendations identified in this watershed plan (e.g. *Durham Community Climate Adaptation Plan* and *Durham Community Climate Change Local Action Plan*).

Note:
Climate change projections to 2100 for TRCA's jurisdiction and the Region of Durham are available through their respective open data portals.

Three potential future land use scenarios were developed and analyzed as part of this watershed planning process to assess possible changes and impacts in both the built and natural environments. The year 2015 was used as the baseline for this watershed planning process due to the availability of data sets at the initiation of this project.
It is worth noting that since 2015 was used as the baseline for scenario analysis, potential impacts from the extension of Highway 407 (completed in 2016) through the headwaters of Carruthers Creek can only be assumed. Ongoing monitoring of the Carruthers Creek watershed will help determine any potential changes to overall watershed health arising from the construction of this highway infrastructure.

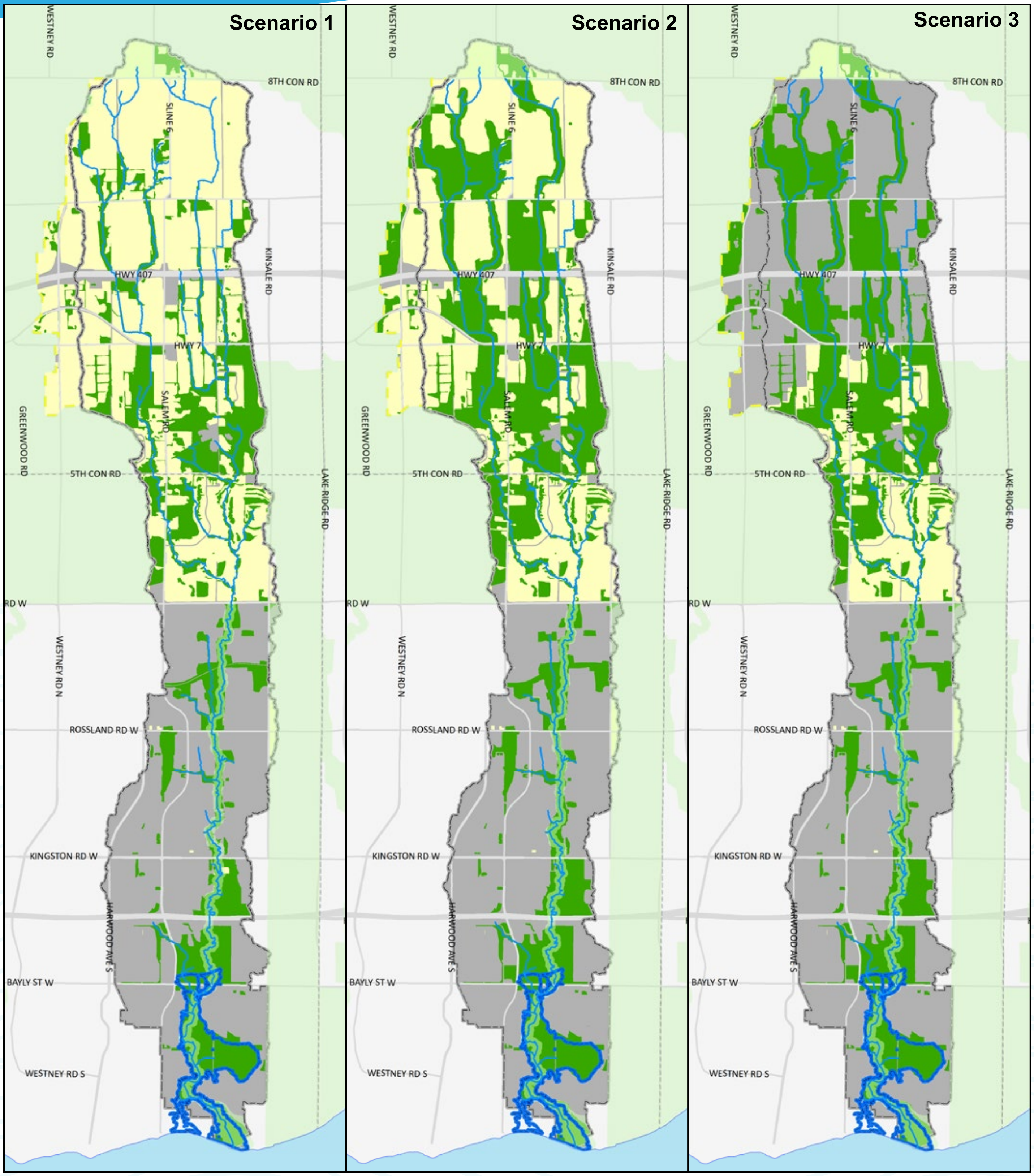
TABLE 3:
Potential Future Land Use Scenarios

Scenario 1 (+Official Plan)	This scenario assumes that all lands south of the Greenbelt are developed up to 2031 based on approved Official Plans. This scenario included municipally designated NHS's that were part of Official Plans. This scenario provides insight into how watershed conditions will likely change as approved Official Plans are implemented.
Scenario 2 (+NHS)	This scenario assumes the same development as Scenario 1 but includes the enhanced NHS (i.e. potential natural cover). New and updated information from natural heritage science and practice was incorporated to identify potential areas for natural cover that would improve ecosystem functions and services in the future. This scenario provides insights into how watershed conditions will likely change with increased consideration of additional natural cover.
Scenario 3 (+Potential Urban)	This scenario assumes post-2031 development in the headwaters of Carruthers Creek (north of the Greenbelt), outside the enhanced NHS. This scenario made general assumptions on the types of land uses associated with typical urbanization. It did not make assumptions on the levels of stormwater management controls or other mitigation measures (e.g. green infrastructure) that may accompany urban development. This level of analysis would be done during subsequent planning stages when detailed land use configurations are known. This scenario provides insights into how watershed conditions will likely change if potential full growth is approved in the watershed.

See **Figure 5** for representative maps of each scenario.

FIGURE 5:

Future Scenarios Mapping



Toronto and Region Conservation Authority

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Date: September 2019
Created by: TRCA Information Services/Information Technologies
Disclaimer:
The Data used to create this map was compiled from a variety sources and dates. The TRCA takes no responsibility for errors or omissions in the data and retains the right to make changes and corrections at anytime without notice. For further information about the data on this map, please contact the TRCA GIS Department. (416) 661-6600.

Carruthers Creek Watershed Plan: Future Scenarios 1-3

0 0.5 1 2 3 KM

Municipal Boundary
Watercourse
Land Use
Natural
Rural
Urban
Flood Vulnerable Cluster
Greenbelt Boundary
Carruthers Creek Watershed Boundary
Carruthers Creek Watershed Plan Study Area

4.3 SCENARIO ANALYSIS

As part of this watershed planning process, key components of watershed health were assessed using the previously discussed three future scenarios.

The results of these scenario analyses were used to:

1. Understand the implications of each scenario on overall watershed health and integrity.

2. Develop the management framework for this Carruthers Creek Watershed Plan, which can be used to inform land use and infrastructure decisions.

It is important to note that scenario analysis does not result in decisions about the type and configuration of land uses. Instead, scenario analysis helps to inform decisions through the municipal planning process (e.g. Official Plans).

It is the responsibility of the applicable municipality to determine the ultimate land use configuration for any future changes within the watershed.

Appropriate mitigation strategies are developed during the detailed planning stages for new developments once the scope of any future land use change is known. These mitigation strategies include assessments of the appropriate levels of stormwater controls, the use of green infrastructure to maintain natural water balance as much as possible, and opportunities for ecological restoration.

Table 4 explains the implications of the three potential future scenarios for each of the key watershed issues as identified in **Subsection 3.3**. Based on the technical assessments completed as part of this watershed planning process, **Table 4** identifies whether the watershed responds positively (conditions improve), neutrally (conditions remain the same), or negatively (conditions deteriorate) to the potential future scenario in comparison to the identified benchmark.

The colour coding in **Table 4** indicates the severity of how the watershed component reacts:

GREEN UP ARROW: >+5% change indicates watershed conditions improve from a hydrologic or ecological perspective

EQUAL SIGN: 0 to +5% or 0 to -5% change indicates a roughly equal comparison from a hydrologic or ecological perspective

YELLOW DOWN ARROW: -6% to -10% change indicates watershed conditions deteriorate from a hydrologic or ecological perspective

PURPLE DOWN ARROW: >-10% change indicates watershed conditions significantly deteriorate from a hydrologic or ecological perspective

The changes identified in **Table 4** are calculated by comparing scenario 1 to the current conditions, whereas scenarios 2 and 3 are compared to scenario 1. Since scenario 1 represents the currently approved Official Plan, it represents a future scenario that will occur, therefore it is more realistic to compare scenarios 2 and 3 to scenario 1. Some of the scenario analysis technical reports referenced in **Section 9** compare the three future scenarios to current conditions. The numbers identified in **Table 4** have been adapted accordingly to compare scenarios 2 and 3 to scenario 1.

TABLE 4:
Scenario Analysis Implications

WATER RESOURCE SYSTEM

Includes: the features and areas of the WRS, including aquatic habitat, and their functions. Percent change is based on changes to impervious cover mentioned under aquatic health. Impervious cover is a critical measure of various factors[11] that impact aquatic health.

See **Figure 9** in **Section 7** for an illustration of subwatershed quality.

CURRENT CONDITIONS (From subsection 3.3[12])	SCENARIO 1 (+OP) (Compared to Current Conditions)	SCENARIO 2 (+NHS) (Compared to Scenario 1)	SCENARIO 3 (+POTENTIAL URBAN) (Compared to Scenario 1)
% change →	↓ -6%	= +1%	↓ -12%
Aquatic Health			
Subwatershed quality: NW and NE good – fair; central and south fair – poor Impervious cover at 24% across the watershed	**Subwatershed quality:** no change from current conditions Impervious cover at 30% across the watershed	**Subwatershed quality:** NW shows improvement to good Impervious cover at 29% across the watershed	**Subwatershed quality:** all four have fair – poor conditions Impervious cover at 42% across the watershed
Riparian corridor (30 m buffer along streams)			
49% natural cover along the corridor	50% natural cover along the corridor	65% natural cover along the corridor	65% natural cover along the corridor
Streamflow (average surface water discharge)			
0.52 m^3/s	0.53 m^3/s	0.53 m^3/s	0.56 m^3/s
Groundwater discharge (average rate)			
201 mm/year	197 mm/year	201 mm/year	194 mm/year
Groundwater recharge (average rate)			
152 mm/year	147 mm/year	152 mm/year	141 mm/year

[11]These factors include channel stability, water quality, stream biodiversity, and natural flow. See the Aquatic Impact Assessment technical report for more information.

[12]The numbers for streamflow, groundwater discharge, and recharge are different in **Table 4** from **Table 2** due to models used for the scenario analysis.

NATURAL HERITAGE SYSTEM

Includes: the the features and areas of the NHS, including terrestrial habitat and their functions. Percent change is based on an equally weighted average of the total natural cover and habitat quality values.

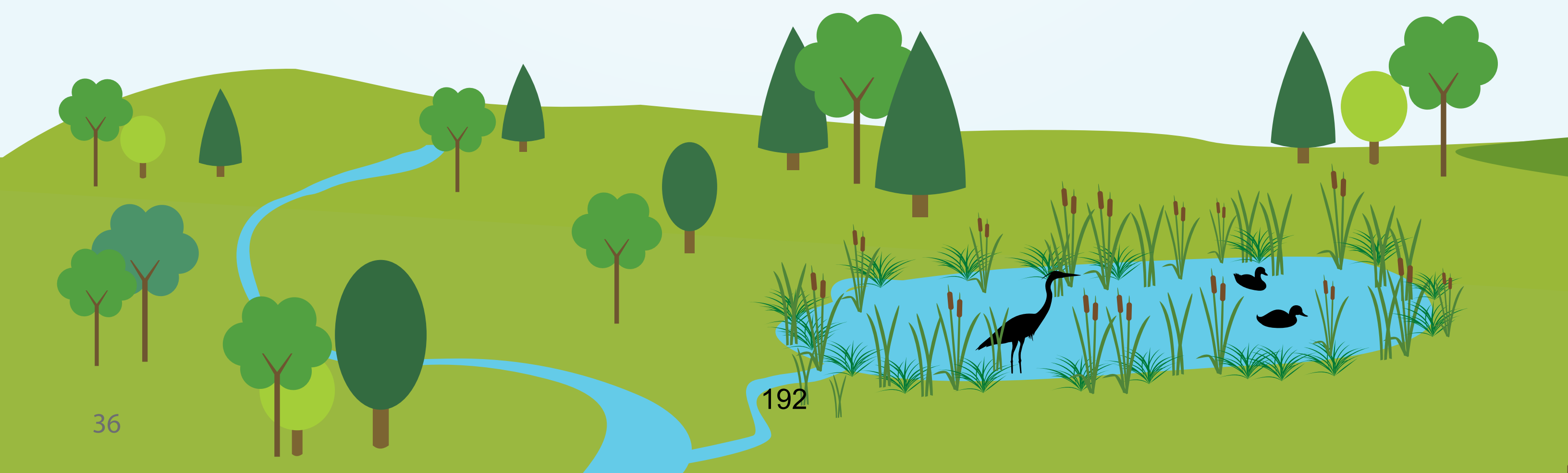
CURRENT CONDITIONS (From subsection 3.3)	SCENARIO 1 (+OP) (Compared to Current Conditions)	SCENARIO 2 (+NHS) (Compared to Scenario 1)	SCENARIO 3 (+POTENTIAL URBAN) (Compared to Scenario 1)
% change →	= 0%	↑ +7%	[13] ↑ +6%
Total natural cover			
25% natural cover	25% natural cover	36% natural cover	36% natural cover
Habitat quality (average LAM[14] score)			
7.6	7.5	7.9	7.6
Habitat connectivity (regional at watershed-scale)[15]			
28%	28%	45%	45%
Climate vulnerabilities (average of five high vulnerabilities indicators)[16]			
51%	51%	55%	55%

[13]While habitat quantity (as represented by natural cover) increases under scenario 3 relative to scenario 1, the habitat quality results require a caveat. LAM scores are an equally rated average of patch size, shape, and matrix influence. Under scenario 2, the matrix influence score increases threefold from scenario 1, indicating improved habitat quality. Under scenario 3, the matrix influence score decreases, indicating decrease in habitat quality. So, while patch size and shape increase under scenarios 2 and 3, scenario 3 negatively affects the matrix influence of habitat quality.

[14]These LAM scores, known as Landscape Analysis Model, combines the metrics of patch size (larger patches support larger populations), patch shape (habitat fragmentation) and matrix influence (influence of surrounding land uses). A LAM score of 6 – 8 = poor. See the Terrestrial Impact Assessment technical report for more information.

[15]Habitat connectivity values represent the percentage of area for connectivity priorities that overlap with the proposed enhanced NHS. Improved connectivity has benefits for habitat quantity and quality. In other words, higher percentages indicate more habitat connectivity corridors.

[16]The average high vulnerability indicators are ground surface temperature, climate sensitive community, habitat patch quality, soil drainage, and wetlands. The climate vulnerabilities values represent the percentage of climate vulnerable features represented in the proposed enhanced NHS. A higher percentage indicates more habitat included in the system, and therefore, if protected, improved resiliency to climate change.



WATER QUALITY[17]

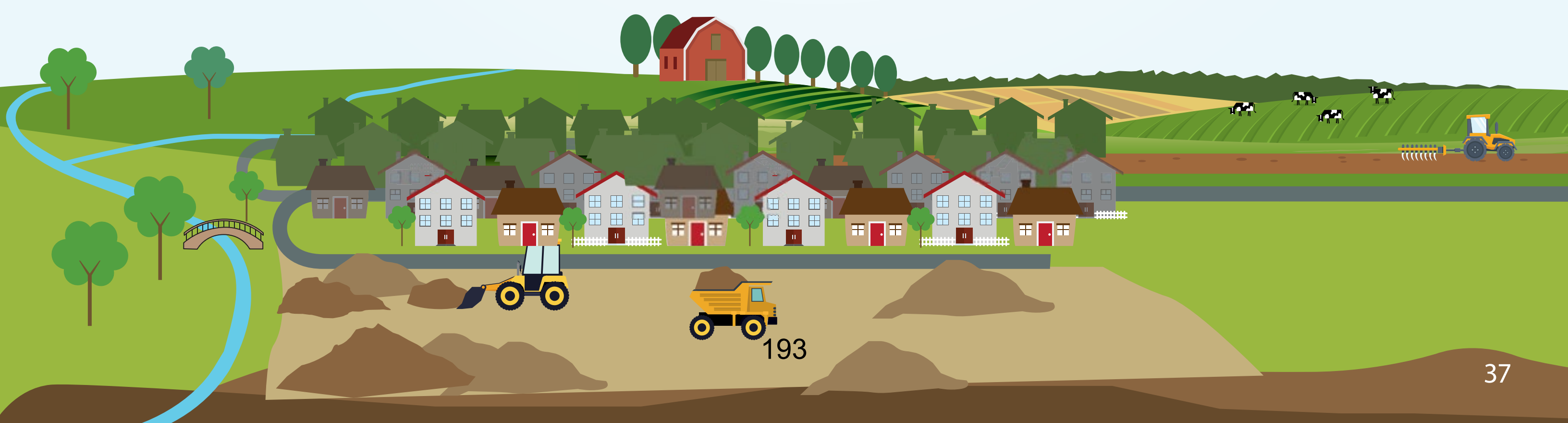
Focused on parameters of concern associated with urbanization and agricultural land uses. Amounts are based on a comparison of 2005 to 2015 average flow.

CURRENT CONDITIONS (From subsection 3.3)	SCENARIO 1 (+OP) (Compared to Current Conditions)	SCENARIO 2 (+NHS) (Compared to Scenario 1)	SCENARIO 3 (+POTENTIAL URBAN) (Compared to Scenario 1)
% change →	It is difficult to draw a conclusion on the percent change for water quality solely. As mentioned in the WRS row of this table, water quality is one of the factors considered under the impacts of impervious cover. Of the parameters of concern identified in **Table 2**, TSS and total phosphorus were assessed as part of scenario analysis.		
Total Suspended Solids[18]			
4,602 tonnes	4,674 tonnes	4,641 tonnes	4,939 tonnes
Total Phosphorus[19]			
9,843 tonnes	9,864 tonnes	9,295 tonnes	8,602 tonnes

[17] Stream water quality in urbanized watersheds is generally degraded by increased turbidity, nutrients, metals, *E. coli*, and other contaminants due to more impervious surfaces and increased runoff. See the Aquatic Impact Assessment technical report for more information.

[18] **Table 2** in **Subsection 3.3** identified TSS readings at three monitoring stations in mg/L. For the purposes of scenario analysis, TSS was measured in tonnes at the outlet of the watershed (i.e. where it drains into Lake Ontario).

[19] **Table 2** in **Subsection 3.3** identified total phosphorus readings at three monitoring stations in mg/L. For the purposes of scenario analysis, total phosphorus was measured in tonnes at the outlet of the watershed (i.e. where it drains into Lake Ontario).



NATURAL HAZARDS
(Flooding and Erosion)

Focused on flood modelling as measured by peak flows[20]. Percent change is based on the Regional Storm (i.e. Hurricane Hazel) at two points in the watershed. The Regional Storm for TRCA's jurisdiction is based on a historical storm of record, Hurricane Hazel. Design storms are based on statistical analysis of rainfall over a period of record. Hurricane Hazel is a 12-hour event with 212 mm of rainfall, which assumes completely saturated soils.

CURRENT CONDITIONS (From subsection 3.3)	**SCENARIO 1 (+OP)** (Compared to Current Conditions)	**SCENARIO 2 (+NHS)** (Compared to Scenario 1)	**SCENARIO 3 (+POTENTIAL URBAN)** [21] (Compared to Scenario 1)
% change at Taunton Road →	= +2%	= +2%	↓ -113%
% change at Shoal Point Road	↓ -6%	= +2%	↓ -41%
Regional Storm (i.e. Hurricane Hazel)			
71.61 m^3/s at Taunton Road	69.90 m^3/s at Taunton Road	68.59 m^3/s at Taunton Road	148.84 m^3/s at Taunton Road
140.52 m^3/s at Shoal Point Road	149.50 m^3/s at Shoal Point Road	147.19 m^3/s at Shoal Point Road	210.63 m^3/s at Shoal Point Road
5-year Storm (i.e. 1 in 5 probability of flow being exceeded in any one year)[22]			
7.27 m^3/s at Taunton Road	7.18 m^3/s at Taunton Road	6.58 m^3/s at Taunton Road	6.80 m^3/s at Taunton Road
11.00 m^3/s at Shoal Point Road	11.71 m^3/s at Shoal Point Road	11.11 m^3/s at Shoal Point Road	11.83 m^3/s at Shoal Point Road

[20]Peak flows are the maximum rate of discharge during the period of runoff caused by a storm. Potential erosion issues were not assessed. However, erosion is likely to be worse with increased peak flows.

[21]All existing stormwater management facilities were removed from the model to account for the system failing or being at capacity during a Regional Storm event.

[22]The 5-year event uses a 60.07 mm rainfall event over a 24-hour period, which assumes an average (normal) soil condition.

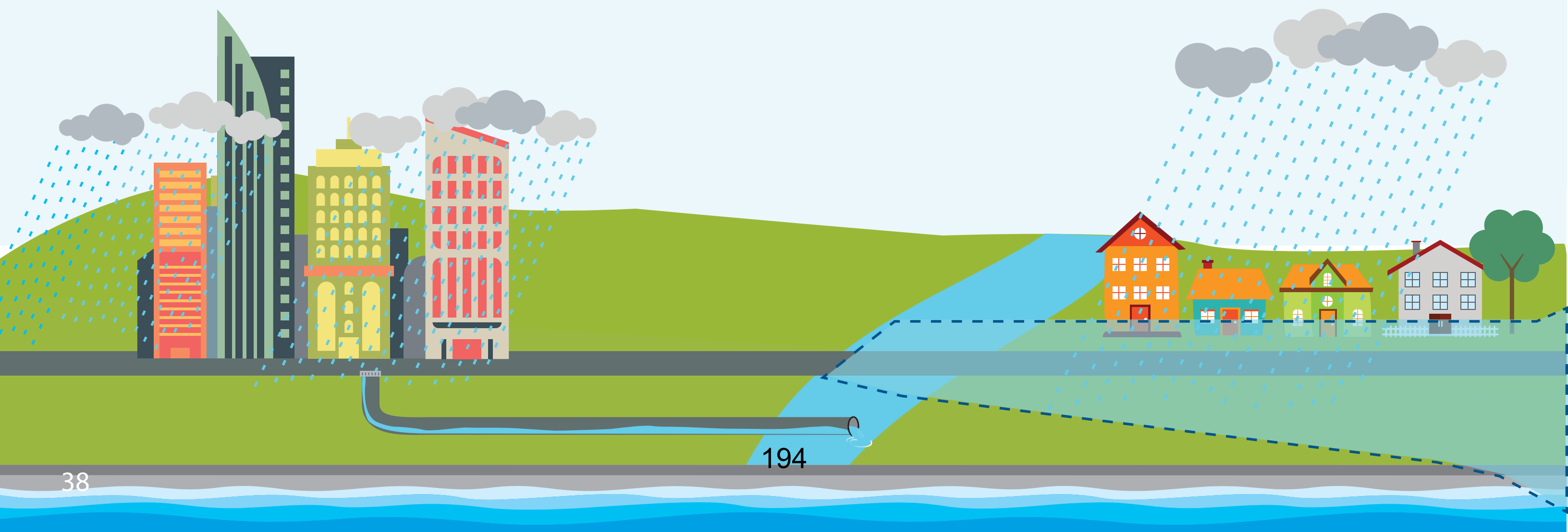


Table 4 illustrates expected changes to watershed conditions based on available information and assessments conducted as part of this watershed planning process. The management framework in **Section 5** identifies what is necessary to protect, enhance, and restore watershed conditions. It also identifies management recommendations to encourage more sustainable land uses.

Summary of implications:

	Scenario 1	Scenario 2	Scenario 3
WATER RESOURCE SYSTEM	Aquatic conditions remain relatively poor, similar to existing conditions, and there is an increase in impervious cover across the watershed.	One of the four subwatersheds shows improved aquatic conditions.	All four subwatersheds have fair-poor aquatic conditions, likely resulting in the loss of Redside Dace, a listed endangered species.
NATURAL HERITAGE SYSTEM	Natural cover and habitat quality remain similar to current conditions.	Natural cover increases and habitat quality improves.	Natural cover increases, but habitat quality does not improve by as much as scenario 2.
WATER QUALITY	Slight increases in both total suspended solids and total phosphorus.	Total phosphorus and total suspended solids decrease.	Total suspended solids increase, total phosphorus decreases.
NATURAL HAZARDS	Peak flows do not significantly change from current conditions (i.e. increases and decreases at Taunton and Shoal Point Roads under the Regional and 5-year storm events).	Peak flows decrease slightly at Taunton and Shoal Point Roads under the Regional and 5-year storm events.	Peak flows significantly increase at Taunton and Shoal Point Roads under the Regional and 5-year storms; more so for the former.

What does this mean?

These results demonstrate the importance of ensuring that land use and infrastructure planning decisions are made to minimize and mitigate impacts to the watershed regardless of potential future land use configurations. The management framework in Section 5 outlines the goals, objectives, indicators, and management recommendations necessary to ensure the long-term health and sustainability of the watershed.

The results of this scenario analysis emphasize the importance of protecting, enhancing, and restoring the WRS (**Subsection 5.2**) and NHS (**Subsection 5.3**).

In addition to the summary of implications, it is important to recognize the following:

- Limiting impervious cover in any potential future growth areas, or through redevelopments, provides significant benefits to aquatic biodiversity. Federal guidance recommends urbanizing watersheds maintain less than 10% impervious land cover, while already degraded urban systems should not exceed a second threshold of 25% to 30%. Scenario 1 shows impervious cover reaching this 30% threshold with only a marginal improvement to 29% under Scenario 2. See **Figure 9** in **Section 7** for more information.
- Increasing natural cover and improving habitat quality has noticeable benefits for the watershed (e.g. improvements to aquatic conditions and slight reductions of peak flows).
- Ecological restoration and improvements to land use practices (e.g. increased use of green infrastructure and improved stormwater management) could address existing water quality issues.
- The existing flooding and erosions issues can be mitigated through improved land uses (e.g. green infrastructure) and infrastructure (e.g. stormwater management) as outlined in the management recommendations of **Subsection 5.1**. In the event of future development in the headwaters of Carruthers Creek, it will be vital to develop mitigation strategies to limit the impacts of further urbanization by implementing the management recommendations outlined in **Subsection 5.4**.

The management framework is designed to address existing issues and the implications of these scenarios by accounting for new developments, redevelopments, and prioritizing the importance of protecting, enhancing, and restoring both the WRS and NHS.

5. Management Framework

The management framework for the Carruthers Creek Watershed Plan represents what needs to be done to protect, enhance, and restore watershed health[23]. The management framework consists of goals, objectives, indicators, and management recommendations.

TRCA developed this management framework in collaboration with its municipal partners and refined it based on feedback from stakeholders and the public.

The goals, objectives, and management recommendations were developed to address the issues identified through watershed characterization and account for potential different future land use scenarios. Many of the management recommendations are expected to mitigate many of the potential impacts associated with potential land use changes, as identified through the scenario analysis.

Each of the goals are complementary, with no one goal being more important than another. To fully realize the vision for Carruthers Creek will require the implementation of each goal area. Management recommendations were grouped under the most appropriate objective and are also listed in no particular order.

Any recommendations contained in the scenario analysis technical reports are consolidated in this management framework. Refer to the technical reports for detailed methodologies and findings beyond what was summarized in **Sections 3** and **4**. This watershed plan is the final source for goals, objectives, indicators, and management recommendations related to Carruthers Creek. Readers are encouraged to refer to the technical reports for more detailed implementation suggestions.

[23] As mentioned in **Subsection 1.1**, the CTC Source Protection Plan also applies in the Carruthers Creek watershed and includes policies to protect drinking water. Implementation of this Source Protection Plan is required under the *Clean Water Act, 2006*. Consideration of Great Lakes agreements and legislation is also important for effective watershed management. These requirements are in addition to, and complementary of, the management framework identified in this watershed plan.

TABLE 5:
Management Framework Explanation

Management Framework Components	Description
GOALS	Represent the outcomes to achieve.
OBJECTIVES	Are the specific statements about desired results, or steps to be undertaken, to achieve the goal.
INDICATORS	Explain how progress on implementing the objective is going to be tracked or measured. Some indicators are compared to the benchmarks identified in **Table 2**. Other indicators are about reporting on implementation progress as it relates to policies, best practices, or infrastructure improvements and do not have an associated benchmark in **Table 2**. Where applicable, the guidelines identified in **Table 2** can be used as a measure to achieve.
MANAGEMENT RECOMMENDATIONS	Specifically explain what should be done to accomplish the relevant objective.

The management framework consists of three goals, nine objectives, and 11 indicators (see **Figure 6**). The management recommendations for each goal area are described in **Subsections 5.1 – 5.3**.

The management recommendations apply to the entire watershed, identifying opportunities to improve conditions in the developed portion of the watershed and the types of studies and best practices that should be utilized for any potential future development, or redevelopment. **Subsection 5.4** summarizes recommendations that would specifically apply to any potential Settlement Area Boundary Expansion in the headwaters of Carruthers Creek.

GOAL 1

Land Use

Achieve sustainable land use and infrastructure development patterns to protect, enhance, and restore water quality and maintain stable water balance.

OBJECTIVE 1
Minimize the impacts of land uses through sustainability policies and the use of low impact development and green infrastructure.

Indicators:
Report on implementation of sustainable development policies/standards.

OBJECTIVE 2
Install and upgrade stormwater infrastructure using best available technologies to reduce runoff; resulting in improved water balance and water quality.

Indicators:
Report on the status of stormwater management.

OBJECTIVE 3
Manage the risks of natural hazards through appropriate mitigation measures and restoration.

Indicators:
Reduce number of flood vulnerable structures and roads.

OBJECTIVE 4
Encourage the use of agricultural best management practices to minimize agricultural runoff and improve rural land stewardship.

Indicators:
Work with the agricultural community to track implementation of best management practices.

GOAL 2

Water Resource System

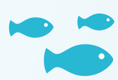
Protect, enhance, and restore the areas and features that make up the Water Resource System (including aquatic habitat) for ecosytem resilience and sustainabilty.

OBJECTIVE 1
Implement appropriate policies and programs that protect, enhance, and restore the areas and features that comprise the Water Resource System.

Indicator:
Appropriate policy designations are in place for the Water Resourse System.

OBJECTIVE 2
Promote aquatic habitat connectivity to faciltate native fish movement throughout the watershed.

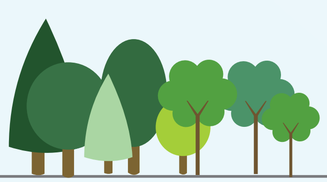
Indicator:
Maintain, or improve, aquatic health rankings.



GOAL 3

Natural Heritage System

Protect, enhance, and restore the Natural Heritage System and urban forest within the watershed to improve ecosystem resilience and sustainability.



OBJECTIVE 1
Improve the quality and quantity of the Natural Heritage System across the watershed through ecosystem protection, enhancement, and restoration, and implementation of relevant policies.

Indicators:
Increase total natural cover in the watershed.

Appropriate policy designations are in place for the Natural Heritage System.

OBJECTIVE 2
Ensure habitat exists for native terrestrial species to thrive throughout the watershed.

Indicators:
Maintain, or increase, the number and area of species and vegetation communities of concern.

OBJECTIVE 3
Increase the urban forest cover within the developed portion of the watershed to improve social and environmental well-being.

Indicator:
Increase total tree canopy in the watershed.

5.1 LAND USE / INFRASTRUCTURE GOAL

GOAL 1

Achieve sustainable land use and infrastructure development patterns to protect, enhance, and restore water quality and maintain stable water balance.

This goal area focuses on the policy, land use, and infrastructure planning processes that influence the health of the watershed. The management recommendations are numbered to correspond with their applicable goal and objective.

TABLE 6:
Land Use Management Recommendations

Land Use Objective	Management Recommendations
LAND USE OBJECTIVE 1 Minimize the impacts of land uses through sustainability policies and the use of low impact development and green infrastructure.	**1.1.1** Lower-tier municipalities, in collaboration with the Region of Durham and TRCA, to adopt green development policies, or standards, and require new developments, and redevelopments, to utilize low impact development and green infrastructure techniques to limit the impacts of increased impervious cover. The following shall apply to any municipal policies, or standards, in particular within ESGRAs, as identified on **Map 1B** a. new developments shall minimize impervious cover and strive to achieve 90^{th} percentile volume control of annual rainfall b. redevelopments shall minimize impervious cover and strive to achieve 75^{th} percentile volume control of annual rainfall
	1.1.2 The Region of Durham and lower-tier municipalities, in collaboration with TRCA, to develop mechanisms to track and report on implementation of sustainable development practices to assess the effectiveness of policies and standards.
	1.1.3 If it is determined that a Settlement Area Boundary Expansion is required in the headwaters of Carruthers Creek, the Region of Durham, in collaboration with the lower-tier municipalities and TRCA, will identify, based on consensus between the identified parties, the subsequent planning processes and further studies and assessments, that would be required to implement any such expansion. These requirements should be reflected as policies within the Regional Official Plan and include the requirement for the preparation of a secondary plan and a subwatershed plan (or equivalent), which would be supported by, at a minimum, the following studies, assessments, and further considerations: a. a hydraulic assessment b. how natural hazards will be assessed and mitigated (i.e. the risk of flooding and erosion will not increase) c. how the Natural Heritage System and Water Resource System will be protected, enhanced, and restored d. how water quality and quantity will be protected e. how flood mitigation solutions will be funded, including identification of the responsible parties for providing the funding. This includes the cost of any necessary studies, engineering design, and actual construction/maintenance of flood mitigation works

Land Use Objective	Management Recommendations
LAND USE OBJECTIVE 1 cont'd	**1.1.4** During planning for transportation infrastructure improvement projects, or new projects, the Region of Durham and lower-tier municipalities to implement best management practices for design, expansions and widenings in accordance with TRCA's *Crossing Guideline for Valley and Stream Corridors*, and ensure consistent policies and standards are in place to facilitate hydraulic function (e.g. prevent flooding) and ecological connectivity (e.g. wildlife passage). See **Map 3** for priority crossings.
	1.1.5 Lower-tier municipalities to improve the management of excess soils and prevent fill deposition that is incompatible with the soils and hydrology of the area by: a. ensuring adequate policies and bylaws are in place to manage excess soil b. improving compliance and enforcement of policies through collaboration between TRCA and municipalities c. conducting education and outreach on: i. the importance of proper soil management ii. existing regulatory requirements iii. regulatory responsibilities of various agencies, including who to contact with concerns d. collaborating with agencies and other levels of government, including the Region of Durham, to ensure infrastructure projects that generate, or receive excess soil follow best management practices
	1.1.6 The Region of Durham and lower-tier municipalities, in collaboration with other levels of government and TRCA, to work to reduce the amount of chlorides entering the watershed by: a. continuing to implement best management practices for winter de-icing procedures on public property b. continuing education and outreach on salt management for private property
	1.1.7 TRCA, in collaboration with the Town of Ajax, to identify and promote opportunities for sustainable community retrofits in priority planting neighbourhoods (See **Map 8**).

Land Use Objective	Management Recommendations
LAND USE OBJECTIVE 2 Install and upgrade stormwater infrastructure using best available technologies to reduce runoff; resulting in improved water balance and water quality.	**1.2.1** Lower-tier municipalities, in collaboration with the Region of Durham and TRCA, through stormwater master planning continue to: a. employ best management practices for stormwater management and consistent design criteria to manage runoff quantity and quality b. consider stormwater funding options for cost recovery and to reduce impervious surfaces in the watershed c. examine opportunities to retrofit outdated stormwater infrastructure and install stormwater controls in areas without controls through long-term planning and investment strategies d. refine existing policies to ensure modern stormwater controls are required e. adaptively manage stormwater infrastructure through operation maintenance schedules and procedures
	1.2.2 Lower-tier municipalities, in collaboration with the Region of Durham and TRCA, to develop mechanisms to track the status and effectiveness of stormwater management infrastructure.
	1.2.3 Lower-tier municipalities to explore opportunities to enhance stormwater management in neighbourhoods with outdated or no stormwater facilities by retrofitting infrastructure to meet modern stormwater design criteria, as much as possible, given site characteristics.
	1.2.4 For new developments, lower-tier municipalities to require hydrologic analysis and erosion threshold assessments downstream of potential stormwater management facilities that need to demonstrate no negative, or adverse, downstream impacts, prior to municipal approvals.
LAND USE OBJECTIVE 3 Manage the risks of natural hazards through appropriate mitigation measures and restoration.	**1.3.1** TRCA, in collaboration with lower-tier municipalities, to prioritize the restoration of the erosion hazard sites identified on **Map 4**. Additional channel restoration, or increased stream bank protection may be required as preventative measures in areas downstream of new developments.
	1.3.2 The Region of Durham and lower-tier municipalities, in collaboration with TRCA, to identify potential hazard risks to sewer and existing road infrastructure associated with in-stream creek erosion and implement strategies to eliminate identified risks.

Land Use Objective	Management Recommendations
LAND USE OBJECTIVE 3 cont'd	**1.3.3** Implement appropriate flood mitigation measures for the Flood Vulnerable Cluster in the Town of Ajax, which could involve: a. reopening, or initiating, a new environmental assessment to provide a more comprehensive list of alternatives to offset impacts associated with potential development in the headwaters b. the application of regional control in the headwaters of Carruthers Creek, if developed, and required by the updated flood modelling (see management recommendation 1.3.5)
	1.3.4 TRCA, in collaboration with the Region of Durham and lower-tier municipalities, to educate property owners in high flood risk areas about proper lot level practices (e.g. removing hydraulic impairments).
	1.3.5 TRCA will continue to complete comprehensive flood plain mapping based on routinely updated hydraulic models and updated land use information to inform municipal planning decisions. Regulatory flood plain mapping is updated based on approved land uses.
LAND USE OBJECTIVE 4 Encourage the use of agricultural best management practices to minimize agricultural runoff and improve rural land stewardship.	**1.4.1** In collaboration with the agricultural community and provincial ministries, TRCA, the Region of Durham and lower-tier municipalities to identify opportunities to expand best management practices that reduce agricultural runoff and improve water management, such as: a. use cover crops and / or leave crop residue b. adopt no till farm practices during non-growing season c. conduct soil testing for nutrients and adjust fertilizer application rates, if required
	1.4.2 In collaboration with the agricultural community, rural land owners, and provincial ministries, TRCA, the Region of Durham, and lower-tier municipalities to identify opportunities to improve rural land stewardship best management practices through: a. natural buffers between agricultural lands and natural and / or water resource features and areas b. implementation of Environmental Farm Plans and other rural land stewardship programs (e.g. TRCA's Rural Clean Water Programs) c. education / outreach about the benefits of utilizing best management practices to improve habitat (e.g. meadows for sensitive bird species)

5.2 WATER RESOURCE SYSTEM GOAL

GOAL 2

Protect, enhance, and restore the areas and features that make up the Water Resource System (including aquatic habitat) for ecosystem resilience and sustainability.

This goal area focuses on ensuring policies are in place for the long-term protection of the WRS and undertaking priority restoration initiatives to benefit the long-term resiliency of the WRS. The WRS is presented in **Map 1A** and **Map 1B**. The areas and features that comprise the WRS are to be protected in accordance with the recommendations laid out in this subsection.

TABLE 7:
WRS Management Recommendations

WRS Objective	Management Recommendations
WRS OBJECTIVE 1 Implement appropriate policies and programs that protect, enhance, and restore the areas and features that comprise the Water Resource System.	**2.1.1** The Region of Durham and lower-tier municipalities, in collaboration with TRCA, to ensure the protection of the Water Resource System (**Map 1A** and **Map 1B**) and its functions, by: a. updating Official Plans and zoning bylaws to protect the Water Resource System b. assessing existing standards and guidelines for land use and infrastructure development to ensure they reflect current provincial policy direction to protect, enhance, and restore the quality and quantity of water c. avoiding development near key hydrologic features through the establishment of appropriate buffers d. requiring the implementation of appropriate mitigation measures where avoidance of key hydrologic areas is not possible, in order to maintain hydrologic functions
	2.1.2 TRCA, in collaboration with the Region of Durham and lower-tier municipalities, to routinely update mapping data layers for all components of the Water Resource System as new information becomes available.

WRS Objective	Management Recommendations
WRS OBJECTIVE 1 cont'd	**2.1.3** TRCA, in collaboration with the Region of Durham and lower-tier municipalities, to prioritize the restoration of the aquatic sites identified on **Map 4**, which have been selected for contributing to the following: a. enhancing habitat quality and watershed connectivity b. ensuring biodiversity persists c. improving watershed resiliency to climate change
	2.1.4 If it is determined that a Settlement Area Boundary Expansion is required in the headwaters of Carruthers Creek, the City of Pickering, in collaboration with the Region of Durham, Town of Ajax, and TRCA, prior to approvals of a secondary plan, to demonstrate through a subwatershed plan (or equivalent) that: a. key hydrologic features will be protected and hydrologic functions maintained b. where avoidance of key hydrologic areas is not possible, appropriate mitigation measures are to be implemented to maintain downstream hydrologic functions c. there will be no negative or adverse downstream effects, such as increased flooding, erosion, or deteriorated water quality through a hydraulic analysis (to quantify and map depth and extent of impacts) and other relevant modelling
WRS OBJECTIVE 2 Promote aquatic habitat connectivity to facilitate native fish movement throughout the watershed.	**2.2.1** TRCA, in collaboration with the Region of Durham and lower-tier municipalities and landowners, to remove the six priority barriers to fish movement identified in **Map 5**
	2.2.2 TRCA, through its application review function, to identify and implement avoidance, conservation, design, and mitigation measures for the protection and / or recovery of native aquatic species, including Redside Dace and its habitat. For activities that affect Redside Dace habitat, consult the *Guidance for Development Activities in Redside Dace Protected Habitat* (MNRF 2016), MECP and DFO to determine requirements under species at risk legislation.

5.3 NATURAL HERITAGE SYSTEM GOAL

GOAL 3

Protect, enhance, and restore the Natural Heritage System and urban forest within the watershed to improve ecosystem resilience and sustainability.

This goal area focuses on improving the quality and quantity of natural systems throughout the watershed. The proposed enhanced NHS identified on **Map 2** is recommended by TRCA to achieve this goal. It will be up to municipalities to adopt a NHS that is consistent with provincial policy and informed by the goals and objectives of the CCWP. The proposed enhanced NHS includes areas with existing natural cover and areas that are targeted to be potential natural cover through restoration. Refinements to the recommended NHS may be considered assuming the scientific analysis is consistent with the goals and objectives of the CCWP. The recommended NHS is designed to move towards the minimum target for natural cover in an urban and urbanizing watershed as established in TRCA's *Terrestrial Natural Heritage System Strategy* (2007) and *How Much Habitat is Enough?* (Environment and Climate Change Canada, 2013). Assuming that the identified potential natural cover areas are restored, the recommended NHS achieves approximately 36% natural cover across the watershed, including approximately 25% forests and successional forests and 7% wetlands, consistent with the minimum targets. A large amount of the land recommended for potential natural cover occurs in the headwaters of Carruthers Creek. If development proceeds in this area, it will be essential to restore and protect (i.e. through securement) an amount of land consistent with the recommended NHS.

To appropriately implement a NHS will require updates to municipal Official Plans, which can then guide future land use decisions to avoid development in the municipally adopted NHS, mitigate any impacts or, where impacts are unavoidable, provide ecosystem compensation. The management recommendations related to the NHS in this subsection are consistent with TRCA's protection hierarchy of avoid, minimize, mitigate, and as a last resort compensate.

Urban forests provide valuable terrestrial habitat, help manage stormwater, provide clean air, and other socio-economic benefits (e.g. regulates local temperatures, improves personal well-being). Including urban forestry under this NHS goal recognizes the integrated nature of natural areas (i.e. NHS) and the ecological value of additional natural cover in parks, on streets, or private property (i.e. urban forests).

TABLE 8:
NHS Management Recommendations

NHS Objective	Management Recommendations
NHS OBJECTIVE 1 Improve the quality and quantity of the Natural Heritage System across the watershed through ecosystem protection, enhancement, and restoration, and implementation of relevant policies.	**3.1.1** The Region of Durham, as part of its Municipal Comprehensive Review, to ensure the protection, enhancement, and restoration of a Natural Heritage System consistent with the goals and objectives of this watershed plan (**Map 2** for recommended NHS) by: a. including existing natural cover areas identified in **Map 2** in the Regional Official Plan b. providing direction to lower-tier municipalities to include policies in their Official Plans to protect, enhance and restore existing natural cover areas as identified in **Map 2** c. recognizing the potential natural cover areas identified in **Map 2** in the Regional Official Plan and providing direction to lower-tier municipalities to include any relevant policies in their Official Plans to enhance and restore potential natural cover areas d. avoiding infrastructure development (i.e. buildings and structures) and minimizing infrastructure linear feature crossings, in a municipally designated enhanced Natural Heritage System e. providing direction to lower-tier municipalities on the establishment of minimum vegetation protection zones along natural heritage features, with the ability of the minimum vegetation protection zone to be confirmed through an appropriate environmental study
	3.1.2 Lower-tier municipalities, in collaboration with TRCA, to ensure the protection, enhancement, and restoration of a Natural Heritage System consistent with the goals and objectives of this watershed plan (**Map 2**), including the target of achieving 36% natural cover across the watershed, by: a. designating in their Official Plans, at a minimum, existing natural cover as identified in **Map 2** b. including policies in their Official Plans to identify enhancement and restoration opportunities for potential natural cover areas as identified in **Map 2** c. assessing existing standards and guidelines for land use and infrastructure development to ensure they reflect current provincial policy direction to maintain, restore, or enhance the municipally designated Natural Heritage System

NHS Objective	Management Recommendations
NHS OBJECTIVE 1 cont'd	**3.1.2 (cont'd)** d. avoiding infrastructure development (i.e. buildings and structures) and minimizing infrastructure linear feature crossings, in a municipally designated enhanced Natural Heritage System e. adopting municipal policies for ecosystem compensation that meet or exceed TRCA's *Guideline for Determining Ecosystem Compensation*, where development in a municipally designated enhanced Natural Heritage System is unavoidable f. applying a minimum vegetation protection zone along natural heritage features at the boundary of a municipally designated enhanced Natural Heritage System. A minimum 30 metre vegetation protection zone is recommended, unless otherwise determined through an appropriate environmental study g. requiring development and site alterations be designed and approved to prevent encroachment into a municipally designated enhanced Natural Heritage System
	3.1.3 TRCA, in collaboration with the Region of Durham and lower-tier municipalities, to prioritize the restoration of the terrestrial sites identified on **Map 4**, which have been selected for contributing to the following: a. increasing habitat quantity b. enhancing habitat quality and connectivity c. ensuring biodiversity persists d. adapting for climate vulnerabilities
	3.1.4 TRCA, in collaboration with the Region of Durham and lower-tier municipalities, to explore opportunities to secure the sites identified on **Map 6** for ecological protection and to increase public land ownership and connectivity along the main channel of Carruthers Creek south of Taunton Road.

NHS Objective	Management Recommendations
NHS OBJECTIVE 1 cont'd	**3.1.5** TRCA, the Region of Durham and lower-tier municipalities to regularly update their trail guidelines and standards for consistency, and to ensure that any new, or modifications to existing trails, use best practices, such as prioritizing the use of boardwalks in sensitive areas (e.g. wetlands), and implementing methods to ensure trail users stay on marked trails (e.g. signage, barriers to humans and dogs, but not other species, and limited access during breeding season).
	3.1.6 TRCA, in collaboration with the Region of Durham and lower-tier municipalities, to minimize impacts to the municipally designated Natural Heritage System from any active recreation and human activity by: a. ensuring proper trail management and signage b. providing education and outreach on the importance of the municipally designated Natural Heritage System c. promoting community stewardship to maintain and monitor the municipally designated Natural Heritage System for improper trail usage (e.g. off-trail compaction and erosion), illegal dumping and invasive species, while encouraging community restoration programs (e.g. tree plantings)
	3.1.7 Wetland water balance studies that demonstrate how the hydrological function of the wetland is to be protected will be undertaken by the landowner for any potential future growth in the areas identified on **Map 7**, or other areas identified during subwatershed planning, prior to applicable planning approvals.
NHS OBJECTIVE 2 Promote terrestrial habitat connectivity to ensure native species thrive throughout the watershed.	**3.2.1** The Region of Durham, lower-tier municipalities, TRCA, landowners, and other agencies will collaborate to manage problematic invasive species.
	3.2.2 TRCA will continue to work with landowners to restore meadow habitat areas in support of open country bird species at risk, in accordance with the terrestrial restoration priorities identified on **Map 4**

NHS Objective	Management Recommendations
NHS OBJECTIVE 3 Increase the urban forest cover within the developed portion of the watershed to improve social and environmental well-being.	**3.3.1** Lower-tier municipalities, in collaboration with the Region of Durham and TRCA, to update existing urban forest studies and consolidate them into a comprehensive study that: a. accounts for all public and private lands b. develops targets for public and private lands for inclusion in an urban forest strategy c. develops indicators for the quality and quantity of the urban forest for inclusion in an urban forest strategy
	3.3.2 The Region of Durham and lower-tier municipalities, in collaboration with TRCA, to develop a comprehensive urban forest strategy that: a. enhances tree and soil conservation in accordance with *Preserving and Restoring Healthy Soil: Best Practices for Urban Construction* at any new development, or redevelopment, (e.g. Carruthers Creek Business Area), and on regional property (e.g. along Taunton Road) as depicted on **Map 8** b. focuses urban forest tree planting programs in the Town of Ajax as depicted on **Map 8** c. encourages an urban forest with diverse and native (or non-invasive) tree species and class sizes d. ensures consistent policies and bylaws for tree conservation on public and private lands e. explores opportunities to increase the capacity of the Region of Durham to implement an Urban Forest Strategy consistent with this management recommendation f. encourages participation in knowledge-sharing and collaboration through the Regional Public Works Commissioners of Ontario's Urban Forestry Sub-working Group and Ontario's Municipal Arborist and Urban Foresters Association g. includes urban forest targets for existing developed areas and any future development as part of the strategy

5.4 CARRUTHERS CREEK HEADWATERS MANAGEMENT

There are several management recommendations that refer to potential future studies, subwatershed planning, or potential development in the headwaters of Carruthers Creek. The headwaters that could potentially have development in the future are the lands outside of the Greenbelt north of Highway 7. At the moment, these lands are not designated as part of the settlement area of the City of Pickering in their Official Plan, or the Region of Durham's urban area boundary. For any future development to occur, a Settlement Area Boundary Expansion, in compliance with the Growth Plan, would need to occur. The following management recommendations speak to what would be required based on provincial policy and the recommendations in this watershed plan. These management recommendations were already discussed under their relevant goal, but are repeated here as they are specific to the headwaters of Carruthers Creek. Should a decision be made to proceed with a Settlement Area Boundary Expansion, the full suite of management recommendations in **Subsections 5.1 – 5.3** would apply to that area.

TABLE 9:
Headwaters Specific Management Recommendations

	Relevant Management Recommendations	Rationale and Provincial Policy Basis
1.1.3	If it is determined that a Settlement Area Boundary Expansion is required in the headwaters of Carruthers Creek, the Region of Durham, in collaboration with the lower-tier municipalities and TRCA, will identify, based on consensus between the identified parties, the subsequent planning processes and further studies and assessments, that would be required to implement any such expansion. These requirements should be reflected as policies within the Regional Official Plan and include the requirement for the preparation of a secondary plan and a subwatershed plan (or equivalent), which would be supported by, at a minimum, the following studies, assessments, and further considerations: a. a hydraulic assessment b. how natural hazards will be assessed and mitigated (i.e. the risk of flooding and erosion will not increase) c. how the Natural Heritage System and Water Resource System will be protected, enhanced, and restored d. how water quality and quantity will be protected e. how flood mitigation solutions will be funded, including identification of the responsible parties for providing the funding. This includes the cost of any necessary studies, engineering design, and actual construction/maintenance of flood mitigation works	Appropriate scoping of any subwatershed studies for potential future Settlement Area Boundary Expansions will allow those studies to build upon work completed through this watershed planning process in a collaborative fashion. Growth Plan policies 2.2.8.3 (d) / (e) and 4.2.1.3 (c).

	Relevant Management Recommendations	Rationale and Provincial Policy Basis
1.1.4	During planning for transportation infrastructure improvement projects, or new projects, the Region of Durham and lower-tier municipalities to implement best management practices for design, expansions and widenings in accordance with TRCA's *Crossing Guideline for Valley and Stream Corridors*, and ensure consistent policies and standards are in place to facilitate hydraulic function (e.g. prevent flooding) and ecological connectivity (e.g. wildlife passage). See **Map 3** for priority crossings.	This management recommendation is intended to ensure hydrological and ecological connectivity by improving crossings when new transportation infrastructure is built, or existing infrastructure is upgraded. This recommendation will help protect the integrity of the WRS and NHS, consistent with Growth Plan policies 4.2.1 and 4.2.2.
1.2.4	For new developments, lower-tier municipalities to require hydrologic analysis and erosion threshold assessments downstream of potential stormwater management facilities that need to demonstrate no negative, or adverse, downstream impacts, prior to municipal approvals.	This management recommendation is intended to identify potential changes to the functions of the WRS arising from new development. It is consistent with Growth Plan policies related to stormwater management (3.2.7).
1.3.3	Implement appropriate flood mitigation measures for the Flood Vulnerable Cluster in the Town of Ajax, which could involve: a. reopening, or initiating, a new environmental assessment to provide a more comprehensive list of alternatives to offset impacts associated with potential development in the headwaters b. the application of regional control in the headwaters of Carruthers Creek, if developed and required by updated flood modelling	This management recommendation is in reference to existing flooding issues in the lower part of the Carruthers Creek watershed in the Town of Ajax. The exact nature of the flood mitigation measure will depend on whether development proceeds in the headwaters of Carruthers Creek.

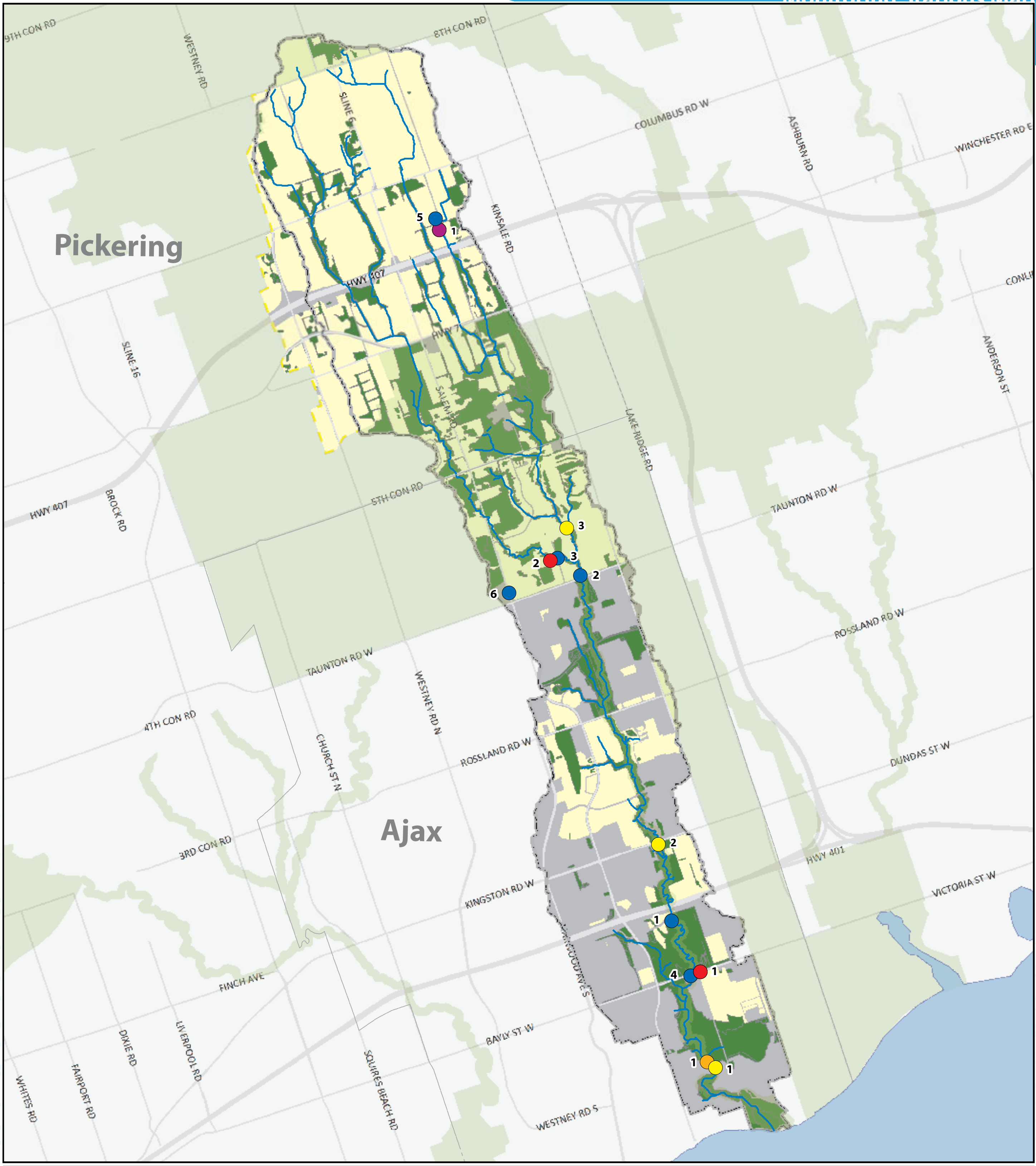
	Relevant Management Recommendations	Rationale and Provincial Policy Basis
2.1.4	If it is determined that a Settlement Area Boundary Expansion is required in the headwaters of Carruthers Creek, the City of Pickering, in collaboration with the Region of Durham, Town of Ajax, and TRCA, prior to approvals of a secondary plan, to demonstrate through a subwatershed plan (or equivalent) that: a. key hydrologic features will be protected and hydrologic functions maintained b. where avoidance of key hydrologic areas is not possible, appropriate mitigation measures are to be implemented to maintain downstream hydrologic functions c. there will be no negative or adverse downstream effects, such as increased flooding, erosion, or deteriorated water quality through a hydraulic analysis (to quantify and map depth and extent of impacts) and other relevant modelling	Similarly, to management recommendation 1.1.3, this management recommendation identifies what is necessary to protect the integrity of the WRS and NHS. Growth Plan policies 2.2.8.3 (d) / (e), 4.2.1.3 (c), 4.2.2.3, and 4.2.2.6.
3.1.7	Wetland water balance studies that demonstrate how the hydrological function of the wetland is to be protected will be undertaken by the landowner for any potential future growth in the areas identified in **Map 7**, or other areas identified during subwatershed planning, prior to any planning approvals.	Wetlands are vital features to both the WRS and NHS. Any development in proximity to wetland features should demonstrate the protection of hydrologic functions. Growth Plan policies 4.2.1.2, 4.2.1.4, and 4.2.2.3.

6. Monitoring and Evaluation

Monitoring is vital to the successful implementation of this watershed plan. Monitoring will help evaluate trends in watershed conditions and track the implementation of plan objectives. Monitoring will help determine what is working to maintain or improve conditions and what, if necessary, needs to change should conditions deteriorate.

The Carruthers Creek monitoring program is designed to evaluate both watershed health and indicators associated with objectives of this watershed plan. The monitoring stations map (**Figure 7**) identifies monitoring stations by category based on what they monitor. **Table 10** explains the Carruthers Creek monitoring program in detail. The stations identified in the monitoring stations map are cross referenced in the stations column in **Table 10** (e.g. the first station listed in the table is an aquatic station, which is the yellow number 1 on the map).

Additional monitoring stations are likely necessary to adequately track watershed health trends and the identified indicators over time. TRCA, in collaboration with its municipal partners, will identify opportunities to expand watershed monitoring with appropriate resourcing. It will be particularly important to ensure monitoring stations are collecting data in all parts of the watershed. Currently, monitoring stations are limited in the northern part of the watershed. If development occurs in the headwaters of Carruthers Creek, it may be necessary to add additional monitoring stations.



Toronto and Region Conservation Authority

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Date: September 2019
Created by: TRCA Information Services/Information Technologies
Disclaimer:
The Data used to create this map was compiled from a variety sources and dates. The TRCA takes no responsibility for errors or omissions in the data and retains the right to make changes and corrections at anytime without notice. For further information about the data on this map, please contact the TRCA GIS Department. (416) 661-6600.

Carruthers Creek Watershed Plan: Monitoring Stations

0 0.5 1 2 3 KM

- Aquatic
- Groundwater
- Terrestrial
- Water Quality
- Water Quantity

- Municipal Boundary
- Watercourse
- Greenbelt Boundary

Land Use

- Natural
- Rural
- Urban
- Carruthers Creek Watershed Boundary
- Carruthers Creek Watershed Plan Study

TABLE 10:
Carruthers Creek Monitoring Program

Monitoring Category	Stations	Monitoring Frequency	What is monitored?	Why do we monitor it?
WATER RESOURCE SYSTEM (aquatic ecosystems)	**ID#: CC001WM** (Yellow #1 on map) **ID#: CC002WM** (Yellow #2 on map) **ID#: CC003WM** (Yellow #3 on map)	Every three years	Fish community, aquatic habitat, and benthic invertebrate community	**Indicator:** Maintain, or increase, aquatic health rankings. Applicable to WRS Objective 2. Monitoring these aquatic habitat characteristics allows for the assessments of the overall health of the aquatic ecosystem.
NATURAL HERITAGE SYSTEM (terrestrial ecosystems)	**ID#: FV-18 & FV-18_1** (Orange #1 on map)	Annually	Vegetation and forest birds	**Indicator:** Maintain, or increase, the number and area of species and vegetation communities of concern. Applicable to NHS Objective 2. Monitoring these terrestrial habitat characteristics helps to understand how the system is functioning and if there are changes to species composition over time. **Note:** This indicator requires inventory data from across the watershed to be properly assessed. The identified monitoring stations only collect data at that particular location and therefore do not assess trends across the watershed. An inventory would need to be conducted within the next ten years to update information regarding current conditions.

Monitoring Category	Stations	Monitoring Frequency	What is monitored?	Why do we monitor it?
SURFACE WATER QUALITY	**ID#: 107002** (Red #1 on map)	Monthly samples	Water chemistry (e.g. nutrients), metals, bacteria, and temperature	Applicable to overall watershed health and trends to know whether water quality conditions are improving or not. Monitoring water quality helps to understand the impacts of land uses on local water quality that ultimately flows into Lake Ontario.
	ID#: CC005 (Red #2 on map)			
SURFACE WATER QUANTITY	**ID#: HY013** (Blue #1 on map)	Continuous water level data collected, reported in 15-minute intervals	Stream level, discharge, and temperature	Applicable to overall watershed health and trends to know whether hydrology conditions are improving or not. Monitoring stream level, discharge and temperature helps to understand the interconnections between groundwater and surface water. This information can be used to guide the management and protection of baseflow levels to protect aquatic life and ensure sustainable human use of surface water.
	ID#: HY090 (Blue #2 on map)			
	ID#: HY089 (Blue #3 on map)			
	ID#: WQ002 (Blue #4 on map)	Continuous water level and certain water quality data collected, reported in 15-minute intervals Monthly grab samples for full suite of water quality parameters Also takes event-based (i.e. heavy rainfall) water quality samples	Stream level, discharge, and temperature Note: also measures water quality as part of Lake Ontario tributary monitoring	Applicable to overall watershed health and trends to know whether hydrology and water quality conditions are improving or not. The primary purpose of this station is to assess nutrient loadings to Lake Ontario.

Monitoring Category	Stations	Monitoring Frequency	What is monitored?	Why do we monitor it?
	ID#: HY121 (Blue #5 on map)	Continuous real-time (reporting every 5 minutes)	Rainfall and snowfall amount and temperature	Applicable to overall watershed health and trends to know whether hydrology conditions are improving or not. Precipitation monitoring information assists with flood forecasting and warning, event-based sampling, and watershed planning.
	ID#: HY122 (Blue #6 on map)			
GROUNDWATER QUANTITY	**ID#: HY121** (Purple #1 on map)	Hourly groundwater level and temperature, and monthly manual groundwater level measurements	Water level	Applicable to overall watershed health and trends to know whether hydrogeology conditions are improving or not. Groundwater and surface water interactions are essential for a functioning WRS. Understanding groundwater conditions is vital to understanding the nature of these interactions.

Note:
The following indicators are not evaluated through a particular monitoring station in Carruthers Creek, but will be periodically assessed through GIS analyses:

- Reduce number of flood vulnerable structures and flood vulnerable roads (Land Use Objective 2)
- Increase total natural cover in the watershed (NHS Objective 1)
- Increase total tree canopy in the watershed (NHS Objective 3)

The remaining indicators are qualitative (e.g. ensuring policies are in place) and will be reported on by TRCA in collaboration with its municipal partners.

Reporting

As part of the Carruthers Creek monitoring program, TRCA, in collaboration with its municipal partners, will conduct annual reporting to communicate on the health of the watershed and plan implementation progress.

Annual reporting will help to track watershed health trends and the indicators identified as part of this watershed plan.

Some components of this watershed plan may not be reported on annually (e.g. aquatic community and terrestrial species). This is due to different monitoring frequencies for certain components (e.g. aquatic species are surveyed every three years).

Adaptive Management

Adaptive management is a systematic process (see **Figure 8**) for continually improving practices by learning and applying updated knowledge to improve project outcomes. In the context of this watershed plan, adaptive management, in combination with the monitoring program, will allow modifications and refinements to management recommendations, and/or the monitoring program throughout the life cycle of this watershed plan. For example, if water quality continues to deteriorate, certain land use management recommendations may not be resulting in the desired outcome, requiring adjustment.

FIGURE 8:
Adaptive Management Cycle

7. Maps

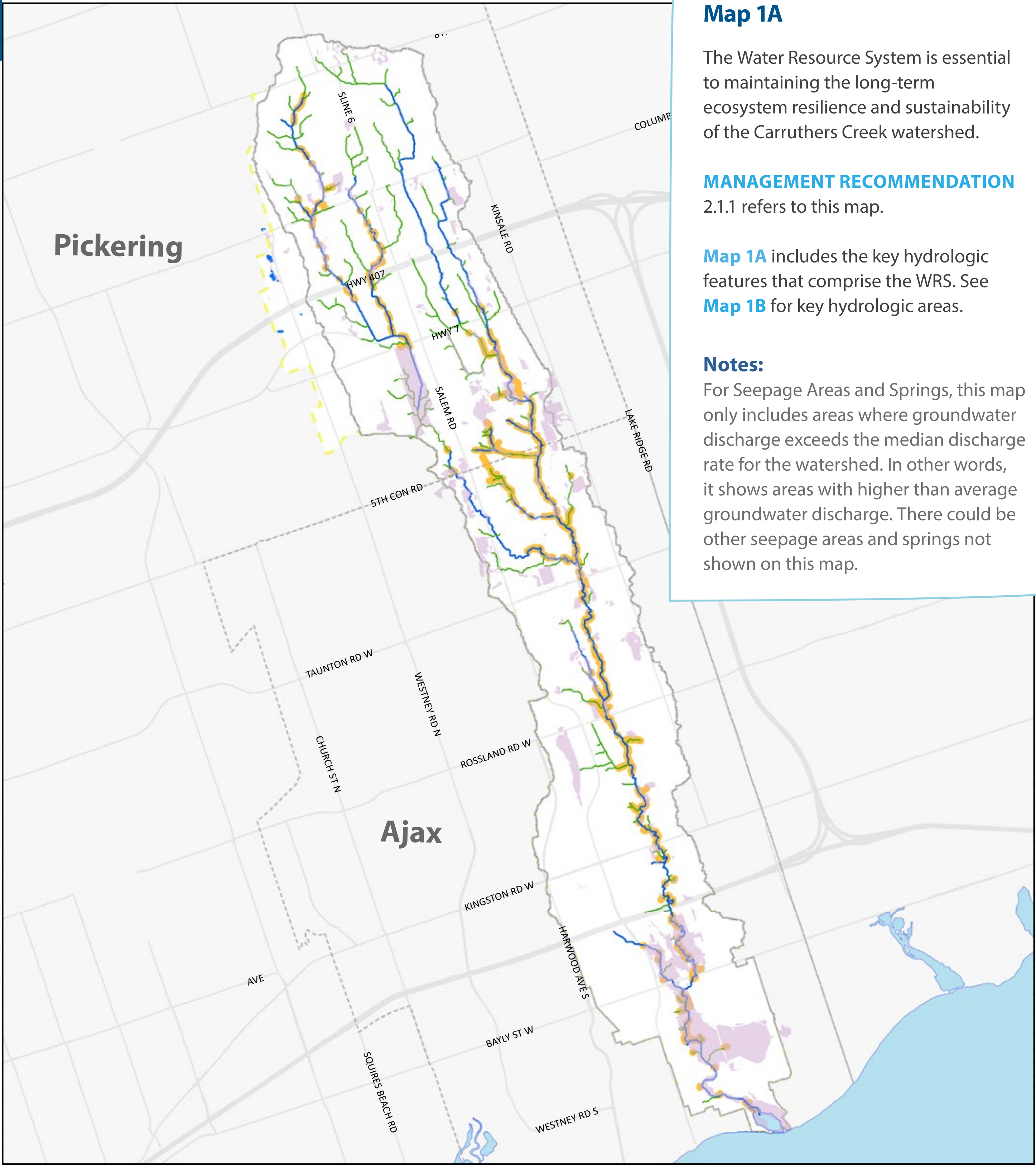
Map 1A

The Water Resource System is essential to maintaining the long-term ecosystem resilience and sustainability of the Carruthers Creek watershed.

MANAGEMENT RECOMMENDATION
2.1.1 refers to this map.

Map 1A includes the key hydrologic features that comprise the WRS. See **Map 1B** for key hydrologic areas.

Notes:
For Seepage Areas and Springs, this map only includes areas where groundwater discharge exceeds the median discharge rate for the watershed. In other words, it shows areas with higher than average groundwater discharge. There could be other seepage areas and springs not shown on this map.



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Carruthers Creek Watershed Plan: Water Resource System - Map A

0 0.5 1 2 3 KM

Key Hydrologic Features
- Inland Lakes
- Intermittent Streams
- Permanent Streams
- Seepage Areas and Springs
- Wetlands
- Municipal Boundary
- Carruthers Creek Watershed Boundary
- Carruthers Creek Watershed Plan Study

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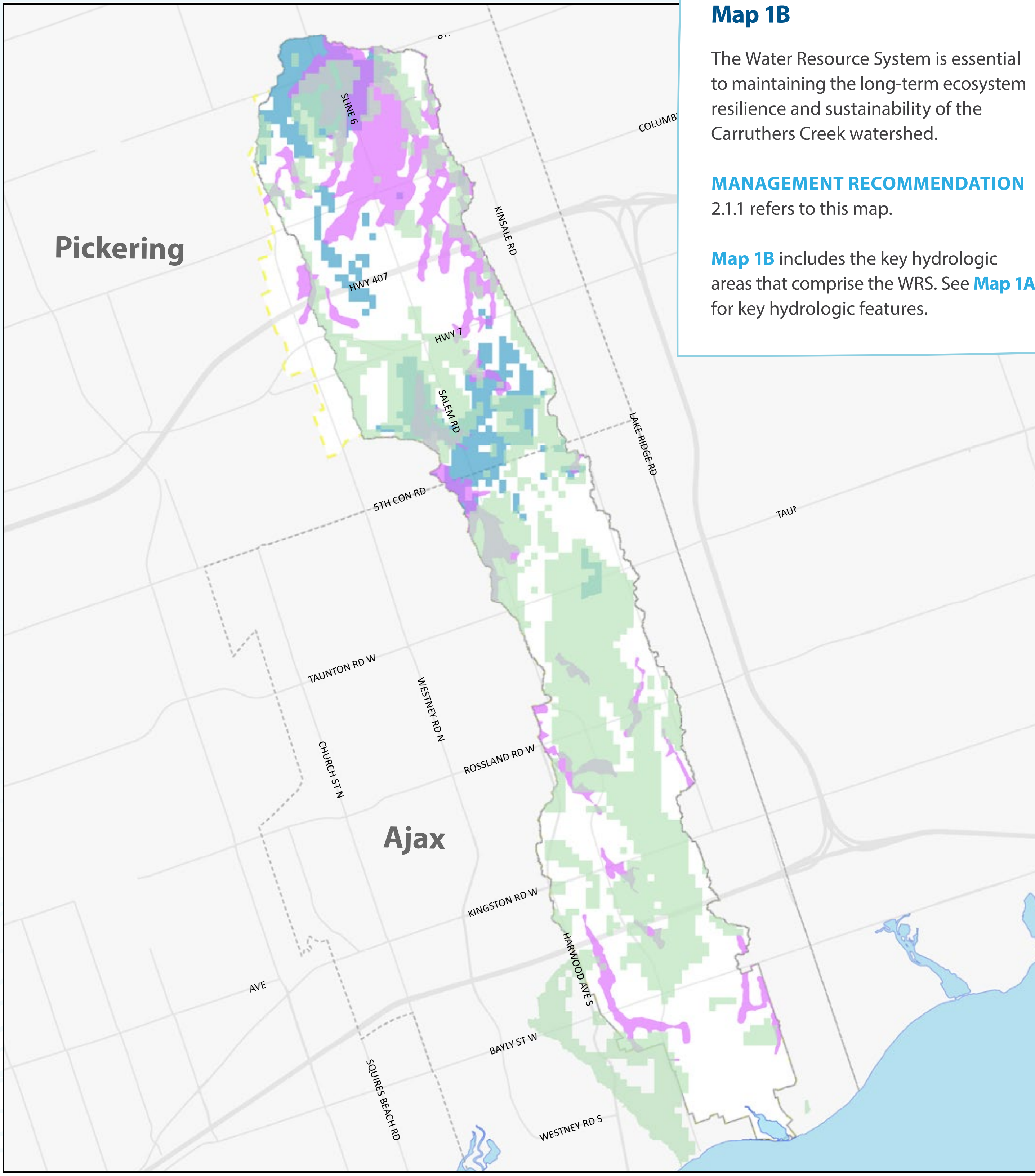
Map 1B

The Water Resource System is essential to maintaining the long-term ecosystem resilience and sustainability of the Carruthers Creek watershed.

MANAGEMENT RECOMMENDATION 2.1.1 refers to this map.

Map 1B includes the key hydrologic areas that comprise the WRS. See **Map 1A** for key hydrologic features.



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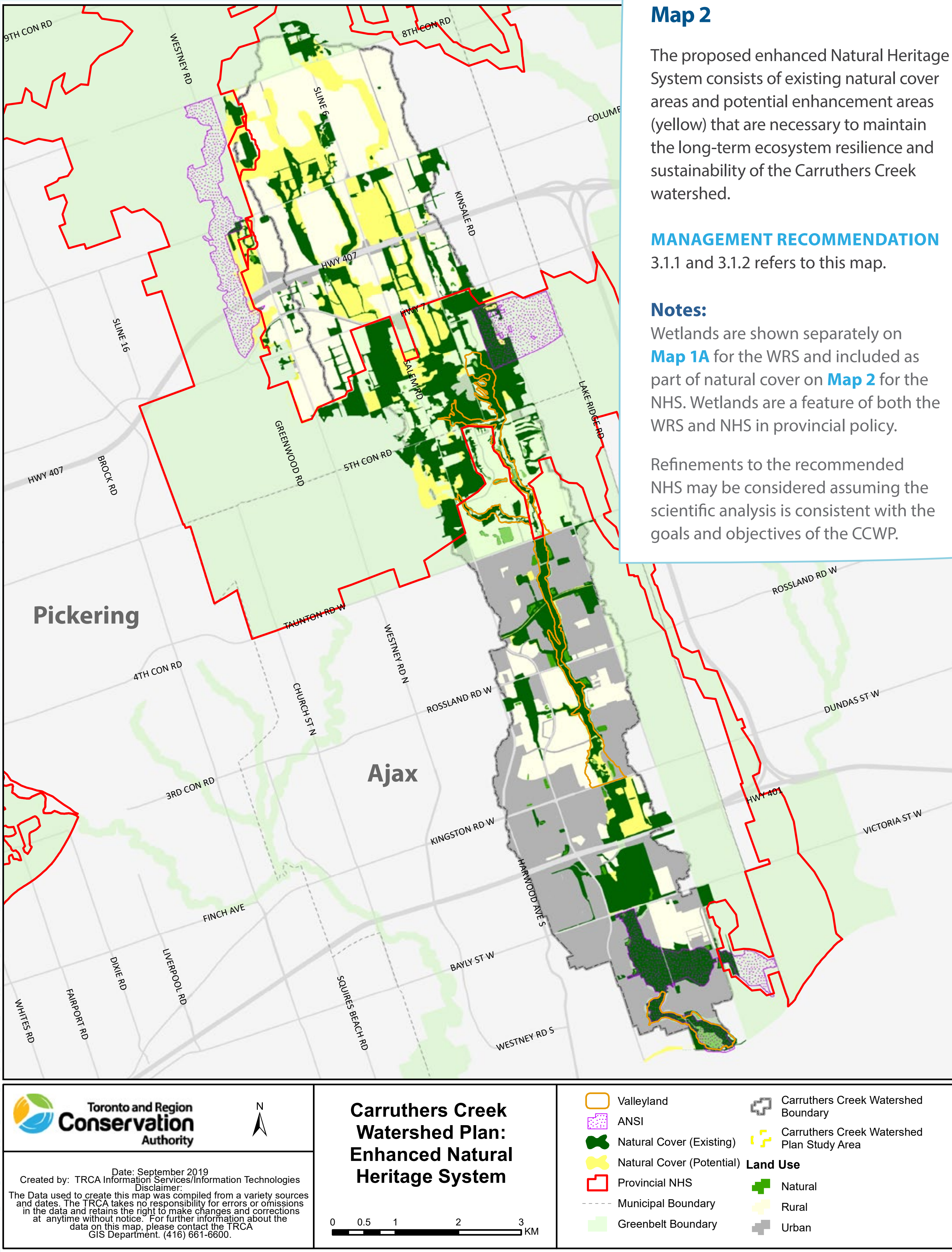
Carruthers Creek Watershed Plan: Water Resource System - Map B

0 0.5 1 2 3 KM

Key Hydrologic Areas
- Highly Vulnerable Aquifers
- Significant Groundwater Recharge Areas
- Ecologically Significant Groundwater Recharge Areas
- Municipal Boundary
- Carruthers Creek Watershed Boundary
- Carruthers Creek Watershed Plan Study



Map 2

The proposed enhanced Natural Heritage System consists of existing natural cover areas and potential enhancement areas (yellow) that are necessary to maintain the long-term ecosystem resilience and sustainability of the Carruthers Creek watershed.

MANAGEMENT RECOMMENDATION
3.1.1 and 3.1.2 refers to this map.

Notes:
Wetlands are shown separately on **Map 1A** for the WRS and included as part of natural cover on **Map 2** for the NHS. Wetlands are a feature of both the WRS and NHS in provincial policy.

Refinements to the recommended NHS may be considered assuming the scientific analysis is consistent with the goals and objectives of the CCWP.

Map 3

This map represents both priority hydrological and ecological connectivity (i.e. habitat connectivity) improvements.

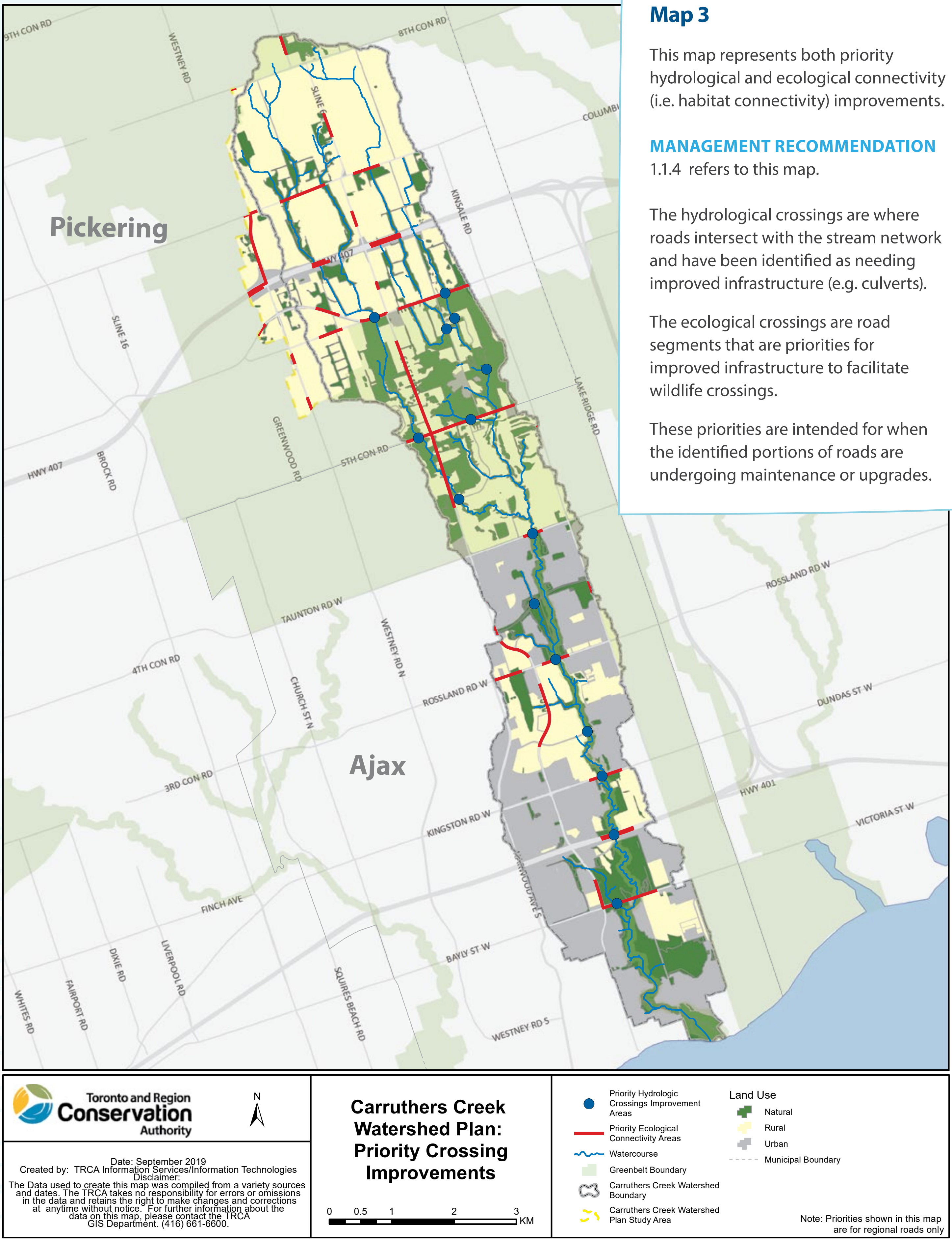
MANAGEMENT RECOMMENDATION

1.1.4 refers to this map.

The hydrological crossings are where roads intersect with the stream network and have been identified as needing improved infrastructure (e.g. culverts).

The ecological crossings are road segments that are priorities for improved infrastructure to facilitate wildlife crossings.

These priorities are intended for when the identified portions of roads are undergoing maintenance or upgrades.



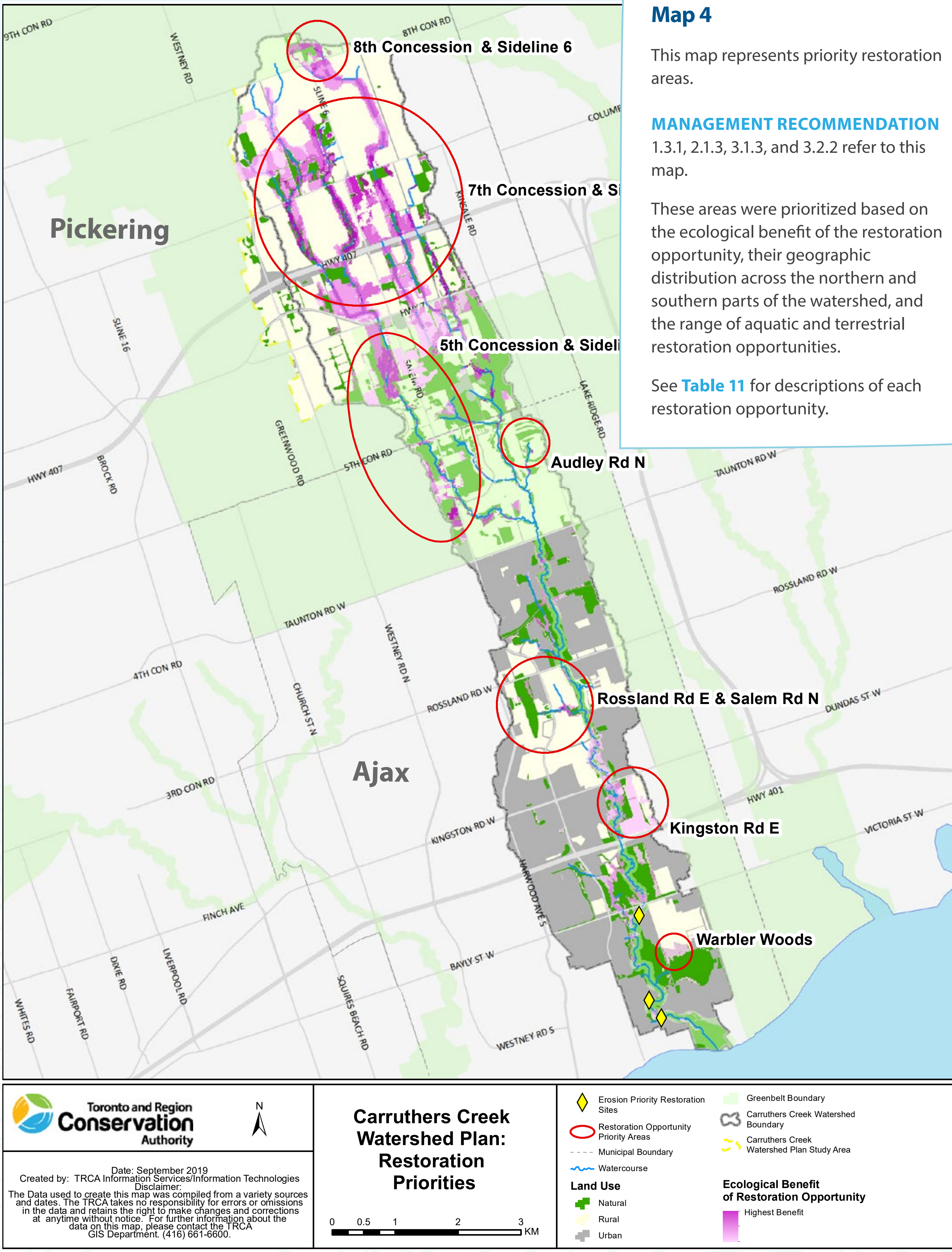
Map 4

This map represents priority restoration areas.

MANAGEMENT RECOMMENDATION
1.3.1, 2.1.3, 3.1.3, and 3.2.2 refer to this map.

These areas were prioritized based on the ecological benefit of the restoration opportunity, their geographic distribution across the northern and southern parts of the watershed, and the range of aquatic and terrestrial restoration opportunities.

See **Table 11** for descriptions of each restoration opportunity.



Restoration Opportunity Planning for Carruthers Creek

Restoration opportunity planning is TRCA's current process for identifying and recording site-level information for terrestrial and aquatic restoration opportunities (e.g. wetland, riparian, forest, meadow, and stream restoration). TRCA's Integrated Restoration Prioritization (IRP) tool is used to help select priority restoration opportunities where ecological impairments exist and, if restored, could contribute most to the terrestrial natural heritage and water resource systems.

Restoration opportunities in the Carruthers Creek watershed were originally identified using desktop assessment techniques as per the restoration opportunity planning methodology. For the CCWP, a more detailed prioritization method using additional data identified the most important areas to consider for restoration. This involved combining the IRP scores with the criteria listed in management recommendations 2.1.3 for aquatic and 3.1.2 for terrestrial. TRCA then overlaid these scores with the restoration opportunity planning information to identify the highest scoring areas, which are circled in **Map 4** (Note: the Audley Road N opportunity was selected for meadow restoration potential in support of management recommendation 3.2.2).

TABLE 11:
Restoration Opportunity Summaries

Location	Restoration Opportunity
8th Concession and Sideline 6	• Forest, wetland, stream, and riparian restoration opportunities have been identified in areas of residential and agricultural land uses. • Forest restoration will help connect and expand existing forest to the north. • Large-scale wetland and riparian restoration would restore headwater drainage feature functions and benefit downstream habitat. Existing land use patterns have altered streams, wetlands, and riparian areas. • With agriculture as the predominant land-use, the focus of restoration should be to work with property owners to restore and maintain marginal lands that do not negatively impact agricultural use but promote best management practices and contribute to the potential enhanced natural heritage system.
7th Concession and Sideline 6	• Forest, wetland, stream, and riparian restoration opportunities were identified in this largely agricultural area. • Highest priority areas include riparian corridors and around existing forest patches. • Portions in the north-east and along hydro corridors of this area provide meadow restoration opportunities. • Areas of wetland restoration will increase habitat diversity, contribute to the reduction of run-off, and increase water infiltration and storage.
5th Concession and Sideline 6	• Forest, wetland, riparian, and meadow restoration opportunities were identified in this priority area. • Restore large area of wetland and riparian habitat in the northern portion of this area. • Meadow habitat can be created along the hydro corridor running east to west in this area. • Existing forests can be expanded along the proposed enhanced NHS.
Audley Road North	• Restore wetland and meadow habitat to the east of the stream, in collaboration with golf course. • Meadow restoration potential in the hydro corridor to the south of the area to support habitat for sensitive species.
Rossland Road East and Salem Road North	• Restore riparian buffer to the west of the main branch of the creek and create a forest buffer between future development and the NHS. • Work with developer to restore wetlands and riparian corridors and encourage the use of best management practices such as low impact development and buffers as part of any development.
Kingston Road East	• Restore riparian cover along the main channel of Carruthers Creek. • Restore large wetlands to the east of this area and plant riparian and forest habitat around the wetlands. • Restore ponds in flood plain north of Kingston Road East to enhance wetland habitat and connect corridor along the stream network.
Kingston Road East	• Restore wetland habitat north of existing wetland to provide a buffer between this area and potential development.
Warbler Woods	• Restore wetland habitat north of existing wetland to provide a buffer between this area and potential development.

Map 5

This map represents priority fish barriers for removal to restore in-stream aquatic habitat connectivity.

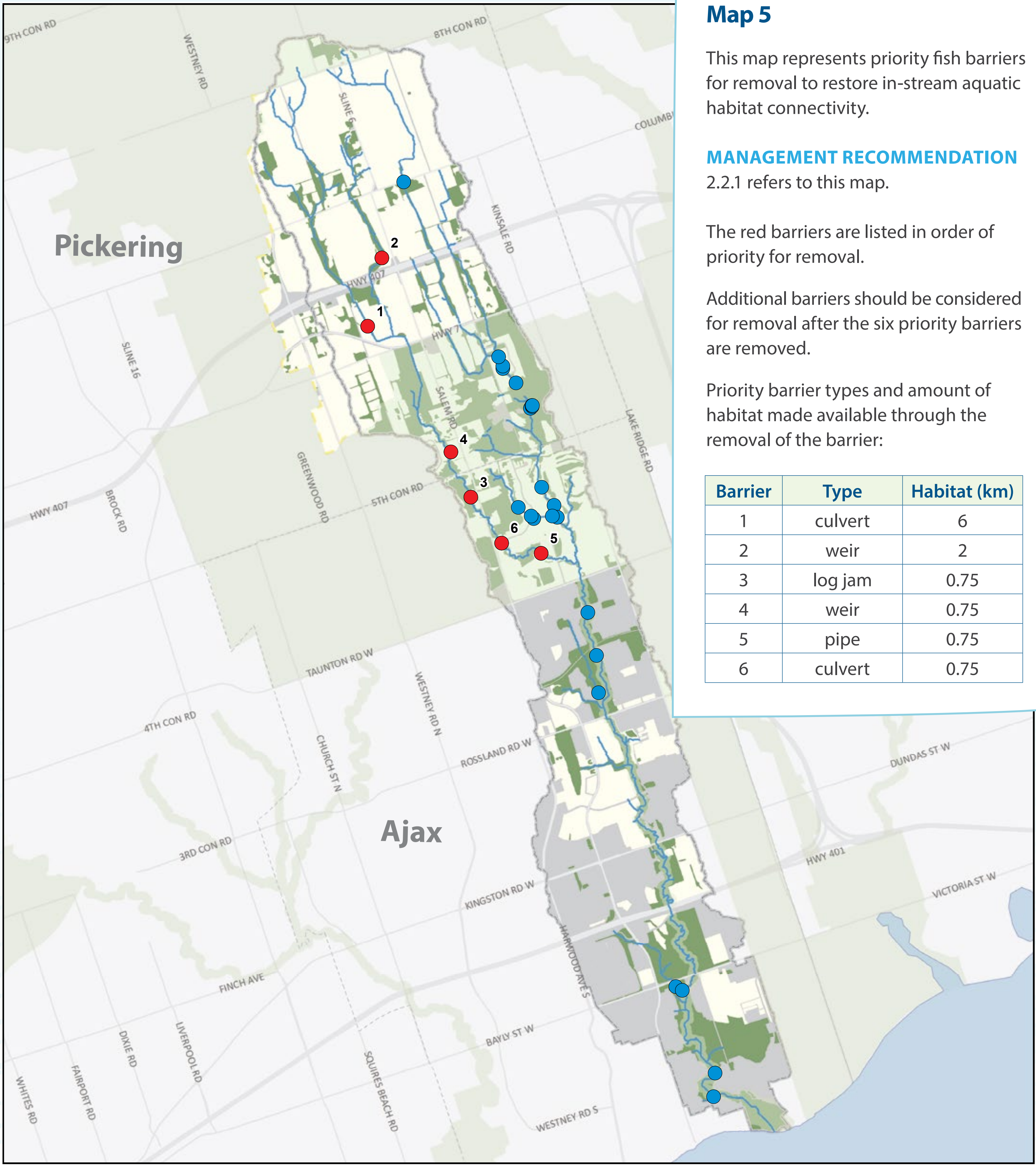
MANAGEMENT RECOMMENDATION
2.2.1 refers to this map.

The red barriers are listed in order of priority for removal.

Additional barriers should be considered for removal after the six priority barriers are removed.

Priority barrier types and amount of habitat made available through the removal of the barrier:

Barrier	Type	Habitat (km)
1	culvert	6
2	weir	2
3	log jam	0.75
4	weir	0.75
5	pipe	0.75
6	culvert	0.75



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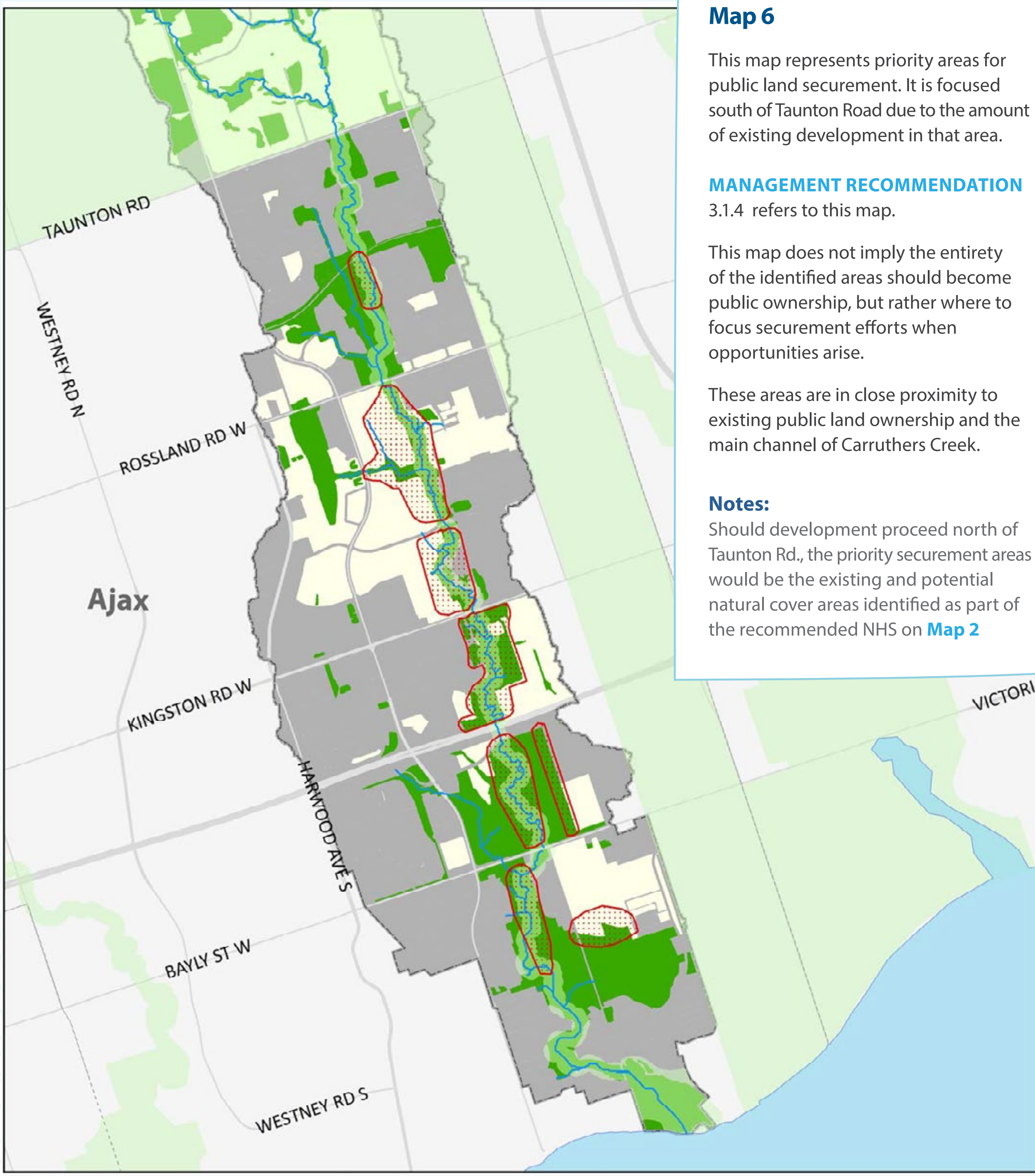
Carruthers Creek Watershed Plan: Fish Barriers

0 0.5 1 2 3 KM

Priority Barriers
Other Barriers
Municipal Boundary
Watercourse
Greenbelt Boundary
Carruthers Creek Watershed Boundary
Carruthers Creek Watershed Plan Study Area

Land Use
Natural
Rural
Urban



Map 6

This map represents priority areas for public land securement. It is focused south of Taunton Road due to the amount of existing development in that area.

MANAGEMENT RECOMMENDATION
3.1.4 refers to this map.

This map does not imply the entirety of the identified areas should become public ownership, but rather where to focus securement efforts when opportunities arise.

These areas are in close proximity to existing public land ownership and the main channel of Carruthers Creek.

Notes:
Should development proceed north of Taunton Rd., the priority securement areas would be the existing and potential natural cover areas identified as part of the recommended NHS on **Map 2**

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Carruthers Creek Watershed Plan: Priority Securement Areas

0 0.4 0.8 1.6 KM

Priority Securement Areas
Inland Lakes
Watercourse
Municipal Boundary
Greenbelt Boundary
Carruthers Creek Watershed Boundary
Carruthers Creek Watershed Plan Study Area

Land Use
Natural
Rural
Urban

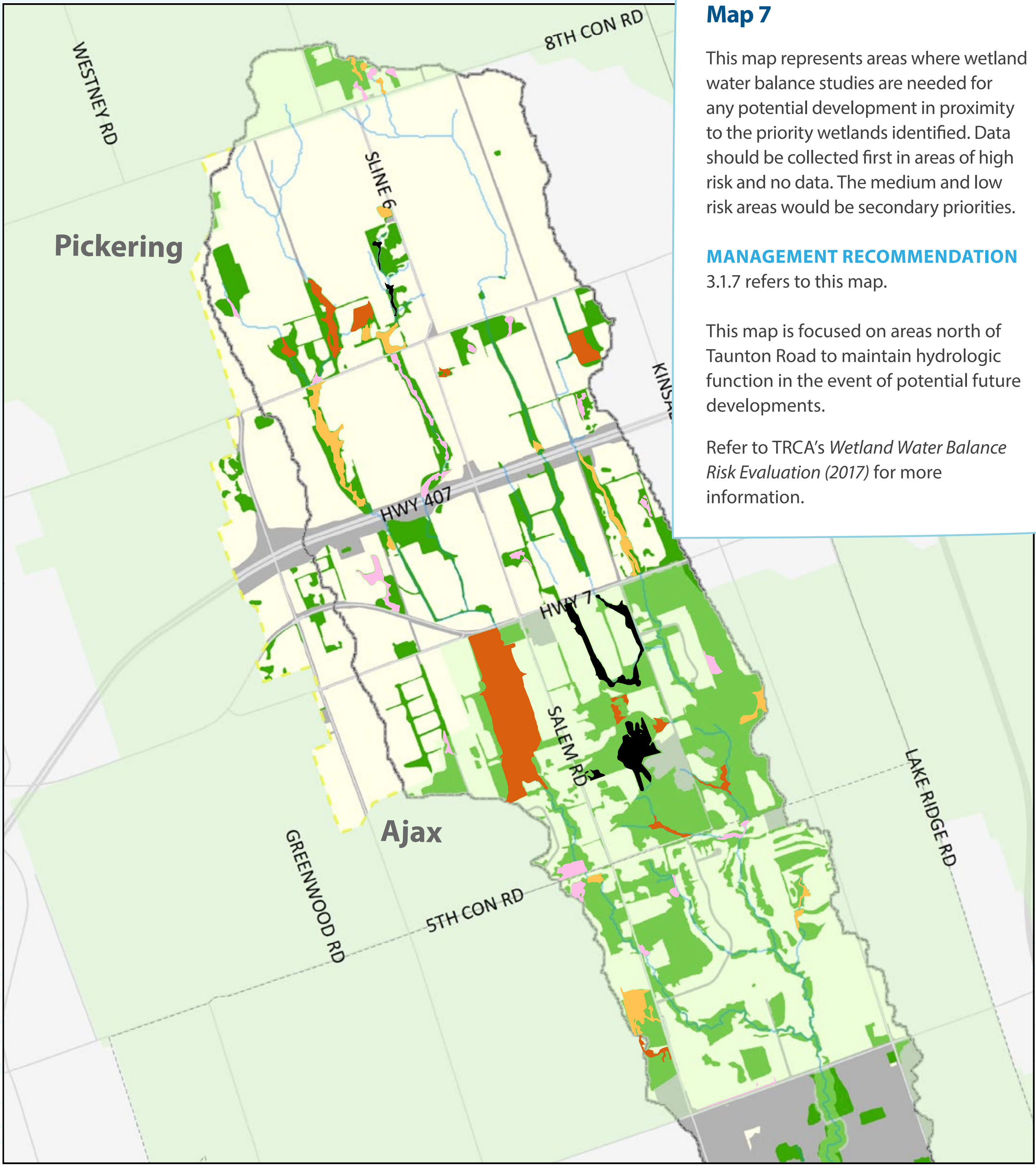
Map 7

This map represents areas where wetland water balance studies are needed for any potential development in proximity to the priority wetlands identified. Data should be collected first in areas of high risk and no data. The medium and low risk areas would be secondary priorities.

MANAGEMENT RECOMMENDATION
3.1.7 refers to this map.

This map is focused on areas north of Taunton Road to maintain hydrologic function in the event of potential future developments.

Refer to TRCA's *Wetland Water Balance Risk Evaluation (2017)* for more information.



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Carruthers Creek Watershed Plan: Wetland Water Balance Study Priorities

0 0.5 1 KM

Wetland Priorities*
- No Data
- High
- Medium
- Low
- Municipal Boundary
- Watercourse
- Greenbelt Boundary
- Carruthers Creek Watershed Boundary
- Carruthers Creek Watershed Plan Study Area

Land Use
- Natural
- Rural
- Urban

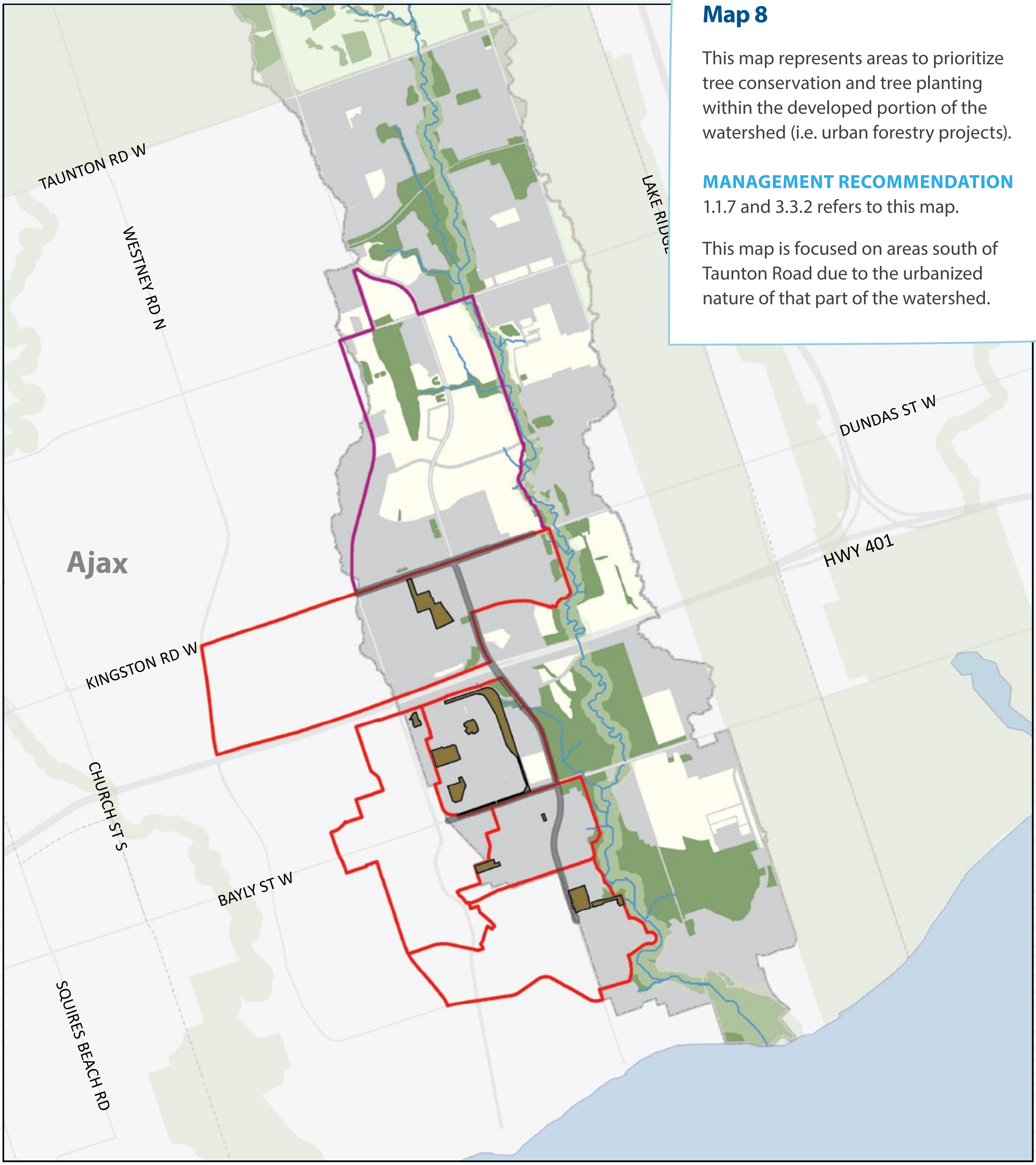
*Classifications based on TRCA Wetland Water Balance Risk Evaluation framework

Map 8

This map represents areas to prioritize tree conservation and tree planting within the developed portion of the watershed (i.e. urban forestry projects).

MANAGEMENT RECOMMENDATION
1.1.7 and 3.3.2 refers to this map.

This map is focused on areas south of Taunton Road due to the urbanized nature of that part of the watershed.



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Carruthers Creek Watershed Plan: Priority Urban Forestry Areas

0 0.25 0.5 1 KM

Road Priorities
Parks in Priority Neighbourhoods
Priority Conservation Neighbourhood
Priority Planting Neighbourhoods
Municipal Boundary
Watercourse
Greenbelt Boundary
Carruthers Creek Watershed Boundary
Carruthers Creek Watershed Plan Study Area

Land Use
Natural
Rural
Urban

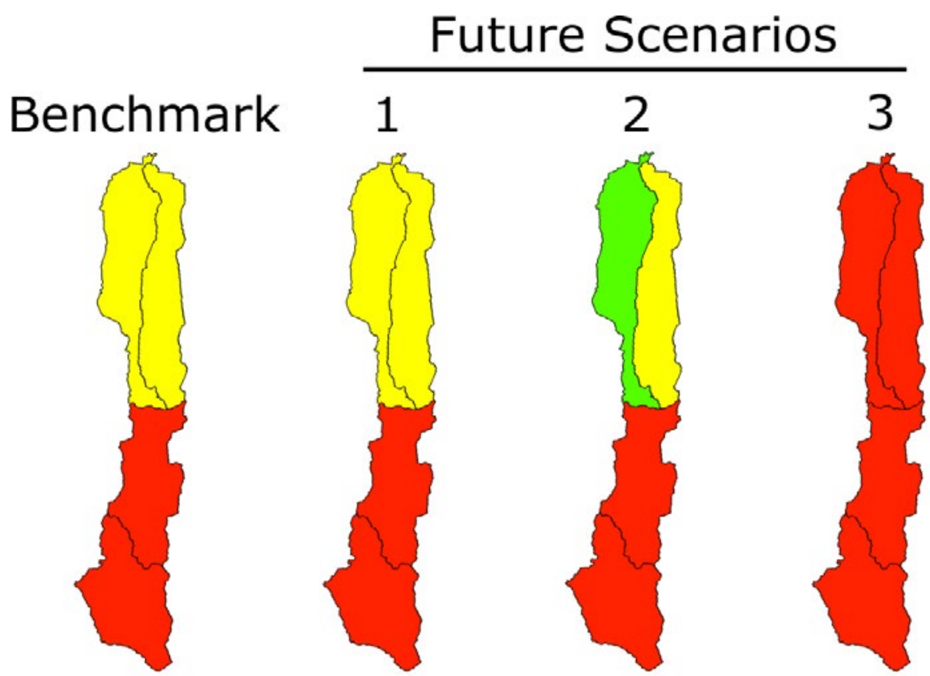

Figure 9

As discussed in **Table 4** for the aquatic health of the WRS, subwatershed quality was assessed based on impervious cover under the existing benchmark conditions and the three future scenarios. The proposed enhanced NHS benefits the aquatic ecosystem in scenario 2 where the north-west subwatershed improves from good – fair to good. The increase in impervious cover associated with scenario 3 results in all four subwatersheds degrading to fair – poor conditions, and will likely result in the loss of Redside Dace, a listed endangered species, within the Carruthers Creek watershed. Implementing the management recommendations identified in this watershed plan, especially limiting impervious cover and undertaking restoration activities will help Redside Dace habitat.

The rating scale for subwatershed quality is based on the amount of impervious cover, with:

- Good (green) = 0% to 10% imperviousness
- Good – fair (yellow) = 10% to 25% imperviousness
- Fair – poor (red) = greater than 25% imperviousness

Notes: the percent imperviousness identified in **Subsection 4.3** is for the entire watershed; while the subwatersheds may have different imperviousness values (e.g. Scenario 1 has 30% imperviousness across the entire watershed, whereas imperviousness by subwatershed is as follows: 10% north-west, 11% north-east, 53% central and 49% south).

See Aquatic Impact Assessment technical report for more information.

8. Glossary

Aquifer

A saturated permeable geologic unit that can transmit significant quantities of groundwater under ordinary hydraulic gradients. They can be classified as confined or unconfined. In southern Ontario, aquifers are typically comprised of sand and/or gravel, or fractured limestone.

Source: TRCA's Living City Policies, 2014

Biodiversity

The variability among organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species and ecosystems.

Source: TRCA's Living City Policies, 2014

Ecological Integrity

Which includes hydrologic integrity, means the condition of ecosystems in which,

a. the structure, composition and function of the ecosystems are unimpaired by stresses from human activity,
b. natural ecological processes are intact and self-sustaining,
c. the ecosystems evolve naturally.

Source: Greenbelt Plan, 2017

Ecosystem Services

The benefits provided by ecosystems that are critical to the environment's life support systems and that contribute to human welfare both directly and indirectly and therefore represent social and economic value.

Source: TRCA's Living City Policies, 2014

Green Infrastructure

Natural and human-made elements that provide ecological and hydrologic functions and processes. Green infrastructure can include components such as natural heritage features and systems, parklands, stormwater management systems, street trees, urban forests, natural channels, permeable surfaces, and green roofs.

Source: Growth Plan, 2020

Headwater Drainage Features

Ill-defined, non-permanently flowing drainage features that may not have defined beds and banks.

Source: TRCA's Living City Policies, 2014

Highly Vulnerable Aquifer

Aquifers, including lands above the aquifers, on which external sources have or are likely to have a significant adverse effect.

Source: Growth Plan, 2020

Hydrologic Function

The functions of the hydrologic cycle that include the occurrence, circulation, distribution and chemical and physical properties of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere, and water's interaction with the environment including its relation to living things.

Source: Growth Plan, 2020

Hydrogeology

A science that describes the movement of groundwater, and its interaction with water that moves on the ground surface in rivers, lakes, streams, and over land. Groundwater seeps into the ground to varying depths and collects in aquifers. Groundwater can remain stored underground for periods ranging from a few days to thousands of years.

Source: TRCA's Living City Policies, 2014

Hydrology

The engineering science that analyzes the different components of the hydrologic cycle, and takes into account that the natural cycle can be altered by human and natural activities.

Source: TRCA's Living City Policies, 2014

Life Science Areas of Natural and Scientific Interest (ANSIs)

An area that has been identified as having life science values related to protection, scientific study, or education; and further identified by the Ministry of Natural Resources and Forestry using evaluation procedures established by that Ministry, as amended from time to time.

Source: Growth Plan, 2020

Low Impact Development

An approach to stormwater management that seeks to manage rain and other precipitation as close as possible to where it falls to mitigate the impacts of increased runoff and stormwater pollution. It typically includes a set of site design strategies and distributed, small-scale structural practices to mimic the natural hydrology to the greatest extent possible through infiltration, evapotranspiration, harvesting, filtration, and detention of stormwater. Low impact development can include, for example: bio-swales, vegetated areas at the edge of paved surfaces, permeable pavement, rain gardens, green roofs, and exfiltration systems. Low impact development often employs vegetation and soil in its design, however, that does not always have to be the case and the specific form may vary considering local conditions and community character.

Source: Growth Plan, 2020

Natural Hazards *(Consisting of Erosion Hazard and Flooding Hazard)*

EROSION HAZARD

Means the loss of land, due to human or natural processes, that poses a threat to life and property.

FLOODING HAZARD

Means the inundation of areas adjacent to a shoreline or a river or stream system not ordinarily covered by water.

Source: PPS, 2020

Natural Heritage System

A system made up of natural heritage features and areas, and linkages intended to provide connectivity (at the regional or site level) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species, and ecosystems. The system can include key natural heritage features, key hydrologic features, federal and provincial parks and conservation reserves, other natural heritage features and areas, lands that have been restored or have the potential to be restored to a natural state, associated areas that support hydrologic functions, and working landscapes that enable ecological functions to continue.

Source: Growth Plan, 2020

Negative Impacts

Means:

a. in regard to policy 1.6.6.4 and 1.6.6.5 degradation to the quality and quantity of water, sensitive surface water features and sensitive ground water features, and their related hydrologic functions, due to single, multiple or successive development.

b. in regard to policy 2.2, degradation to the quality and quantity of water, sensitive surface water features and sensitive ground water features, and their related hydrologic functions, due to single, multiple or successive development or site alteration activities;
c. in regard to fish habitat, any permanent alteration to, or destruction of fish habitat, except where, in conjunction with the appropriate authorities, it has been authorized under the Fisheries Act; and
d. in regard to other natural heritage features and areas, degradation that threatens the health and integrity of the natural features or ecological functions for which an area is identified due to single, multiple or successive development or site alteration activities.

Source: PPS, 2020

Regional (flood) Control

Stormwater management control of flood flows from the regional storm event (Hurricane Hazel) to mitigate increases in flood risk associated with development (urbanization).

Source: TRCA's Living City Policies, 2014

Riparian

The areas adjacent to water bodies such as streams, wetlands and shorelines. Riparian areas form transitional zones between aquatic and terrestrial ecosystems.

Source: TRCA's Living City Policies, 2014

Seepage Areas and Springs

Sites of emergence of groundwater where the water table is present at the ground surface.

Source: Growth Plan, 2020

Significant Groundwater Recharge Area

An area that has been identified:
a. as a significant groundwater recharge area by any public body for the purposes of implementing the PPS, 2014;
b. as a significant groundwater recharge area in the assessment report required under the Clean Water Act, 2006; or
c. as an ecologically significant groundwater recharge area delineated in a subwatershed plan or equivalent in accordance with provincial guidelines.

For the purposes of this definition, ecologically significant groundwater recharge areas are areas of land that are responsible for replenishing groundwater systems that directly support sensitive areas like cold water streams and wetlands.

Source: Growth Plan, 2020

Sustainable Community Retrofits

Focus on actions in older, urban neighbourhoods by retrofitting buildings and infrastructure, regenerating habitats and urban ecology, and revitalizing a community's social fabric. TRCA's Sustainable Neighbourhood Action Program provides examples of sustainable community retrofits.

Source: Sustainable Neighbourhood Action Program, TRCA, 2020

Urban Forest

All trees, shrubs and understorey plants, as well as the soils that sustain them, on public and private property within an urban setting.

Source: TRCA's Living City Policies, 2014

Vegetation Protection Zone

A vegetated buffer area surrounding a key natural heritage feature or key hydrologic feature.

Source: Growth Plan, 2020

Water Balance

The hydrologic cycle of precipitation, groundwater infiltration, evapotranspiration (into the atmosphere and by plant interception), and surface runoff. .

Source: TRCA's Living City Policies, 2014

Water Resource System

A system consisting of ground water features and areas and surface water features (including shoreline areas), and hydrologic functions, which provide the water resources necessary to sustain healthy aquatic and terrestrial ecosystems and human water consumption. The water resource system will comprise key hydrologic features and key hydrologic areas.

Source: Growth Plan, 2020

9. References

Carruthers Creek Watershed Characterization Technical Reports

Dr. Richard Gerber and Mike Doughty, Oak Ridges Moraine Groundwater Program, 2017. *Carruthers Creek Watershed Plan: Hydrogeology.* Prepared for the Toronto and Region Conservation Authority and the Region of Durham.

Matrix Solutions Inc., 2017. *Carruthers Creek Watershed Plan: Fluvial Geomorphology Assessment of Regional Watershed Monitoring Program Data 2003 – 2016*. Prepared for the Toronto and Region Conservation Authority and the Region of Durham.

Toronto and Region Conservation Authority, 2017. *Carruthers Creek Watershed Plan: Aquatic Crossing and Barrier Assessment Report.* Prepared for the Region of Durham.

Toronto and Region Conservation Authority, 2017. *Carruthers Creek Watershed Plan: Aquatic Habitat and Community Characterization.* Prepared for the Region of Durham.

Toronto and Region Conservation Authority, 2017. *Carruthers Creek Watershed Plan: Headwater Drainage Features Characterization.* Prepared for the Region of Durham.

Toronto and Region Conservation Authority, 2017. *Carruthers Creek Watershed Plan: Preliminary Water Quantity Characterization.* Prepared for the Region of Durham.

Toronto and Region Conservation Authority, 2018. *Carruthers Creek Watershed Plan: Water Quantity Characterization*. Prepared for the Region of Durham.

Toronto and Region Conservation Authority, 2017. *Carruthers Creek Watershed Plan: Surface Water Quality Characterization*. Prepared for the Region of Durham.

Toronto and Region Conservation Authority, 2017. *Carruthers Creek Watershed Plan: Terrestrial Biological Inventory and Assessment.* Prepared for the Region of Durham.

Carruthers Creek Watershed Scenario Analysis Technical Reports

Matrix Solutions Inc., 2019. *Carruthers Creek Watershed Plan: Fluvial Geomorphic Assessment.* Prepared for the Toronto and Region Conservation Authority and the Region of Durham.

Oak Ridges Moraine Groundwater Program, 2019. *Carruthers Creek Watershed Plan: Groundwater Modelling*. Prepared for the Toronto and Region Conservation Authority and the Region of Durham.

Toronto and Region Conservation Authority and Environment and Climate Change Canada, 2019. *Carruthers Creek Watershed Plan: Soil Water Assessment Tool (SWAT) Modelling*. Prepared for the Region of Durham.

Toronto and Region Conservation Authority, 2019. *Carruthers Creek Watershed Plan: Aquatic Impact Assessment*. Prepared for the Region of Durham.

Toronto and Region Conservation Authority, 2019. *Carruthers Creek Watershed Plan: Stormwater Management*. Prepared for the Region of Durham.

Toronto and Region Conservation Authority, 2019. Carruthers Creek Watershed Plan: Hydrological Assessment. Prepared for the Region of Durham.

Toronto and Region Conservation Authority, 2019. *Carruthers Creek Watershed Plan: Terrestrial Impact Assessment*. Prepared for the Region of Durham.

Toronto and Region Conservation Authority, 2019. *Carruthers Creek Watershed Plan: Urban Forest Assessment*. Prepared for the Region of Durham.

Provincial / Federal Policies / Plans / Guidance

Canadian Council of Ministers of the Environment, no date. *Water Quality Guidelines for the Protection of Aquatic Life*.

CTC Source Protection Committee, 2019. *Approved Source Protection Plan: CTC Source Protection Region*. Amendment (Version 2.0) effective March 25, 2019.

Environment and Climate Change Canada, 2013. *How Much Habitat is Enough?* Third Edition.

Ontario, 2019. *A Place to Grow: Growth Plan for the Greater Golden Horseshoe.*

Ontario, 2017. *Greenbelt Plan.*

Ontario, 2016. *Guidance for Development Activities in Redside Dace Protected Habitat.*

Ontario, 2016. *Water Management: Policies, Guidelines, Provincial Water Quality Objectives*

Ontario, 2014. *Provincial Policy Statement. Under the Planning Act.*

Great Lakes Agreements and Policiess

Government of Canada and Government of Ontario, 2014. *Canada – Ontario Agreement on Great Lakes Water Quality and Ecosystem Health.*

Government of Canada and Government of the United States of America, 2012. *Great Lakes Water Quality Agreement.*

Ontario, 2016. *Ontario's Great Lakes Strategy.*

Municipal Official Plans

City of Pickering, 2018. *Pickering Official Plan: Edition 8.*

Region of Durham, 2017. *2017 Durham Regional Official Plan*

Town of Ajax, 2016. *Official Plan.*

Municipal Guidelines, Reports or Strategies

Cole Engineering, 2012. *Carruthers Creek Flood Management and Analysis EA*. Regional Official Plan Amendment No. 128 Impact Report. Prepared for the Town of Ajax.

Region of Durham, 2016. *Towards Resilience: Durham Community Climate Adaptation Plan 2016.*

Region of Durham, 2012. *From Vision to Action: Region of Durham Community Climate Change Local Action Plan 2012.*

TRCA Guidelines

Credit Valley Conservation and Toronto and Region Conservation Authority, 2014. *Evaluation, Classification and Management of Headwater Drainage Features Guidelines.*

Credit Valley Conservation and Toronto and Region Conservation Authority, 2010. *Low Impact Development Stormwater Management Planning and Design Guide.*

Toronto and Region Conservation Authority, 2018. *Guideline for Determining Ecosystem Compensation (after the decision to compensate has been made).*

Toronto and Region Conservation Authority, 2017. *Wetland Water Balance Risk Evaluation.*

Toronto and Region Conservation Authority, 2016. Integrated Restoration Prioritization: *A Multiple Benefit Approach to Restoration Planning.*

Toronto and Region Conservation Authority, 2016. *Wetland Water Balance Monitoring Protocol.*

Toronto and Region Conservation Authority, 2015. *Crossings Guideline for Valley and Stream Corridors.*

Toronto and Region Conservation Authority, 2014. *The Living City Policies: for Planning and Development in the Watersheds of the Toronto and Region Conservation Authority.*

Toronto and Region Conservation Authority, 2012. *Preserving and Restoring Healthy Soil: Best Practices for Urban Construction.*

Toronto and Region Conservation Authority, 2012. *Stormwater Management Criteria.*

Toronto and Region Conservation Authority, 2007. *Terrestrial Natural Heritage System Strategy.*

Developed in collaboration with
the **Town of Ajax** and **City of Pickering**

DURHAM REGION

Toronto and Region Conservation Authority

Toronto and Region Conservation Authority

Public Review of Draft

Carruthers Creek Watershed Plan

Comment Submissions Summary

May, 2021

Contents

1. INTRODUCTION

This report provides a summary of all the submissions from the public review comment period on the draft Carruthers Creek Watershed Plan (CCWP).

The draft CCWP was released for public review on March 13, 2020 for an expected 90-day review period. On April 8, 2020, at a special meeting of the Regional Council of Durham, the public comment period was paused until the Covid-19 emergency state was lifted. On December 16, 2020, staff were authorized to resume public engagement on the draft CCWP with the public review period closing March 19, 2021. Two virtual open houses were held in February 2021 on the draft CCWP (see Consultation Summary – February 2021).

In addition to the questions asked and positions made by attendees at the two virtual open houses, a total of 27 public submissions were received on the draft CCWP. A further 182 email submissions were provided to the Region of Durham via an Environmental Defence email campaign (See **Appendix A** for the wording of the email submission and response provided by the Region of Durham).

TRCA regularly communicated project updates through the project subscribers list, social media, municipal channels, a newspaper ad, and direct mailouts, to raise awareness of the virtual open houses and to advise the public of the opportunity to review and comment on the draft CCWP.

2. PUBLIC REVIEW SUBMISSIONS SUMMARY

During the public review period of the draft CCWP, submissions were received using the online comment form (19), direct email/letter submission (6), and through municipal Council processes (2).

The online comment form allowed respondents to rate the draft CCWP based on three questions in addition to allowing specific comments on sections of the plan. See **Table 1** for the ratings received. Not all respondents who used the online comment form answered these questions.

TABLE 1 - RATING QUESTIONS SUMMARY

	How would you rate the draft plan structure, length, organization on a scale of 1 to 5, where 1 equals "poor" and 5 equals "excellent"?	**Is the information presented clearly and concisely? Please provide a rating on a scale of 1 to 5, where 1 equals "not at all clear and concise" and 5 equals "very clear and concise".**	**Do you support the goals, objectives, indicators and management recommendations in the draft plan? Please provide a rating on a scale of 1 to 5, where 1 equals "strongly opposed" and 5 equals "strongly supportive".**
Average Rating	4	4	4
Note: 13 submissions answered each of these questions.			

2.1 Online Submissions

Submissions using the online comment form were also able to provide general or section-specific comments, which are presented in **Table 2**. The table provides details such as the name of the individual making the submission (if provided), a summary of the comments made, and any response/changes to the CCWP as a result of the comments. Comments are presented in no particular order. Note that not all comments are included as some were outside the scope of the watershed plan. These comments included specific questions about property issues that were directly responded to by TRCA.

TABLE 2 - FEEDBACK FROM ONLINE COMMENT FORMS

Section	Comments	Changes to CCWP (If applicable) / Response to Comments
General Comments	**No Name Provided** The plan is excellent to protect and monitor the health of the watershed. To have a healthy watershed, you must stop contaminants, before they need to be cleaned up!! Durham Region needs to have a better collection system, to prevent material (i.e. waste) from entering the watershed.	Comments noted.
	No Name Provided Protect the headwaters to build resiliency against climate change.	Comments noted.
	W. Parish Development of the Rouge headwaters in Richmond Hill has led to wide scale high water events that damage property and the aquatic ecosystem. Ajax will face the same issues if the headwaters are not protected and if flood control measures are not put in place. This will increase the costs to municipalities through flooding, erosion, and reduced water quality.	Comments noted. Subsection 5.4 of the CCWP identifies the studies that would be required in the event of a Settlement Area Boundary Expansion in the headwaters of Carruthers Creek.
	S. Roche The plan offers a compelling overview of the current situation and need for action to manage and maintain this watershed. The report is very well laid out. It offers a useful introduction to the many technical terms and methodological approaches used in such a comprehensive assessment and provides a thoughtful layout of the recommended actions and responses to the considerable growth and changes in Durham Region. Overall, a well written and carefully prepared report that gives	Comments noted.

Section	Comments	Changes to CCWP (If applicable) / Response to Comments
	me confidence that ecosystem health, riparian management, water quality and quantity, and regional conservation are important priorities for Durham Region.	
	A. Wilton Although the watershed is small, there are a number of significant natural heritage features. This includes coastal wetlands. Increasing forest size is important for certain species. It is good to develop these plans to help determine priorities for conservation and restoration.	Comments noted.
	M. Pileggi Great work. Very clear and concise. Watershed plan shows the importance of protecting the headwaters of Carruthers Creek.	Comments noted.
	G. Lenders Excellent, very well-organized plan of action. The watershed plan exemplifies the utmost importance of protecting, enhancing and restoring the health of the headwaters of Carruthers Creek.	Comments noted.
	B. Murphy Everything in our power should be done to protect natural features especially watersheds and biodiversity. Any scenario that reduces these should not be considered.	Comments noted.
	M. Oates Please object to the Town of Pickering pushing through their plan to build on the Carruthers Creek watershed without adequate public info or meetings. Shame on Pickering!	Comments noted.
	No Name Provided You have to stop allowing our ecosystems and greenspace to be ruined.	Comments noted.
	D. McLaughlin The intentions of the CCWP seem to be good, but there are some deficiencies to be addressed. Climate change considerations appear to be factored in, but according to reports from a number of credible sources (numerous articles provided), climate models have gravely underestimated the pace of climate change. Consequently, the analyses and	The purpose of scenario modelling is to evaluate a range of potential future outcomes and measure the associated impacts on the watershed. This allows for the

<table>
<tr><th>Section</th><th>Comments</th><th>Changes to CCWP (If applicable) / Response to Comments</th></tr>
<tr><td></td><td>recommendations of the CCWP are inadequate due to the conservative bias of the climate models.

Concern that the good intentions of the watershed plans can be superseded by the decision-making powers of political entities involved in land use planning and development (e.g. little progress made from previous plan, continuing losses of natural cover).

Another area of concern is chlorides, which will be exacerbated by any further urban expansion.

Due to these concerns, here are some recommendations:
• Highest priority should be given to protecting and expanding the natural heritage and water resources
• The three scenarios detailed in the CCWP should be scrapped
• A new, sole scenario should replace those scenarios and include the following objectives:
    ○ Prohibit any new urban or agricultural expansion north of Taunton Road,
    ○ Pursue efforts to enhance and expand the Natural Heritage System (NHS) and Water Resource System (WRS) beyond that described in the CCWP. To that purpose, acquire all relevant properties as they become available, and
    ○ Conservation authorities, not susceptible to pressure from politicians and the development industry should have the power to veto any plans or developments that adversely impact watersheds.</td><td>development of appropriate management recommendations so that the health and integrity of the watershed can be maintained and improved under a range of future scenarios.

The mandate of conservation authorities is governed by the Conservation Authorities Act.

The CCWP places high priority on protecting the NHS and WRS (Goal 2 and 3). The CCWP places significant emphasis on protecting, enhancing, and restoring both the WRS and NHS by:
• recommending policies,
• identifying enhancement areas, and
• identifying priority restoration and public land securement sites.

The development of the CCWP has been a collaborative effort between TRCA, the Region of Durham, City of Pickering, and Town of Ajax.</td></tr>
</table>

Section	Comments	Changes to CCWP (If applicable) / Response to Comments
	J. Longo Greater value needs to be given to our natural areas. I appreciate the quality of work the conservation authorities engage in and would like to support them further. Let's see less minimum standards and more maximization of our natural areas. There needs to be a cost for the destruction poor planning creates that does not fall on taxpayers. In light of recent reporting on the limitations placed on the TRCA by the provincial government, I am concerned that municipalities might choose to limit the involvement of the TRCA. For instance, the Veraine development in the northern end of the watershed makes me worry that Pickering will try to do something like they are doing with the Duffins Creek watershed. I would also like to lend my support to TRCA and their function of managing flooding and preserving/enhancing the natural heritage, wildlife, and water quality of the watershed.	The CCWP encourages increases to natural areas through enhancements, restoration, and public land securement. There are management recommendations to improve development standards and encourage the use of green infrastructure under Goal 1. Subsection 5.4 of the CCWP identifies the studies that would be required in the event of a Settlement Area Boundary Expansion in the headwaters of Carruthers Creek.
	C. Pryce I just want to show my support to protect the watershed from development. Protecting wildlife biodiversity and preparing for the results of climate change is of the utmost importance to me.	Comments noted.
Executive Summary	**S. Roche** It might be useful to add a few more comments about the recommended actions for policymakers. This will ensure that those that do not read the full document still have a sense of the key actions.	The Executive Summary has been updated to highlight some key components of the management framework.
Section 4: Future Watershed Conditions	**S. Roche** I think this section is nicely laid out and presents a strong framework for decision-making regarding the strategies that make Scenarios 1 through 3 reality. One minor suggestion might be to categorize the Summary of Implications section by Scenario, providing a summary statement of how well each scenario performs, and then the specific comments pertaining	The summary of implications has been updated to provide a summary statement per scenario in relation to the key issues of: WRS, NHS,

Section	Comments	Changes to CCWP (If applicable) / Response to Comments
	to each. As a reader not having reviewed this content before, I naturally wanted to see a breakdown of the overall effects by scenario, which followed the table format.	water quality, and natural hazards.

2.2 Letter Submissions

In addition to submissions using the online comment form, six letters were directly submitted to TRCA. **Table 3** provides the name of the individual or group that submitted the letter, a general summary of the comments received, and any response/changes to the CCWP as a result of the comments. Comments are presented in no particular order.

TABLE 3 - SUMMARY OF LETTER SUBMISSION COMMENTS

Comments	Changes to CCWP (If applicable) / Response to Comments
S. Parish	
Engagement Process Concern that the online comment form is not designed to get meaningful input and that Covid-19 will prevent meaningful engagement.	The online comment form included rating questions and allowed for detailed comments for each section of the plan. The draft CCWP was publicly released on March 13, 2020. The originally planned April 30, 2020 open house was cancelled due to the Covid-19 pandemic. Two virtual open houses were held in February 2021, with comments due March 19, 2021. A Consultation Summary of the Public Review of Draft Carruthers Creek Watershed Plan is available. A total of 134 individuals attended the virtual open houses held in February 2021, compared to approximately 50 individuals that intended the in-person open houses in Ajax and Pickering on the draft management framework in October 2019.
Implications of Headwater Development Concern regarding the implications of scenario 3 (headwater urbanization) to the Water Resource System and natural hazards (i.e. flooding). The plan talks about mitigation using green development policies and low impact development techniques but does not quantify the costs of any development to	As noted in the draft CCWP, scenario analysis does not result in decisions about the type and configuration of land uses. The Region of Durham is currently undertaking its Municipal Comprehensive Review, which will determine whether there is a need for any Settlement Area Boundary Expansions. In the event that a Settlement Area Boundary Expansion is

Comments	Changes to CCWP (If applicable) / Response to Comments
taxpayers of Ajax. Urges TRCA to recommend against scenario 3 clearly and unequivocally.	approved for the lands in northeast Pickering (i.e. Carruthers Creek headwaters), the management recommendations outlined in subsection 5.4 of the CCWP would apply. These recommendations outline the types of studies that would need to occur if development is approved. The issue of funding the appropriate flood mitigation has been added to the relevant management recommendation.
Ontario Headwaters Institute	
Comment Review Process Concern that public comments will not be transparently handled and addressed. Suggests that members of the public should be part of the review team.	TRCA has consistently posted consultation summaries on the project webpage at each stage of this watershed planning process. This document serves as the record oF comments received during the public review of the draft CCWP and how the comments are being addressed. The Region of Durham is including this record as part of its report to Committee and Council.
Evans Planning on behalf of Pinebrown Salem Lands Ltd.	
Scenario 3 Land Use Designation Concern that lands at the south-east corner of Salem Road and Seventh Concession are designated as a natural area under Scenario 3. Given that the subject lands were previously identified as a Regional Centre in the previous draft of the Region of Durham Official Plan, it is anticipated that these lands will be incorporated into the urban boundary through the Region's current Municipal Comprehensive Review process. The subject lands do not contain any significant environmental features. The Natural Area land use designation should be removed.	The subject lands are identified as "potential" natural cover in the recommended NHS. These areas are recommended for restoration to build resilience into the NHS. The recommended NHS uses the latest data, science, and modelling approaches to: • increase natural cover to a sufficient quantity, • protect natural system quality, • protect biodiversity, and • manage climate vulnerabilities. The subject lands abut existing natural cover. An enhanced NHS has benefits for water quality, the aquatic system, and can reduce the amount of runoff through increased retention and infiltration. At this time, no decision has been made by the Region of Durham through the Municipal Comprehensive Review process for a Settlement Area Boundary Expansion in northeast Pickering.

Comments	Changes to CCWP (If applicable) / Response to Comments
Scenario Analysis Implications – Water Resource System and Natural Hazards The usage of engineered porous surfaces (LIDs) and other engineered solutions to stormwater runoff are not considered. As a result, the estimated impacts for scenarios 2 and 3 appear to be inflated and do not reflect the reality of modern development. A conventional stormwater management pond can aid in achieving necessary flood control within future urban areas.	The following updates have been made to the CCWP: • Text has been added to Table 3 to explain the assumptions made in Scenario 3 and the appropriate stage of the planning process for detailed assessment of mitigation options. • Text has been added to Subsection 4.3 elaborating on potential mitigation strategies. • The percent change associated with each scenario for the natural hazards has been modified to show change at both Taunton and Shoal Point Roads for the Regional Storm rather than an average. Text has been added explaining what the Regional Storm and 5-years storm mean. Additionally, a footnote has been added to explain that the modelling for the Regional Storm assumes existing stormwater management facilities fail or at capacity. As a result, the numbers for peak flows would not change for the Regional Storm since a conventional stormwater management pond cannot accommodate this storm event. • The summary of implications at the end of Subsection 4.3 have been clarified, connecting them to the appropriate management recommendations (e.g. Subsection 5.4 for further studies in the event of headwater development). Subsection 5.4 of the CCWP identifies the studies that would be required in the event of a Settlement Area Boundary Expansion in the headwaters of Carruthers Creek. It is at those detailed planning stages where decisions on engineering solutions would be made.
Scenario Analysis Implications – Natural Heritage System The NHS scenario analysis did not take into consideration parkland dedication within potential development lands. Parkland size and shape can	Parkland is a different land use that is not consistent with the natural heritage features and areas that comprise the NHS. For example, parkland can refer to open fields, recreation spaces (e.g. tennis courts),

Comments	Changes to CCWP (If applicable) / Response to Comments
positively influence and contribute to the NHS providing for natural habitat connectivity, preservation of core features and provide buffers between land uses.	or community centres, which are not compatible with the NHS goal and objectives. Currently the subject lands are not within the urban boundary. Due to this, there were no specific parkland locations or sizes to model. Opportunities to protect, enhance, and restore natural heritage features and areas would be considered at the appropriate planning stage if this were to change, including parkland as a potential buffer between land uses.
Tile Drainage Conversion of agricultural lands, removal of tile drainage and replacement by modern stormwater infrastructure and green infrastructure would reduce the estimated risk of flooding and erosion.	Currently the subject lands are not within the urban boundary. Mitigation strategies supported by science would be identified at the appropriate planning stage if this changes.
Conclusion We found the Authority's recommendations within the Draft Watershed Plan to be concerning, with lack of consideration for modern, green, and engineered infrastructure. As a result, estimated impacts appear to be inflated and do not reflect the reality of modern development. The subject lands are within the Region's "whitebelt" lands and are poised for future urban development given their strategic location at the intersection of Salem Road and Seventh Concession Road. The lands do not contain any significant environmental features and the sterilization of these lands is not appropriate and unnecessary.	The draft CCWP and its recommendations were developed in collaboration with municipal partners. Goal 1 and its associated objectives and management recommendations relate to improved land use and infrastructure development patterns, including low impact development, green infrastructure, and improved stormwater management. Currently the subject lands are not within the urban boundary and no decision has been made on a Settlement Area Boundary Expansion. The findings of the hydrology assessment are consistent with the previous Cole study completed in 2011. One of the key purposes of the CCWP was to demonstrate the potential implications of future development on the watershed, so that the level of impact that needs to be mitigated is clear. It will be up to proponents of future development to identify how that impact will be mitigated at the appropriate planning stage. Refer to previous response on the purpose of the NHS.

<table>
<tr><th>Comments</th><th>Changes to CCWP (If applicable) / Response to Comments</th></tr>
<tr><td colspan="2">Ontario Nature, Environmental Defence, Land Over Landings, Environmental Action Now Ajax - Pickering</td></tr>
<tr><td>Vision and Goals
Congratulations on the thoroughly researched and expertly presented draft plan that you have developed for the Carruthers Creek Watershed. We fully support its vision and the three goals for land use, the WRS, and the NHS.</td><td>Comments noted.</td></tr>
<tr><td>Concluding Remarks
Looking across the three scenarios, it is evident that only scenario 2 supports the goals of protecting, enhancing, and restoring water quality, the water resource and natural heritage systems. Scenario 3, which assumes development in the headwaters, would lead to a decline in watershed health across the board. The Planning Team should include concluding remarks related to the adverse impacts of urbanization on the headwaters of Carruthers Creek.</td><td>The summary of implications in the CCWP has been updated to better communicate the implications of each scenario and what that means.
As noted in the draft CCWP, scenario analysis does not result in decisions about the type and configuration of land uses. The management framework in section 5 of the CCWP is designed to address existing watershed issues and the implications of the potential future scenarios to help inform land use planning decisions.</td></tr>
<tr><td colspan="2">North East Pickering Landowners Group Inc. (NEPLG) – See Appendix B for Comments on Technical Reports</td></tr>
<tr><td>Recommended Natural Heritage System
During public engagement, TRCA staff noted that there will be opportunities to refine the proposed NHS with appropriate scientific justification that meets the goals and objectives of the Watershed Plan. The CCWP should be revised to include the following wording: “opportunity for refinement of the NHS would be possible with appropriate scientific justification that still meets the targets and objectives of the Watershed Plan.”
There is no mention in the management recommendations that the exact size and configuration of the NHS could fluctuate based on the required future studies. It is requested that Map 2 include wording in this regard as well.</td><td>Text has been added to the introduction to Goal 3 and map 2 to address this comment.
Management recommendation 3.1.1 has been updated to elaborate on the role of the Region of Durham to provide direction to lower-tier municipalities on the designation of a NHS within lower-tier Official Plans.
Language has been added to the management recommendation to distinguish between the need to protect existing natural cover as identified in map 2 and having policies to identify enhancement and restoration opportunities for potential natural cover areas as identified in map 2.</td></tr>
<tr><td>Future Management Scenarios
Concern that Scenario 2 and 3 are unrealistic scenarios because:</td><td>The scope of the scenarios as presented in the draft CCWP was developed by TRCA in collaboration with its municipal partners.</td></tr>
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<tr><th>Comments</th><th>Changes to CCWP (If applicable) / Response to Comments</th></tr>
<tr><td>Scenario 2 assumes that existing rural community will voluntarily set aside significant portions of their agricultural operations for the creation of an enhanced NHS
Scenario 3 is unrealistic as unmitigated development is not allowed given minimum watershed management mitigation and protection requirements. Modelled as unmitigated, the 77% increase in downstream flooding on page 38 is misleading and paints a negative picture related to future development, and is not consistent with overall provincial policy.
Scenario 3 is not permitted based on provincial policy.</td><td>For scenario 2, the design of the enhanced NHS was based on objectives to:
increase natural cover to a sufficient quantity,
protect natural system quality,
protect biodiversity, and
manage climate vulnerabilities.
These objectives test the benefits of an enhanced NHS. An enhanced NHS has benefits for water quality, the aquatic system, and can reduce the amount of runoff through increased retention and infiltration.

Under Goal 1, objective 4 recognizes the need to work with the agricultural community on rural land stewardship. In the event that urbanization does not occur within the headwaters, TRCA would use the enhanced NHS to identify opportunities with rural land owners (e.g. incentive programs, grants, etc.).

The flooding results cited (77%) represent an average of two points in the watershed for the Regional Storm (i.e. Hurricane Hazel). As noted in the Hydrological Assessment Technical Report, existing stormwater management facilities were removed from the model to account for the system failing or being at capacity during the Regional Storm event. Subsection 5.4 of the draft CCWP addresses additional studies that would be needed to identify appropriate mitigation measures in the event of future development based on more detailed planning applications.

The findings of the hydrology assessment are consistent with the previous Cole study completed in 2011. One of the key purposes of the CCWP was to demonstrate the potential implications of future development on the watershed, so that the level of impact that needs to be mitigated is clear. It will be up to proponents of future development to identify</td></tr>
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<table>
<tr><th>Comments</th><th>Changes to CCWP (If applicable) / Response to Comments</th></tr>
<tr><td></td><td>how that impact will be mitigated at the appropriate planning stage, in accordance with provincial policy.
The following updates have been made to the CCWP in relation to the comments:
Text has been added to Table 3 to explain the assumptions made in Scenario 3 and the appropriate stage of the planning process for detailed assessment of mitigation options,
Text has been added to Subsection 4.3 elaborating on the potential mitigation strategies,
The percent change associated with each scenario for the natural hazards has been modified to show change at both Taunton and Shoal Point Roads for the Regional Storm rather than an average. Text has been added explaining what the Regional Storm and 5-years storm mean. Additionally, a footnote has been added to explain that the modelling for the Regional Storm assumes existing stormwater management facilities fail or at capacity, and
The summary of implications at the end of Subsection 4.3 have been clarified, connecting them to the appropriate management recommendations (e.g. Subsection 5.4 for further studies in the event of headwater development).</td></tr>
<tr><td>Enhanced Natural Heritage System
Scenario 2 and 3 include an enhanced NHS that is also the TRCA recommended enhanced NHS (map 2) to achieve the third goal. While the NEPLG is committed to the goals within the CCWP, the recommended NHS is misleading as it is the only measure to increase diversity and mitigate the impacts of development (Scenario 3).
CCWP makes recommendations for linkage corridors that are consistent with the size and</td><td>Provincial policies, including the definition of the NHS, recognize the importance of regional and site-scale connectivity as part of natural heritage system planning.
The recommended NHS uses the latest science and practices in natural systems planning. The recommended NHS represents a realistic and attainable system for this urbanizing watershed that is more consistent with federal guidance on how much habitat is necessary to maintain ecological functions and biodiversity.</td></tr>
</table>

Comments	Changes to CCWP (If applicable) / Response to Comments
scale of Regional Corridors (500m or more in width). However, these Regional Corridors have already been established through the Greater Golden Horseshoe NHS system and include the Duffins Creek and Iroquois Shoreline. Local connectivity to these systems will likely require smaller corridors that are more consistent with the existing watercourses.	The referenced recommended corridor widths are minimums. The recommended enhanced NHS is about improving connectivity and building long-term resilience to the potential impacts of future growth and climate change.
Regional Planning The use of the CCWP in the land use planning process needs to be clarified, and significant adjustments made if the intent is that the Region will use this work to update its Official Plan. If this is the case, the work will be used as a land use planning exercise and must be prepared in the context of overall good planning and the public interest. A scenario must be included which assumes full inclusion of northeast Pickering within a settlement area. So as not to preclude the appropriate development of this area, the form and size of the NHS should be appropriately balanced with the overall land use planning objectives of the Provincial Policy Statement and the Growth Plan for the Greater Golden Horseshoe, such as the need to provide for compact and connected communities, viable employment areas, walkability and transit supportive development, and the cost effective and efficient extension of infrastructure. This will typically result in a feature-based NHS with limited linkage areas and a heavier reliance on green infrastructure to support natural processes. In particular, the onus is upon the Region to implement, and where appropriate refine the provincial mapping of the NHS for the Growth Plan at the time of initial implementation in their official plan. If the work prepared by the TRCA will be used by the Region to update/refine the NHS in northeast Pickering, then this work must occur within, and not outside of the overall MCR process.	Scenario 3 assumes development in northeast Pickering. Provincial policies recognize the integrated nature of natural heritage and water resource systems, and recognize the watershed as the meaningful ecological scale for long-term planning (PPS 2.2.1, Growth Plan 4.2.1 and 4.2.2). PPS policy 2.1.2 states: The diversity and connectivity of natural features in an area, and the long-term ecological function and biodiversity of natural heritage systems, should be maintained, restored or, where possible, improved, recognizing linkages between and among natural heritage features and areas, surface water features and ground water features. The methods utilized to develop the enhanced NHS as part of the CCWP are consistent with the provincial policy framework, which encourages a systems-based approach. The watershed plan is one of many studies and factors that the Region of Durham will need to consider as part of its Municipal Comprehensive Review. The identification of an “enhanced” or “targeted” NHS is standard practice in contemporary watershed planning exercises. The Region of Durham is considering how to appropriately implement Natural Heritage Systems, including the recognition of enhanced/targeted components through the

Comments	Changes to CCWP (If applicable) / Response to Comments
	Municipal Comprehensive Review process. It is acknowledged that the policy treatment for "enhancement" cover areas could be different than existing natural cover areas. A management recommendation that supports this general approach has been included in the final watershed plan to provide flexibility in how the Region and Area Municipalities implement the enhanced Natural Heritage System through their respective land use planning instruments. Management recommendation 3.1.1 has been updated accordingly.
CCWP Land Use Definitions Some residential estates, golf courses, cemeteries and hydro corridors are designated as agricultural uses and therefore the total agricultural lands are overstated in the CCWP analysis.	Footnote 6 on page 23 of the draft CCWP explains that water, recreational, golf courses, cemeteries, and hydro corridors are not included in the statistics for changes to land cover cited in Subsection 3.2. The draft CCWP mapping uses three general land use classifications (urban, rural, natural) for simple visualization. The technical analyses used more detailed land use classifications than what is presented in the mapping to determine results.
Pickering Planning and Development Committee Report It should be noted that NEPLG supports all three recommendations within Pickering Report to Planning and Development Committee from September 14, 2020.	Comment noted. **Subsection 2.3, page 19** of this document considers and responds to the comments in the referenced report.
Stakeholder Advisory Committee Requesting participation in a Committee which would provide an opportunity for transparency, sharing of information and advancement of the CCWP.	TRCA and its municipal partners will consider the establishment of a Stakeholder Advisory Committee to guide implementation planning of the watershed plan.
Fieldgate Developments (TFP Pickering Developments Limited)	
TRCA staff mentioned during the February 2021 virtual open houses that three methods were used to determine the NHS being promoted with the study. The results and the methods seem to be beyond which is supported by Provincial Policy and that which	In 2015, the Region of Durham retained TRCA to complete a watershed plan update for Carruthers Creek. The development of the watershed plan supports the Municipal Comprehensive Review process being undertaken by Durham Region and

Comments	Changes to CCWP (If applicable) / Response to Comments
is customary through the TRCA's role in the review and commenting on planning applications and processes. While we recognize that the Watershed Plan is not a planning document it appears to represent TRCA's position on an NHS system to be further used by its municipal partners to inform planning and growth considerations. Additional clarification is requested on the TRCA adopted methods and how they relate to current planning practices, the conservation authority's mandate and adherence to Provincial Policy Statement and the Growth Plan for the Greater Golden Horseshoe.	provincial policies related to watershed planning, which encourage collaboration between municipalities and conservation authorities (Growth Plan 4.2.1.1). The Provincial Policy Statement (2020) defines the NHS as: > a system made up of **natural heritage features and areas**, and **linkages intended to provide connectivity (at the regional or site level**) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species, and ecosystems. These systems can include natural heritage features and areas, federal and provincial parks and conservation reserves, other natural heritage features, lands that have been restored or have the **potential to be restored to a natural state**, **areas that support hydrologic functions,** and **working landscapes that enable ecological functions to continue**. The Province has a recommended approach for identifying natural heritage systems, but **municipal approaches that achieve or exceed the same objective may also be used.** > **(Bold added for emphasis)** Further, provincial policies recognize the integrated nature of natural heritage and water resource systems, and recognize the watershed as the meaningful ecological scale for long-term planning (PPS 2.2.1, Growth Plan 4.2.1 and 4.2.2). PPS policy 2.1.2 states: > The diversity and connectivity of natural features in an area, and the long-term ecological function and biodiversity of natural heritage systems, should be maintained, restored or, where possible,

Comments	Changes to CCWP (If applicable) / Response to Comments
	improved, recognizing linkages between and among natural heritage features and areas, surface water features and ground water features. The methods utilized to develop the enhanced NHS as part of the CCWP are consistent with the provincial policy framework. Details on the methods used to develop the recommended enhanced NHS can be found in the *Terrestrial Impact Assessment Technical Report*. TRCA conducts itself in accordance with the objects, powers, roles, and responsibilities set out for conservation authorities under the *Conservation Authorities Act* and the MNRF Procedural Manual chapter on conservation authorities' policies and procedures for plan review and permitting activities, such as a public commenting body under the *Planning Act,* a service provider to municipal partners, and a resource management agency. This includes the review of municipal planning documents like official plans and zoning by-laws (Plan Input) and development applications under the *Planning Act* (Plan Review). In these roles, and as stated in MECP's "A-Made-In-Ontario Environment Plan," conservation authorities work in collaboration with municipalities and stakeholders to protect people and property from flooding and other natural hazards, and to conserve natural resources.
TFP Pickering requests further dialogue with TRCA and other partners as this plan develops. This is required as the promotions directly impacts the TFP Pickering lands, and such promotions should be considered jointly and on consensus. Given this, we support the option of direct stakeholder engagement in decisions and not through online presentations, so that regular discussions can occur. Further these discussions should occur concurrently and with considerations on the establishment of a Structural Plan with the City of Pickering and the regional growth plan exercise. This	This watershed planning process was initiated in 2015. The recent conclusion of the public comment period on the draft CCWP was the final phase of public consultation. The CCWP has been updated to address feedback from this public review and submitted to Durham Regional Council for consideration. Reports to Council and the records of the various engagement activities undertaken throughout this process are available on the project webpage. On December 16, 2020, Durham Regional Council authorized staff to resume public

Comments	Changes to CCWP (If applicable) / Response to Comments
will ensure a sustainable outline that considers the environment first while looking at complete communities, land needs, and adhering to current planning policies.	consultation to advance the completion of the watershed plan via virtual engagement, which have become a well accepted form of public engagement during Covid-19. Two virtual open houses were held at the beginning of February, attended by a total of 134 individuals, compared to the approximately 50 individuals that attended in person open houses held in Ajax and Pickering in October 2019. The TFP Pickering lands are not currently within the urban boundary. The Region of Durham is currently undertaking its Municipal Comprehensive Review, which will determine whether there is a need for any Settlement Area Boundary Expansions, and if so, where they should occur. In the event that a Settlement Area Boundary Expansion is approved for the lands in northeast Pickering, the management recommendations outlined in subsection 5.4 of the CCWP would apply. These recommendations outline the types of studies that would need to occur prior to planning approvals.
Based on a review of the draft CCWP, prepared by TRCA on behalf of the Region of Durham, it is unclear what the intent of the CCWP is related to the future consideration of lands in northeast Pickering related to urban area expansion. The NHS is mentioned to be refined in the future keeping with the goals of the CCWP, however, the current analysis does not appear to include overall land use planning objectives of the PPS to guide this process and particularly, environmental takeouts. As the CCWP has not been promoted as a planning tool and since the CCWP work is being conducted concurrent with planning studies underway please indicate how the studies are to be integrated given the objectives of this plan. Perhaps in consideration of point 2 above there can be better integration to establish one NHS system which can be used as a baseline in establishing recommendations for the watershed and for planning studies.	The watershed plan is one of many studies and factors that the Region of Durham will need to consider as part of its Municipal Comprehensive Review. As noted earlier, the analysis is consistent with provincial policies like the PPS. The identification of an "enhanced" or "targeted" NHS is standard practice in contemporary watershed planning exercises. The Region of Durham is considering how to appropriately implement Natural Heritage Systems, including the recognition of enhanced/targeted components through the Municipal Comprehensive Review process. It is acknowledged that the policy treatment for "enhancement" cover areas could be different than existing natural cover areas. A management recommendation that supports this general approach has been included in the final watershed plan to provide flexibility in how the Region and Area Municipalities implement the enhanced Natural

Comments	Changes to CCWP (If applicable) / Response to Comments
	Heritage System through their respective land use planning instruments. TRCA has developed the recommended NHS in collaboration with municipal partners and based on in-house technical expertise using the latest science and practices in natural systems planning. The recommended NHS is more consistent with federal guidance on how much habitat is necessary to maintain ecological functions and biodiversity. The recommended NHS represents a realistic and attainable system for this urbanizing watershed and has been demonstrated to assist with achieving broader watershed goals beyond terrestrial ecosystems considerations (e.g. aquatic ecosystem improvements, reduction in peak flows for smaller storm events). Refinements to the recommended NHS may be considered assuming the scientific analysis is consistent with the goals and objectives of the CCWP.

2.3 Committee Reports – City of Pickering and Town of Ajax

On September 14, 2020, City of Pickering staff presented a report to the Planning and Development Committee with recommended changes to the draft CCWP. On October 5, 2020, Town of Ajax staff presented a report to the Community Affairs and Planning Committee with recommended changes to the draft CCWP. **Table 4** identifies the recommended changes and responses to both committee reports.

TABLE 4 - COMMITTEE REPORTS - CITY OF PICKERING AND TOWN OF AJAX

Comments	Changes to CCWP (If applicable) / Response to Comments
City of Pickering	
Provide greater clarity about the "77%" figure identified as the potential increase in downstream peak flows under the hypothetical land use Scenario 3 modelling analysis including: explaining that it is a "worst case" scenario and why; identifying the rainfall and storm duration parameters for a Hurricane Hazel type event; and relating the modelled increases in peak flows to the proposed management recommendations;	The following updates have been made to the CCWP: • Text has been added to Table 3 to explain the assumptions made in Scenario 3 and the appropriate stage of the planning process for detailed assessment of mitigation options, • Text has been added to Subsection 4.3 elaborating on the potential mitigation strategies, • The percent change associated with each scenario for the natural hazards has been modified to show change at both Taunton and Shoal Point Roads for the Regional Storm rather than an average. Text has been added explaining what the Regional Storm and 5-year storms mean. Additionally, a footnote has been added to explain that the modelling for the Regional Storm assumes existing stormwater management facilities fail or at capacity, and • The summary of implications at the end of Subsection 4.3 have been clarified, connecting them to the appropriate management recommendations (e.g. Subsection 5.4 for further studies in the event of headwater development).
Revise Management Recommendation 3.1.1 respecting the protection, expansion and restoration of the NHS in the watershed, to reflect discussion in the introductory text that precedes Table 8: NHS Management Recommendations, to allow	Text has been added to the introduction to Goal 3 and map 2 to address how refinements to the recommended NHS will be considered. Management recommendation 3.1.1 has been updated to elaborate on the role of the Region of

Comments	Changes to CCWP (If applicable) / Response to Comments
consideration of alternative configurations, size and composition for an enhanced NHS to that identified on Map 2 of the Draft CCWP.	Durham to provide direction to lower-tier municipalities to designate a NHS within Official Plans. Language has been added to the management recommendation to distinguish between the need to protect existing natural cover as identified in map 2 and having policies to identify enhancement and restoration opportunities for potential natural cover areas as identified in map 2.
Adding a new Management Recommendation 1.3.6 stating that TRCA continues to support and enhance the existing flood model by increasing the number of rainfall monitoring stations and stream flow gauges on all tributaries including the most minor.	TRCA expanded its monitoring network in the Carruthers Creek watershed by installing two new monitoring stations in 2019 to collect more precipitation data in the watershed. These are represented by water quantity stations #5 and #6 as illustrated in Figure 7 of the draft CCWP. One station is just north of Taunton Road, the other north of Hwy 407. Section 6 on Monitoring and Evaluation discusses the need to add additional monitoring stations to track watershed health (See page 56). Text has been added to this section about expanding the monitoring network in the event of further development.
Town of Ajax	
Management recommendation 1.1.1 encourages new development to minimize impervious cover while controlling higher levels of stormwater. Whereas, less stringent requirements are applied to redevelopment. The management recommendation recognizes it may be more difficult to rehabilitate existing developed to comply with the increased standards, while still applying a quantitative target. A minor amendment is requested to strengthen the management recommendation by replacing the word ‘should’ with ‘shall’ to ensure that this management recommendation is incorporated into Official Plan policy and related standards.	The requested change has been made.

Comments	Changes to CCWP (If applicable) / Response to Comments
Management recommendation 1.1.3 requires that a Terms of Reference be prepared to require additional study, such as completion of a hydraulic assessment, among other requirements, if a SABE is required. Staff have the following comments: While staff agree that a Terms of Reference is required to complete the additional study work and analysis, the management recommendation places the requirement to prepare the ToR on the Region, with input from TRCA, Ajax and Pickering. This management recommendation should be revised to 'require agreement' on all components of the ToR between the Region, TRCA, Ajax and Pickering before commencing work. Staff acknowledge that additional information, such as detailed land uses and mapping are needed prior to undertaking a Hydraulic Analysis. Staff are also of the opinion that such an analysis needs to occur at the earliest stage possible. Therefore, the management recommendation should be revised to require the completion of a Hydraulic Analysis during subwatershed planning and development of the secondary plan, but prior to any planning approvals. It should clearly identify the timing for the completion of work if Scenario 3 proceeds by adding "and secondary planning, prior to planning approvals" after subwatershed planning to read "to develop a Terms of Reference outlining requirements for further studies in support of subwatershed and secondary planning, prior to planning approvals, that includes, but is not limited to . . ."	Management recommendation 1.1.3 has been updated to clarify the process and require consensus among the relevant parties on future studies. Management recommendation 2.1.4 has been updated to address these comments.
Management recommendation 1.3.5 regarding flood plain mapping should be clarified. Staff agree that this is an essential management recommendation regardless of which scenario proceeds. However, staff have concerns related to the timing of this management recommendation. Staff believe that mapping needs to occur at the earliest stage possible.	Flood plain mapping is routinely updated as municipal Official Plans change and with the most recent topographical information. This management recommendation has been updated to clarify the flood plain mapping process. Management recommendation 2.1.4 addresses what conditions must be met through secondary planning

Comments	Changes to CCWP (If applicable) / Response to Comments
Therefore, the management recommendation should be revised to require the completion of the updated mapping during secondary planning and sub-watershed planning, but prior to any planning approvals in the headwaters.	in the event of a Settlement Area Boundary Expansion, including a hydraulic analysis (to quantify and map depth and extent of potential flood impacts).
Management recommendation 2.1.1 related to the protection of the Water Resource System should be updated to remove adequately from clause a.	The requested change has been made.
Management recommendation 3.1.1 outlines initiatives that need to be undertaken to protect, enhance and restore the NHS. The current Official Plans of the Region of Durham, City of Pickering, and Town of Ajax have different approaches to protecting the NHS. A consistent approach should be applied to the entire watershed, which 'designates' the enhanced NHS in the Regional Official Plan and area municipal Official Plans; similar to the Growth Plan, 2020 approach to designating the Provincial NHS in expanded Settlement Areas. As written, the management recommendation only recommends that the municipally 'adopted' enhanced NHS be protected. Recommending only that the municipally adopted enhanced NHS be protected creates ambiguity and undermines the work completed in this watershed plan. Therefore, management recommendation 3.1.1 a) should be strengthened by replacing the word 'adopted' with 'designated' to read "updating Official Plan policies and associated zoning by-laws to protect a municipally designated enhanced NHS" in order to provide greater and consistent protection of the enhanced NHS throughout the watershed. Similarly, management recommendation 3.1.1 f) should also be amended to replace the word 'adopted' with 'designated' to read "requiring development and redevelopments be designated and approved to prevent encroachment into the municipally designated NHS."	Management recommendation 3.1.1 has been split into two recommendations: one for the Region of Durham and one for lower-tier municipalities. 'Designated' has replaced 'adopted' for the lower-tier recommendation. The principle of achieving an overall 'net gain' where possible is already established in TRCA's ecosystem compensation guideline. The 1:1 ratio only applies to habitat types that can be restored without a long delay in re-establishing the lost ecosystem structure and function. Aside from the increased restoration ratios, there are several opportunities to achieve a net gain as part of the guideline. This includes improved ecosystem quality through enhanced restoration and locating restoration sites adjacent to other natural areas to create large, consolidated ecosystems. The management recommendation has been updated to clarify that ecosystem compensation policies should meet or exceed TRCA's guideline.

Comments	Changes to CCWP (If applicable) / Response to Comments
To date, staff have not supported implementing ecosystem compensation protocol policies into the Town's Official Plan in order to prioritize avoidance and protection of features. Further, where compensation has been accepted by the Town, a net gain in environmentally protected land area has been required; whereas the TRCA protocol permits a 1:1 ratio for the lowest level of compensation. Therefore, it is staff's position that adopting TRCA's guidelines for ecosystem compensation be removed; unless the guideline is amended to require greater compensation rations for the lowest level of protection.	
Similar to above, management recommendation 3.1.5 should be updated to replace 'adopted' with 'designated' related to the NHS.	The requested change has been made.
Management recommendation 3.1.6 requires wetland water balance studies be completed by landowners of any potential growth in areas in northeast Pickering, prior to planning approvals. The wording should be strengthened by replacing the word 'should' with 'is to' to read 'wetland water balance studies that demonstrate how the hydrologic function of the wetland is to be protected . . .'	The requested change has been made.
The scenario analysis beginning on page 34 of the draft plan demonstrates how the watershed reacts to each scenario. The draft plan compares Scenario 1 against the current conditions (2016). However, the plan changes its approach by comparing Scenarios 2 and 3 against Scenario 1, instead of comparing these scenarios to current conditions. Staff believe that consistent benchmark, using the current conditions, should be used for all scenario evaluations. Although Scenario 1 is approved in Official Plans and is anticipated to occur, it is difficult for the average reader to understand or visualized future conditions resulting from the current approved Official Plan. It is easier for the reader to use their	The technical work conducted during the scenario analysis stage included some assessments that compared scenarios 2 and 3 to scenario 1, while scenario 1 was compared to existing conditions (e.g. hydrological assessment). To ensure consistency across technical disciplines the results presented in subsection 4.3 of the draft CCWP are all presented in this manner.

Comments	Changes to CCWP (If applicable) / Response to Comments
understanding of current conditions within the watershed as the basis when comparing future conditions. Therefore, staff believe that Scenario's 2 and 3 should be adjusted such that the results are compared against the current conditions.	

3. SUMMARY OF KEY CHANGES TO THE CCWP

As noted in Table 2, Table 3, and Table 4 edits to the draft CCWP have been made to address feedback from public review. Table 5 identifies the section and page number of the CCWP that was changed, the original text, and the revised text.

TABLE 5 - SUMMARY OF KEY CHANGES TO THE CCWP

Section / Page Number	Original Text	Revised Text
Executive Summary	*Revision is new text.*	**The management framework is focused on:** • **Achieving more sustainable land use and infrastructure development patterns through the use of low impact development and green infrastructure policies, improved stormwater management, managing the risks of flooding and erosion, and implementing agricultural best management practices** • **Protecting, enhancing, and restoring the WRS and improving aquatic habitat connectivity** • **Protecting, enhancing, and restoring the NHS and increasing urban forest cover**
4.2 Future Scenarios Table 3 Page 32	Scenario 3: This scenario assumes post-2031 development in the headwaters of Carruthers Creek (north of the Greenbelt), outside the enhanced NHS. This scenario provides insights into how watershed conditions will likely change if potential full growth is approved in the watershed.	This scenario assumes post-2031 development in the headwaters of Carruthers Creek (north of the Greenbelt), outside the enhanced NHS. **This scenario made general assumptions on the types of land uses associated with typical urbanization. It did not make assumptions on the levels of stormwater management controls or other mitigation measures (e.g. green infrastructure) that may accompany urban development. This level of analysis would be completed during subsequent planning stages when detailed land use configurations are known.** This scenario provides insights into how watershed conditions will likely change if

Section / Page Number	Original Text	Revised Text
		potential full growth is approved in the watershed.
4.3 Scenario Analysis Pop-out box Page 34	It is important to note that scenario analysis does not result in decisions about the type and configuration of land uses. Instead, scenario analysis helps to inform decisions through the municipal planning process (e.g. Official Plans). It is the responsibility of the applicable municipality to determine the ultimate land use configuration for any future changes within the watershed.	It is important to note that scenario analysis does not result in decisions about the type and configuration of land uses. Instead, scenario analysis helps to inform decisions through the municipal planning process (e.g. Official Plans). It is the responsibility of the applicable municipality to determine the ultimate land use configuration for any future changes within the watershed. **Appropriate mitigation strategies are developed during the detailed planning stages for new developments once the scope of any future land use change is known. These mitigation strategies include assessments of the appropriate levels of stormwater controls, the use of green infrastructure to maintain natural water balance as much as possible, and opportunities for ecological restoration.**
4.3 Scenario Analysis Water Resource System Page 35	Footnote 11: This assessment does not consider protection measures for the WRS. For example, if impervious surfaces were minimized in groundwater recharge areas, hydrologic function would be maintained.	*Footnote removed based on added text noted above in subsection 4.2 and 4.3.*
4.3 Scenario Analysis Natural Hazards Page 38	Context at top of page: Focused on flood modelling as measured by peak flows. Percent change is based on an average from both locations for the regional storm only (as the worst-case scenario).	Focused on flood modelling as measured by peak flows. **Percent change is based on the Regional Storm (i.e. Hurricane Hazel) at two points in the watershed. The Regional Storm for TRCA's jurisdiction is based on a historical extreme storm of record, Hurricane Hazel. Design storms are based on statistical analysis of rainfall over a period of record. Hurricane Hazel is a 12-hour event**

<table>
<tr><th>Section / Page Number</th><th colspan="4">Original Text</th><th colspan="4">Revised Text</th></tr>
<tr><td></td><td colspan="4"></td><td colspan="4">with 212 mm of rainfall, which assumes completely saturated soils.</td></tr>
<tr><td rowspan="3">4.3
Scenario Analysis
Natural Hazards
Page 38</td><td>Current Conditions</td><td>Scenario 1</td><td>Scenario 2</td><td>Scenario 3</td><td>Current Conditions</td><td>Scenario 1</td><td>Scenario 2</td><td>Scenario 3</td></tr>
<tr><td rowspan="2">% change
-</td><td rowspan="2">= -2%</td><td rowspan="2">= 0%</td><td rowspan="2">-77%</td><td>% change at Taunton Rd</td><td>+2.4%</td><td>+1.9%</td><td>-112.9%</td></tr>
<tr><td>% change at Shoal Point Road</td><td>-6.4%</td><td>+1.5%</td><td>-40.9%</td></tr>
<tr><td>4.3
Scenario Analysis
Natural Hazards
Page 38</td><td colspan="4">Footnote 22
The flood modelling completed as part of scenario analysis did not factor in potential mitigation measures (e.g. modern stormwater infrastructure).</td><td colspan="4">All existing stormwater management facilities were removed from the model to account for the system failing or being at capacity during a Regional storm event.</td></tr>
<tr><td>4.3
Scenario Analysis
Natural Hazards
Page 38</td><td colspan="4">Revision is new text.</td><td colspan="4">New footnote:
The 5-year storm event uses a 60.07 mm rainfall event over a 24-hour period, which assumes an average (normal) soil condition.</td></tr>
<tr><td>4.3
Scenario Analysis
Summary of Implications
Page 39</td><td colspan="4">Summary of implications:
One of the four subwatersheds shows improved aquatic conditions under scenario 2. Conversely, all four subwatersheds have fair – poor aquatic conditions under scenario 3, likely resulting in the loss of Redside Dace, a listed endangered species, within the Carruthers Creek watershed.
The amount of natural cover and habitat quality improves under scenario 2. Under scenario 3, the amount of natural cover</td><td colspan="4">Summary of Implications:<table><tr><th colspan="2">Scenario 1</th></tr><tr><td>WRS</td><td>Aquatic conditions remain relatively poor, similar to existing conditions, and there is an increase in impervious cover across the watershed.</td></tr><tr><td>NHS</td><td>Natural cover and habitat quality remain similar to existing conditions.</td></tr></table></td></tr>
</table>

<table>
<tr><th>Section / Page Number</th><th>Original Text</th><th colspan="2">Revised Text</th></tr>
<tr><td rowspan="14"></td><td rowspan="14">improves, while habitat quality decreases compared to scenario 2 due to the influence of surrounding urban development.
Water quality is currently impaired in the watershed for parameters like chloride, phosphorus, TSS and E. coli. Without improvements to land use practices, salt and stormwater management, water quality is likely to continue to deteriorate with increased urbanization (scenario 3).
There are existing flooding issues in the watershed, which will significantly increase under scenario 3 without the implementation of considerable mitigation measures. The hydrologic assessment shows a reduction in peak flows associated with the recommended NHS for smaller design storms (i.e. 2-year storm).
These hypothetical future scenarios are illustrative of potential watershed conditions.
In addition to the summary of implications, it is important to recognize the following:
Protecting, enhancing and restoring the recommended NHS provides vital watershed benefits as illustrated by Scenario 2 and is consistent with targets as identified in Table 2.
Limiting impervious cover in any potential future growth areas, or through redevelopments, provides significant benefits to aquatic biodiversity. Federal guidance recommends urbanizing watersheds maintain less than 10% impervious land cover, while already degraded urban systems should not exceed a second threshold of 25 to 30%.</td><td>Water Quality</td><td>Slight increases in both total suspended solids and total phosphorus.</td></tr>
<tr><td>Natural Hazards</td><td>Peak flows do not significantly change from current conditions (i.e. increases and decreases at Taunton and Shoal Point Roads under the Regional and 5-year storm events).</td></tr>
<tr><td colspan="2">Scenario 2</td></tr>
<tr><td>WRS</td><td>One of the four subwatersheds shows improved aquatic conditions.</td></tr>
<tr><td>NHS</td><td>Natural cover increases and habitat quality improves.</td></tr>
<tr><td>Water Quality</td><td>Total phosphorus and total suspended solids decrease.</td></tr>
<tr><td>Natural Hazards</td><td>Peak flows decrease slightly at Taunton and Shoal Point Roads under the Regional and 5-year storm events.</td></tr>
<tr><td colspan="2">Scenario 3</td></tr>
<tr><td>WRS</td><td>All four subwatershed have fair-poor aquatic conditions, likely resulting in the loss of Redside Dace, a listed endangered species.</td></tr>
<tr><td>NHS</td><td>Natural cover increases, but habitat quality does not improve by as much as scenario 2.</td></tr>
<tr><td>Water Quality</td><td>Total suspended solids increase, total phosphorus decreases.</td></tr>
<tr><td>Natural Hazards</td><td>Peak flows significantly increase at Taunton and Shoal Point Roads under the Regional</td></tr>
</table>

Section / Page Number	Original Text	Revised Text
	Scenario 1 shows impervious cover reaching this 30% threshold with only a marginal improvement to 29% under Scenario 2. See Figure 9 in Section 7 for more information. The management framework developed as part of this watershed plan contains recommendations to improve watershed conditions regardless of potential future land use decisions. The management framework is designed to account for potential future growth, redevelopment and emphasize the importance of protecting, enhancing and restoring both the WRS and NHS.	<table><tr><td></td><td>**and 5-year storms; more so for the former.**</td></tr></table> **What does this mean?** **These results demonstrate the importance of ensuring that land use and infrastructure planning decisions are made to minimize and mitigate impacts to the watershed regardless of potential future land uses or their configurations. The management framework in Section 5 outlines the goals, objectives, indicators, and management recommendations necessary to ensure the long-term health and sustainability of the watershed.** **The results of this scenario analysis emphasize the importance of protecting, enhancing, and restoring the WRS (Subsection 5.2) and the NHS (Subsection 5.3).** **In addition to the summary of implications, it is important to recognize the following:** • **Limiting impervious cover in any potential future growth areas, or through redevelopments, provides significant benefits to aquatic biodiversity. Federal guidance recommends urbanizing watersheds maintain less than 10% impervious land cover, while already degraded urban systems should not exceed a second threshold of 25 to 30%. Scenario 1 shows impervious cover reaching this 30% threshold with only a marginal improvement to 29% under Scenario 2. See Figure 9 in Section 7 for more information.**

Section / Page Number	Original Text	Revised Text
		• **Increasing natural cover and improving habitat quality has noticeable benefits for the watershed (e.g. improvements to aquatic conditions and slight reductions of peak flows).** • **Ecological restoration and improvements to land use practices (e.g. increased use of green infrastructure and improved stormwater management) could address existing water quality issues.** • **The existing flooding and erosion issues can be mitigated through improved land uses (e.g. green infrastructure) and infrastructure (e.g. stormwater management) as outlined in the management recommendations of Subsection 5.1. In the event of future development in the headwaters of Carruthers Creek, it will be vital to develop mitigation strategies to limit the impacts of further urbanization by implementing the management recommendations outlined in Subsection 5.4.** **The management framework is designed to address existing issues and the implications of these scenarios by accounting for new developments, redevelopments, and prioritizing the importance of protecting, enhancing, and restoring both the WRS and NHS.**
5.1 Land Use and Infrastructure Goal Page 43	1.1.1 Lower-tier municipalities, in collaboration with the Region of Durham and TRCA, to adopt green development policies, or standards, and require new developments, and re-developments, to utilize low impact	1.1.1 Lower-tier municipalities, in collaboration with the Region of Durham and TRCA, to adopt green development policies, or standards, and require new developments, and redevelopments, to utilize low impact

Section / Page Number	Original Text	Revised Text
	development and green infrastructure techniques to limit the impacts of impervious cover. The following should apply to any municipal policies, or standards, in particular within ESGRAs, as identified on map 1b: a. new developments should minimize impervious cover and strive to achieve 90th percentile volume control of annual rainfall b. redevelopments should minimize impervious cover and strive to achieve 75th percentile volume control of annual rainfall	development and green infrastructure techniques to limit the impacts of impervious cover. The following **shall** apply to any municipal policies, or standards, in particular within ESGRAs, as identified on map 1b: a. new developments **shall** minimize impervious cover and strive to achieve 90th percentile volume control of annual rainfall b. redevelopments **shall** minimize impervious cover and strive to achieve 75th percentile volume control of annual rainfall
5.1 Land Use and Infrastructure Goal Pages 43 – 44	1.1.3 If it is determined that a Settlement Area Boundary Expansion is required in the headwaters of Carruthers Creek, in accordance with Growth Plan policies, the Region of Durham, in collaboration with lower-tier municipalities and TRCA, to develop a Terms of Reference outlining requirements for further studies in support of subwatershed planning that includes, but is not limited to: a. a hydraulic assessment b. how natural hazards will be assessed and mitigated (i.e. the risk of flooding will not increase) c. how the Natural Heritage System and Water Resource System will be protected, enhanced and restored d. how water quality and quantity will be protected.	1.1.3 If it is determined that a Settlement Area Boundary Expansion is required in the headwaters of Carruthers Creek, the Region of Durham, in collaboration with the lower-tier municipalities and TRCA, **will identify, based on consensus between the identified parties, the subsequent planning processes and further studies and assessments, that would be required to implement any such expansion. These requirements should be reflected as policies within the Regional Official Plan and include the requirement for the preparation of a secondary plan and a subwatershed plan (or equivalent), which would be supported by, at a minimum, the following studies, assessments, and further considerations**: a. a hydraulic assessment b. how natural hazards will be assessed and mitigated (i.e. the risk of flooding **and erosion** will not increase) c. how the Natural Heritage System and Water Resource System will be protected, enhanced, and restored

Section / Page Number	Original Text	Revised Text
		d. how water quality and quantity will be protected. e. **how flood mitigation solutions will be funded, including identification of the responsible parties for providing the funding. This includes the cost of any necessary studies, engineering design, and actual construction/maintenance of flood mitigation works.**
5.1 Land Use and Infrastructure Goal Page 46	1.3.5 TRCA to complete comprehensive floodplain mapping based on new models and best available information to inform land use and infrastructure decisions.	1.3.5 TRCA **will continue** to complete comprehensive flood plain mapping based on **routinely updated hydraulic** models and **updated land use information to inform municipal planning decisions. Regulatory flood plain mapping is updated based on approved land uses.**
5.2 Water Resource System Goal Page 47	2.1.1 The Region of Durham and lower-tier municipalities, in collaboration with TRCA, to ensure the protection of the Water Resource System (map 1A and B) and its functions, by: a. updating Official Plans and zoning bylaws to adequately protect the Water Resource System . . .	2.1.1 The Region of Durham and lower-tier municipalities, in collaboration with TRCA, to ensure the protection of the Water Resource System (map 1A and B) and its functions, by: a. updating Official Plans and zoning bylaws **to protect** the Water Resource System . . .
5.2 Water Resource System Goal Page 48	2.1.4 If it is determined that a Settlement Area Boundary Expansion is required in the headwaters of Carruthers Creek, in accordance with Growth Plan policies, the City of Pickering, in collaboration with the Region of Durham, Town of Ajax and TRCA, as part of secondary planning to demonstrate through a subwatershed plan (or equivalent) that: a. key hydrologic features will be protected	2.1.4 If it is determined that a Settlement Area Boundary Expansion is required in the headwaters of Carruthers Creek, the City of Pickering, in collaboration with the Region of Durham, Town of Ajax and TRCA, **prior to approvals of a secondary plan** to demonstrate through a subwatershed plan (or equivalent) that: a. key hydrologic features will be protected **and hydrologic functions maintained**

Section / Page Number	Original Text	Revised Text
	b. where avoidance of key hydrologic areas is not possible, appropriate mitigation measures are to be implemented to maintain downstream hydrologic function, and c. there will be no negative or adverse downstream effects, such as increased flooding, erosion, or deteriorated water quality.	*b. no change, except adding an 's' to function* c. there will be no negative or adverse downstream effects, such as increased flooding, erosion, or deteriorated water quality **through a hydraulic analysis (to quantify and map depth and extent of impacts) and other relevant modelling**.
5.3 Natural Heritage System Goal Page 49	The exact configuration and size of the NHS could fluctuate due to other factors (e.g. construction of infrastructure), assuming the analysis is comparable to the one that resulted in the proposed enhanced NHS recommended by TRCA.	**Refinements to the recommended NHS may be considered assuming the scientific analysis is consistent with the goals and objectives of the CCWP.**
5.3 Natural Heritage System Goal Page 50	3.1.1 The Region of Durham and lower-tier municipalities, in collaboration with TRCA, to ensure the protection, enhancement and restoration of a Natural Heritage System consistent with the goals and objectives of this watershed plan (map 2 for recommended NHS) by: a. updating Official Plan policies and associated zoning bylaws to protect a municipally adopted enhanced Natural Heritage System b. assessing existing standards and guidelines for land use and infrastructure development to ensure they reflect current provincial policy direction to maintain, restore or enhance the municipally adopted Natural Heritage System c. avoid infrastructure development (i.e. buildings and structures) and minimize infrastructure linear feature crossings, in	3.1.1 **The Region of Durham, as part of its Municipal Comprehensive Review, to ensure the protection, enhancement, and restoration of a Natural Heritage System consistent with the goals and objectives of this watershed plan (map 2 for recommended NHS) by:** **a. including existing natural cover areas identified in map 2 in the Regional Official Plan** **b. providing direction to lower-tier municipalities to include policies in their Official Plans to protect, enhance, and restore existing natural cover areas as identified in map 2** **c. recognizing the potential natural cover areas identified in map 2 in the Regional Official Plan and providing direction to lower-tier municipalities to include any relevant policies in their Official Plans to enhance and restore potential natural cover areas**

Section / Page Number	Original Text	Revised Text
	a municipally adopted enhanced Natural Heritage System d. adopting municipal policies for ecosystem compensation, in accordance with TRCA's *Guideline for Ecosystem Compensation*, where development in a municipally adopted enhanced Natural Heritage System is unavoidable e. applying a minimum 30 metre vegetation protection zone along features at the boundary of a municipally adopted enhanced Natural Heritage System to protect ecological function f. requiring development and redevelopments be designed and approved to prevent encroachment into a municipally adopted enhanced Natural Heritage System.	**d. avoiding infrastructure development (i.e. buildings and structures) and minimizing infrastructure linear crossings, in a municipally designated enhanced Natural Heritage System** **e. providing direction to lower-tier municipalities on the establishment of minimum vegetation protection zones along natural heritage features, with the ability of the minimum vegetation protection zone to be confirmed through an appropriate environmental study** **3.1.2** **Lower-tier municipalities, in collaboration with TRCA, to ensure the protection, enhancement and restoration of a Natural Heritage System consistent with the goals and objectives of this watershed plan (map 2), including the target of achieving 36% natural cover across the watershed, by:** a. **designating in their Official Plans, at a minimum, existing natural cover as identified in map 2** b. **including policies in their Official Plans to identify enhancement and restoration opportunities for potential natural cover areas as identified in map 2** c. *same as b in original text, except adopted is replaced with designated* d. *same as c in original text, except adopted is replaced with designated and avoiding/minimizing replace avoid and minimize respectively* e. adopting municipal policies for ecosystem compensation **that meet or exceed** TRCA's *Guideline for Ecosystem Compensation,* where development in a

Section / Page Number	Original Text	Revised Text
		municipally **designated** enhanced Natural Heritage System is unavoidable f. applying a minimum 30 metre vegetation protection zone adjacent to natural heritage features, unless otherwise satisfactorily justified through an environmental study g. *same as f in original text, except adopted is replaced with designated, and redevelopments is replaced with site alterations* *Remaining 3.1 management recommendations in subsection 5.3 would be numbered sequentially so that the previous 3.1.2 becomes 3.1.3 and so on.*
5.3 Natural Heritage System Goal Page 51	3.1.5 TRCA, in collaboration with the Region of Durham and lower-tier municipalities, to minimize impacts to the municipally adopted Natural Heritage System from any active recreation and human activity by: a. ensuring proper trail management and signage b. providing education and outreach on the importance of the municipally adopted Natural Heritage System c. promoting community stewardship to maintain and monitor the municipally adopted Natural Heritage System for improper trail usage (e.g. off-trail compaction and erosion), illegal dumping and invasive species, while encouraging community restoration programs (e.g. tree plantings).	**3.1.6** TRCA, in collaboration with the Region of Durham and lower-tier municipalities, to minimize impacts to the municipally **designated** Natural Heritage System from any active recreation and human activity by: a. ensuring proper trail management and signage b. providing education and outreach on the importance of the municipally **designated** Natural Heritage System c. promoting community stewardship to maintain and monitor the municipally **designated** Natural Heritage System for improper trail usage (e.g. off-trail compaction and erosion), illegal dumping and invasive species, while encouraging community restoration programs (e.g. tree plantings).
5.3 Natural Heritage System Goal	3.1.6 Wetland water balance studies that demonstrate how the hydrological function	**3.1.7** Wetland water balance studies that demonstrate how the hydrological function

Section / Page Number	Original Text	Revised Text
Page 51	of the wetland should be protected will be undertaken by the landowner . . .	of the wetland **is to** be protected will be undertaken by the landowner . . .
5.4 Carruthers Creek Headwaters Management Pages 54 – 55	*Management recommendations 1.1.3, 2.1.4, and 3.1.7 have been updated as noted above.*	
6. Monitoring and Evaluation Page 56	*Revision is new text.*	**If development occurs in the headwaters of Carruthers Creek, it may be necessary to add additional monitoring stations.**
7. Maps Page 64	*Revision is new text.*	Map 2, additional note: **Refinements to the recommended NHS may be considered assuming the scientific analysis is consistent with the goals and objectives of the CCWP.**

APPENDIX A

Email Campaign Submission to Durham Regional Chair

(Generic text from all email submissions provided below)

Please respect the findings from the TRCA's report on Carruthers Creek and say no to development in headwaters.

The TRCA has completed the Carruthers Watershed Plan. It has now been circulated for public comment. The report shows unequivocally that this watershed is stressed. There is already a serious problem with flooding and erosion. The report indicates that urbanizing the Carruthers Headwaters will increase flooding hazards by a staggering 77 per cent!

Durham Council has already identified flooding as the number one threat from climate change. The costs to local governments and homeowners will be very large. These lands are also prime agricultural lands which are very important to Durham's largest industry.

The TRCA Report makes it very clear that under no circumstances should the Carruthers Headwaters be urbanized. The cost is too great.

Response Provided by Region of Durham

Thank you for your email. Your comments have been added to the Region's file and sent to staff at the Toronto and Region Conservation Authority (TRCA) for consideration. TRCA entered into a service agreement with the Region to complete the watershed plan.

As you may be aware, a Draft of the Carruthers Creek Watershed Plan Update was released on March 13, 2020 for a 90-day public review and comment period. Following the outbreak of the COVID-19 pandemic, the public review and comment period was placed on hold. Public consultation, including a public open house, will resume once the current state of emergency has been lifted. In the meantime, you may continue to submit comments on the Draft Carruthers Creek Watershed Plan through the Toronto and Region Conservation Authority project website.

The Draft Carruthers Creek Watershed Plan Update assesses the current health of the watershed. It also utilizes scenario modelling to project what the future health of the watershed may be. One of these scenarios (scenario 3) models the likely implications associated with the potential for urban development within the headwaters without mitigation measures. Currently, the lands within the headwaters of Carruthers Creek are not designated as part of the settlement area of the City of Pickering or within the Region of Durham's urban area boundary. At this time there has been no decision to develop the headwaters of Carruthers Creek.

To mitigate the increased risk of downstream flooding, as well as other adverse effects associated with potential urban development within the headwaters, Subsection 5.4 of the Draft Carruthers Creek Watershed Plan outlines a series of management recommendations. The management recommendations of Subsection 5.4 also address the planning processes and further studies that would be required before a decision can be made about development in the headwaters. These management recommendations, along with the broader management framework, would be used to protect, enhance, and restore the Carruthers Creek Watershed, including the implementation of appropriate flood mitigation measures.

It is important to note that watershed plans are not land use plans, nor do they constitute a land use planning decision. However, as required by Provincial Plans, the data, scientific analysis, modelling, scenario evaluation and management recommendations generated through a watershed plan process would be used by municipalities to inform future land use planning decisions.

Should you have any further questions about the content, or the recommendations contained in the Carruthers Creek Watershed Plan, I encourage you to email carruthers@trca.ca and a member of the TRCA project team will respond.

APPENDIX B

The North East Pickering Landowners Group (NEPLG) letter also contained comments specific to many of the Scenario Analysis Technical Reports completed as part of the watershed planning process. Table 6 provides a general overview of those comments grouped by theme and relevant responses.

TABLE 6 - NEPLG COMMENTS ON TECHNICAL REPORTS

Comments	Changes to CCWP (If applicable) / Response to Comments
Modifications to Technical Reports	
Key comments include: • Suggest adding more technical details about methodologies, specifically for the Terrestrial Impact Assessment. • It is not practical to require the development of a Region-wide stormwater management plan for matters related to one watershed. We recognize this recommendation in the technical report was not carried forward to the watershed plan. Therefore, suggest deleting it from the Technical Report. • The hydrologic modelling did not achieve a successful model calibration with the latest stream gauge information. The timing and process for TRCA to complete the hydrologic model calibration should be discussed in the Technical Reports. The hydrology models should undertake a fulsome parameter and calibration/validation exercise, including using more recent data before further use in determining flooding impacts and mitigation approaches. This should be discussed in the documents.	The Technical Reports developed as part of the CCWP were all peer-reviewed. As noted in Regional Council Report #2020-P-15, TRCA and Regional planning staff are confident the draft Watershed Plan is thorough, sound, and defensible. As noted in the CCWP (Section 5), the management recommendations in the watershed plan are to be considered the final source for goals, objectives, indicators, and management recommendations. As noted in the CCWP, the preparation of a hydraulic analysis and demonstration that new developments will not negatively impact natural hazard areas are included as management recommendations. Additionally, a memo provided to SCS Consulting in January 2021 on the review of the hydrology model has been added to the Reports and Resources library on the CCWP project webpage.
Scenario 2 and 3 Assumptions	
Key comments include: • Scenario 2 is not realistic as there is no policy mechanism for existing farmland to be enhanced natural cover. • Scenario 3 is too simplistic without mitigation and could include assumptions on type of land uses,	The scoping of the scenarios for this watershed-scale planning exercise were developed by TRCA in collaboration with its municipal partners. Under Goal 1, objective 4 recognizes the need to work with the agricultural community on rural land stewardship. In the event that urbanization does not occur within the headwaters, TRCA would use the

Comments	Changes to CCWP (If applicable) / Response to Comments
canopy cover, green infrastructure, and stormwater management.	enhanced NHS to identify opportunities with rural land owners (e.g. incentive programs, grants, etc.). The extent and detailed land uses associated with a Settlement Area Boundary Expansion have not been determined. It is therefore difficult to assume the appropriate level of mitigation measures, which would be determined during the appropriate municipal planning stage (e.g. secondary planning). Scenario 3 was intended to give an overview of potential impacts based on typical urbanization patterns, and identify the appropriate studies, assessments, and considerations to include in any potential future secondary plan/subwatershed study. Subsection 5.4 of the CCWP identifies the studies that would be required in the event of a Settlement Area Boundary Expansion in the headwaters of Carruthers Creek. It is more appropriate to model different mitigation strategies at the appropriate planning stages when detailed land uses and configurations are known.
Additional Development Scenario	
Key comments include: • Recommends including a development scenario that includes practices for ecological and hydrological mitigation. • The minimum required stormwater management water quality treatment criteria for new development should be modelled. This is 80% TSS removal.	See response above.
Findings of Technical Reports	
Key comments include: • The impervious cover target needs to recognize impervious cover mitigation measures such as low impact developments. If Scheuler (1994) is going to be used to set system responses to impervious cover, the results should be contextualized with	The headwaters of Carruthers Creek are not currently within the urban boundary. The Region of Durham will decide on future growth based on the results of its Municipal Comprehensive Review. Additional assessment of potential mitigation strategies for future development would occur at the

Comments	Changes to CCWP (If applicable) / Response to Comments
its commentary on the use of stormwater controls. • The scenarios do not consider the impacts of tile drains on headwater drainage features and a future development scenario presents an opportunity to improve the hydrology of these features. • Disagree with the finding that future development will negatively impact fish habitat, as it is more likely that instream habitat conditions will improve in a future development scenario (e.g. naturalized stream corridors, stormwater controls) and that with these improvements fish diversity and abundance will be enhanced. • While low impact development techniques may not be able to erase all impacts of land development, they can certainly reduce the impacts, mitigating the effects of impervious cover. • The TRCA Expanded Groundwater Flow Model is a regional-scale model that was not refined, updated or re-calibrated for Carruthers Creek. The recharge boundary condition as applied in the land use scenarios was interpolated from previous simulations rather than from an updated hydrologic simulation. It is inappropriate to apply preliminary or unvetted tools to make management decisions. • The applied recharge in the future build-out scenario is representative of urban recharge from a large portion of Toronto, Durham, York, and Peel rather than what rates could be achievable with a modern stormwater system in Carruthers Creek.	appropriate planning stage as outlined in subsection 5.4 of the draft CCWP. While low impact development techniques can moderate some severity of impacts associated with impervious cover, they have yet to be demonstrated at a large enough scale to prevent aquatic tipping points from being exceeded. As noted elsewhere, in the event of future development additional studies would provide an opportunity to demonstrate how a future development scenario could improve the hydrology of headwater drainage features. There is a great deal of scientific evidence to suggest that naturalized stream corridors and improved stormwater controls do not result in the level of improvements to fish and aquatic habitat being asserted. Fish and aquatic habitat quality are governed by flow regime which is determined by runoff coefficients and the timing, magnitude, and durations of stormwater flows. Groundwater discharge also needs to be considered. Mitigation measures and habitat enhancements may improve some conditions initially, but the necessity to increase impervious cover with development shifts the system to a degraded state in the long-term. The decision was made to perform a preliminary groundwater modelling analysis that leveraged existing efforts including a peer-reviewed Tier 3 Source Water Protection numerical model and a comprehensive provincial database containing insights from a variety of groundwater investigations going back decades. This combined with some simple assumptions, such as recharge is land use dependent, provided insight of great value into the hydrological nature of Carruthers Creek.

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Toronto and Region Conservation Authority

Item 7.3

Section I – Items for Board of Directors Action

TO: Chair and Members of the Board of Directors
Friday, September 24, 2021 Meeting

FROM: Michael Tolensky, Chief Financial and Operating Officer

RE: **STANDING OFFER SUPPLY FOR PRINT SERVICES AND EQUIPMENT**
Contract No. 10036290

KEY ISSUE
Adoption of Kinetic Group Purchasing Organization (Kinetic GPO) contract for print services and equipment.

RECOMMENDATION

WHEREAS Toronto and Region Conservation Authority (TRCA) is engaged in ongoing business operations that require the use of print equipment;

AND WHEREAS Kinetic GPO has solicited and evaluated proposals through a publicly advertised process for a standing offer method of supply for print services and equipment;

THEREFORE, LET IT BE RESOLVED THAT TRCA staff be directed to utilize the Kinetic GPO contract (#19-02) for print services and equipment for a five-year contract term with Xerox Canada Ltd. ending on September 30, 2026;

AND FURTHER THAT authorized TRCA officials be directed to take whatever action may be required to implement the contract, including the obtaining of necessary approvals and the signing and execution of any documents.

BACKGROUND
TRCA business operations require print services and equipment including, but not limited to:
- Remote Monitoring;
- Printer Supply and Management;
- Service Monitoring;
- Help Desk Service; and
- A Workplace Software Cloud Solution

TRCA is currently leveraging the Ontario Education Collaborative Marketplace (OECM) agreement to lease printer equipment and managed print services through Xerox Canada Ltd. The current contract will end in the beginning of 2022. In consultation with Xerox Canada Ltd., TRCA has made the decision to adopt the Kinetic GPO standing offer supply contract instead of extending the existing OECM agreement. This will allow Xerox Canada Ltd. to offer competitive rates on cost per page and a monthly savings of 20% ($19,000 annually) over the current state.

RATIONALE
Kinetic GPO is a cooperative purchasing organization established for Broader Public Sector entities across Canada with the specific purpose of leveraging group buying to reduce procurement costs. Kinetic GPO has conducted a competitive procurement process to establish

a Print Services and Equipment (#19-02) contract with Xerox Canada Ltd. The Kinetic GPO contract is available to Broader Public Sector agencies which allows TRCA to leverage the goods and services provided under this contract. Leveraging the standing offer contract with Xerox Canada Ltd. will also reduce staff time and administrative costs associated with conducting a new procurement process.

TRCA will benefit from receiving new printer and copier hardware as part of the standing offer contract with Xerox Canada Ltd., who will also assist in the deployment of these new devices. By upgrading the hardware, TRCA will benefit from standardizing the printer and copier equipment across the organization, bringing efficiencies in management and administration. Furthermore, TRCA will also be able to leverage the Xerox Workplace Cloud solution for initial 12-months at no additional cost. This software solution will enable the staff to better manage the printers and copiers across the organization.

Relationship to Building the Living City, the TRCA 2013-2022 Strategic Plan
This report supports the following strategic priority set forth in the TRCA 2013-2022 Strategic Plan:
Strategy 7 – Build partnerships and new business models
Strategy 10 – Accelerate innovation
Strategy 11 – Invest in our staff

FINANCIAL DETAILS
Based upon a review of business operations initiatives, the anticipated costs for the requested goods and/or services is approximately $400,000, plus applicable taxes. This value is based on equipment lease and service costs under the new contract adopting the Kinetic GPO agreement. The costs associated with this contract will be charged to the Corporate Printers account.

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Date: August 10, 2021

Item 8.1

Section III – Items for the Information of the Board

TO: Chair and Members of the Board of Directors
Friday, September 24, 2021 Meeting

FROM: John MacKenzie, Chief Executive Officer

RE: **UPDATE ON MEMORANDUMS OF UNDERSTANDING AND SERVICE LEVEL AGREEMENTS WITH MUNICIPALITIES**

KEY ISSUE

To provide an update to the Board of Directors on work underway to update and achieve Memorandums of Understanding (MOUs) and Service Level Agreements (SLAs) with partner municipalities in the context of the updated *Conservation Authorities Act* (CA Act) and relevant regulations.

RECOMMENDATION

IT IS RECOMMENDED THAT this progress report be received;

THAT staff report back to the Board of Directors on the progress of Memorandum of Understanding and Service Level Agreements once the *Conservation Authorities Act* regulations are released;

AND FURTHER THAT the Clerk and Manager, Policy, circulate this report to TRCA's municipal partners, Conservation Ontario, neighbouring conservation authorities, and the Province, including the Ministry of Environment, Conservation and Parks, Ministry of Northern Development, Mines, Natural Resources and Forestry, and Ministry of Municipal Affairs and Housing.

BACKGROUND

Since 2015, the *Conservation Authorities Act* (CA Act) has been amended several times in order to introduce measures that provide further clarity and transparency surrounding the various types of services that conservation authorities provide to, and on behalf of, municipalities. These amendments were undertaken through the *Building Better Communities and Conserving Watersheds Act, 2017* (Bill 139) in 2017, the *More Homes, More Choice Act* (Bill 108) in 2019, and the *Protect, Support and Recover from COVID-19 Act (Budget Measures), 2020* (Bill 229) in 2020. As a result of these amendments to the CA Act, conservation authorities will need to execute Memorandums of Understanding (MOUs) and Service Level Agreements (SLAs) with partner municipalities to deliver services deemed to be municipal (non-mandatory). Background on the resulting CA Act amendments and implications for the provision of municipal (non-mandatory) services to partner municipalities, as well as a full description of related Board resolutions directing TRCA staff to undertake discussions with municipal partners to develop and execute MOUs and SLAs, can be found in Item 12.7 (Update on Municipal Memorandums of Understanding and Service Level Agreements) from Board of Directors meeting held on February 26, 2021. The most recent update on MOU and SLA discussions with municipalities can be found in Item 8.1 from Board of Directors Meeting held on June 24, 2021.

TRCA staff also continues to participate in the Province's Conservation Authorities Working Group, announced December 16, 2020. TRCA has representation on the Working Group, with additional representation from other conservation authorities (CAs), Conservation Ontario, the Association of Municipalities of Ontario, and municipal, development and agriculture sectors.

Furthermore, the Ministry of Environment, Conservation and Parks posted a document, entitled a "Regulatory Proposal Consultation Guide: Regulations Defining Core Mandate and Improving Governance, Oversight and Accountability of Conservation Authorities" ("the Guide") on the Environmental Registry of Ontario on May 13, 2021. While the Guide does not include draft regulations, it does lay out proposed associated details, including which CA programs and services may be considered mandatory, requirements for municipal MOUs and SLAs, timelines, and the requirements for a Transition Plan and community advisory boards.

In response, TRCA staff drafted and shared a submission on the ERO posting, with input from the Board of Directors. Further information on TRCA's submission, additional details in the Guide, and potential implications, can be found in June 25, 2021 Board of Directors meeting minutes (RES.#A142/21, TRCA Draft Comments to Environmental Registry of Ontario Posting (ERO #019-2986) – Regulatory Proposals (Phase 1) Under the Conservation Authorities Act). TRCA also posted a news release on our website on May 18, 2021 in response to the ERO posting.

RATIONALE
Staff have been undertaking discussions with partner municipalities since June 2019, with discussions increasing in frequency and productivity over the last year. The productivity of MOU/SLA discussions has been supported by the resources developed by staff and described in the Board reports noted above. TRCA staff are also undertaking regular review and updating of the resources developed to ensure that the information provided remains current.

In addition, new resources have been developed. This includes a draft Letter Agreement template (***Attachment 1***). The Letter Agreement template lays out the expected structure and content of a Letter Agreement, which would be appended to the SLA for each specific service, program or project that TRCA undertakes on behalf on a municipality.

TRCA continues to participate in the Province's Conservation Authorities Working Group. Based on TRCA's direct experience with developing MOUs with partner municipalities, staff have provided input related to the principles on which MOUs and SLAs could be based and the mandatory programs and services that conservation authorities would be required to provide. TRCA is encouraged that the direction laid out in the Consultation Guide, including for both the MOU transition plan and the development and execution of MOUs and SLAs themselves, aligns with the approach that TRCA has been taking in both discussions with partner municipalities and in the development of MOU-related resources. In many cases, TRCA is already meeting or exceeding many of the potential requirements of CAs, including having multi-stakeholder advisory committees to TRCA's Board (such as the Regional Watershed Alliance), already delivering mandatory CA services, and undertaking MOUs, SLAs and/or other agreements for the delivery of other individual services, programs and/or projects for municipalities.

Since the last update to the Board of Directors on the MOU-SLA process (June 24, 2021 meeting), discussions with many partner municipalities have continued to progress (***Attachment 2***). This progress includes the following:

- Discussions on MOUs and SLAs have progressed to a more detailed stage with many municipalities. This includes interest from, and discussions with, municipalities that were previously waiting on a release of the regulations associated with the CA Act

amendments. Detailed discussions include developing a municipality-specific process for developing and executing MOUs and SLAs, municipal staff review and discussion of TRCA's list of services, considering which services they currently utilize or might utilize, and municipal staff utilizing the template MOU and SLA drafted by TRCA in the development of MOUs and SLAs for execution. This may also include municipal staff review of the template or adapted MOU and SLA with their legal counsel and/or conferring with their procurement/purchasing staff to understand any limitations and whether amendments may be required to current municipal procurement mechanisms.
- The execution of MOUs and/or MOUs moving to an advanced stage of development or approval. This includes where an MOU and the associated list of services has been drafted and is under review.
- Where relevant, staff have undertaken some joint meetings with municipal staff and neighbouring conservation authorities in order to better coordinate the development of MOUs and SLAs to ensure consistent services across a municipal jurisdiction.

Many municipalities continue to wait until finalized regulations are released prior to bringing MOUs and SLAs to Council for approval and execution, even in cases where there is strong support for this process. Where the municipality has indicated that they would like to wait for the finalized CA Act regulations to be released prior to execution of the agreements, TRCA staff continue to work with partner municipalities to move the MOUs and SLAs forward to an advanced stage so that can easily be brought forward for endorsement. TRCA staff are working towards the proposed Provincial deadline of December 31, 2022 for having MOUs and SLAs in place with partner municipalities. However, recognizing that municipal elections will occur in October 2022, staff are targeting Q1/Q2 2022 as the preferred timeline for executing MOUs and SLAs.

TRCA staff have also begun work on an MOU transition plan, in accordance with the proposed requirements set out by the Province in the Regulatory Proposal Consultation Guide. Staff expect to meet the December 31, 2021 deadline set out by the Province and will bring the MOU Transition Plan to a future Board meeting for review and approval.

Relationship to Building the Living City, the TRCA 2013-2022 Strategic Plan
This report supports the following strategy set forth in the TRCA 2013-2022 Strategic Plan:
Strategy 7 – Build partnerships and new business models

FINANCIAL DETAILS

There is no immediate financial impact due to carrying out the recommendations above. The process of undertaking agreements with municipalities related to non-mandatory municipal programs and services provided by TRCA under the amended *Conservation Authorities Act*, as well as with other external organizations, is expected to have positive financial impacts for TRCA based on the interest from most municipalities in providing funding and or jointly seeking funding for a selection of TRCA service areas that support areas of need for the municipalities in question and shared municipal and TRCA interests.

DETAILS OF WORK TO BE DONE

- Continue to communicate implications of the Consultation Guide to TRCA Board of Directors, municipal partners and relevant stakeholders, as well as information related to the enabling regulations, once released;
- Continue to meet with municipal partners in order to continue development and execution of MOUs based on municipal preferences and needs;

- Continue working with municipalities, where required, to address any potential procurement policy approvals or required by-law amendments to support updated MOUs and SLAs;
- Continue working with neighbouring Conservation Authorities in order to coordinate MOU development;
- Develop the Provincially required MOU transition plan, and bring to TRCA Board of Directors in Q4 2021 for approval; and
- Update existing, and finalize new MOUs and SLAs, as appropriate.

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Attachments: 2

Attachment 1: Template Letter Agreements
Attachment 2: Municipal MOU/SLA Status Progress Table

Toronto and Region Conservation Authority

[*Date*] CFN:

[*Name*]
[*Position*]
[*Department*]
[*Municipality*]
[*Address*]
[*Email*]

Dear [*Name*]:

Re: **[*Project Name*]**

This letter will serve as the letter agreement ("**Letter Agreement**") between Toronto and Region Conservation Authority ("**TRCA**") and the [*City/Town/Region*] ("**Municipality**") for certain work and services to be performed by TRCA in connection with *Project Name* ("**Project**") pursuant to the Service Level Agreement dated _____ between TRCA and the Municipality (the "**Service Level Agreement**").

The Service Level Agreement governs the relationship of the parties generally and this Letter Agreement will serve to document and confirm the specific requirements and the scope of work related to the Project. Unless otherwise defined, all capitalized terms used in this Letter Agreement shall have the same meaning as used in the Service Level Agreement.

BACKGROUND

[*Add relevant background if appropriate*].

OBJECTIVE

The Project will seek to [*add description of objective(s) of Project*].

DESCRIPTION OF SERVICES

TRCA will undertake the Project and carry out the services as set out in Schedule A.

ADDITIONAL TERMS AND CONDITIONS

Additional terms and conditions for the services are set out in Schedule A.

PROJECT SCHEDULE AND BUDGET

The Project Schedule and Budget are set out in Schedule A.

PAYMENT AND COSTS

Payments to TRCA shall be allocated and made in accordance with the Payment Schedule and Billing Terms set out in Schedule B.

ACCEPTANCE

This Letter Agreement is valid and open for acceptance for a period of thirty (30) calendar days following the receipt of submission. After thirty (30) days, TRCA reserves the right to re-evaluate the proposed timeline and Budget.

Should you require more information, please contact [*Project Manager*] at [*Phone Number*] or [*Email Address*].

If the above terms are acceptable to the Municipality, please so indicate by signing this Letter Agreement in the space provided below and returning a signed copy to [*Project Manager*] at [*Email Address*].

Yours truly,

TORONTO AND REGION CONSERVATION AUTHORITY

By: ________________________________
Name:
Title:

Accepted and agreed to this _______ day of ___________, 20____.

MUNICIPALITY

By: ________________________________
Name:
Title:

By: ________________________________
Name:
Title:

Schedule A
Description Of Services, Additional Terms And Conditions,
Project Schedule And Budget

1.0 DESCRIPTION OF SERVICES

2.0 ADDITIONAL TERMS AND CONDITIONS

3.0 PROJECT SCHEDULE

4.0 BUDGET

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Schedule B
Fees and Terms of Payment

1. Fees

The Municipality shall pay TRCA the Fees provided for in the Agreement, calculated and payable in the manner set out in Schedule A. No fees or costs, expenses or disbursements for any additional work beyond the provision of the services will be considered unless pre-approved in writing by the Municipality.

2. Payments

TRCA shall submit [insert payment schedule e.g quarterly invoices or monthly invoices] to the Municipality based upon work completed to the end of [the quarter or month] in accordance with TRCA's pay periods, timelines, payment and other schedules and benchmarks set out in Schedule A. Each such invoice shall contain such details as the Municipality shall require and, without limiting the generality of the foregoing, shall set out the services completed, and Fees incurred to the end of the applicable quarter including harmonized sales tax (HST), along with the timelines, payment and other schedules and benchmarks to which such work relates as noted in Schedule A.

Payment to TRCA is due on delivery. All accounts outstanding after 45 days will be charged interest calculated at 1.5% per month.

The Municipality shall advise TRCA should it have any objection to any invoice, and the parties shall work co-operatively to resolve the matter, and failing resolution, the matter shall be resolved in accordance with the dispute resolution provisions of the Service Level Agreement.

TRCA shall be solely responsible for the payment of all personnel (including without limitation subcontractors and suppliers and their respective personnel) engaged in the used for performance of any of the services.

Municipality	Initial Meeting or Discussions Held	Draft MOU and SLA Shared	Draft Corporate Report Shared	Detailed Discussions Undertaken	Advanced MOU Development or Execution
Adjala-Tosorontio	X	X			
Mono	X	X			
City of Toronto					
Parks Forestry and Recreation, and Transportation	X	X	X	X	X
Toronto Water	X	X	X	X	X
Waste Management	X				
Create TO	X	X		X	X
Toronto Botanical Gardens	X	X	X	X	X
Durham Region					
Region of Durham	X	X	X	X	
Ajax	X	X	X	X	
Pickering	X	X	X	X	
Uxbridge	X	X	X	X	
Peel Region					
Region of Peel	X	X		X	X*
Brampton	X	X	X	X	X
Caledon	X	X	X		
Mississauga	X	X	X	X	
York Region					
Region of York	X	X			
King	X	X	X	X	X
Markham	X	X	X	X	X
Richmond Hill	X	X	X	X	
Vaughan	X	X	X	X	
Whitchurch-Stouffville	X	X	X	X	X

*Region of Peel received Regional Council Approval to execute an SLA for Regional Infrastructure EA Review and Permits on September 9, 2021.

Item 8.2

Section III – Items for the Information of the Board

TO: Chair and Members of the Board of Directors
Friday, September 24, 2021 Meeting

FROM: Anil Wijesooriya, Director, Restoration and Infrastructure

RE: **UPDATE ON AWARD OF CONTRACTS 10035829 AND 10035830 – SUPPLY AND DELIVERY OF ARMOUR STONE TO ASHBRIDGES BAY TREATMENT PLANT LANDFORM PROJECT**

KEY ISSUE
Update on the contract award status for RFT 10035829 and 10035830.

RECOMMENDATION

IT IS RECOMMENDED THAT this report regarding the award of Contracts 10035829 and 10035830 be received.

BACKGROUND
At the Board of Directors Meeting held on June 25, 2021, Resolution #A136/21 was approved as follows:

> *WHEREAS no meetings of TRCA's Executive Committee and Board of Directors are scheduled for the months of July and August 2021;*
>
> *AND WHEREAS Resolution #A183/20, adopted at TRCA's November 20, 2020 Board of Directors meeting previously delegated the approval of all time sensitive procurements for the months July and August 2021 to the Chief Executive Officer or his designate;*
>
> *THEREFORE, LET IT BE RESOLVED THAT the Chief Executive Officer be delegated authority to award Contracts 10035829 and 10035830;*
>
> *THAT should TRCA staff be unable to negotiate a contract with the successful Proponent, staff be authorized to enter into and conclude contract negotiations with other Proponents that submitted quotations, beginning with the next lowest bid meeting TRCA specifications;*
>
> *THAT authorized TRCA officials be directed to take whatever action may be required to implement the contract, including the obtaining of necessary approvals and the signing and execution of any documents;*
>
> *AND FURTHER THAT staff report back on the contract award to the Board of Directors at the September 2021 meeting.*

RATIONALE
A RFT for supply and delivery of armour stone required to build the East headland at Ashbridges Bay Treatment Plant Landform Project was publicly advertised on the public procurement website www.biddingo.com on April 16, 2021. The RFT closed on May 4, 2021. A total of 37 firms downloaded the documents and submissions were received from the following Proponent(s):

- Atlantis Marine Construction Canada Inc.
- CDR Young's Aggregates
- H.R. Doornekamp Construction Ltd.
- Glenn Windrem Trucking
- Gott Natural Stone '99 Inc.
- GU Contracting Inc.
- Real Landscaping Plus Inc

The Procurement Opening Committee opened the Tenders on May 4, 2021 with the following results:

Contract #10035829 – Supply and Delivery of 6,125 tonnes of 2 - 4 tonne Armour Stone

Proponent	Fee (Plus HST)
H.R. Doornekamp Construction Ltd.	$422,625
Atlantis Marine Construction Canada Inc.	$453,250
GU Contracting Inc.	$459,375
Glenn Windrem Trucking	$485,406
Real Landscaping Plus Inc	$503,169
CDR Young's Aggregates	$514,500
Gott Natural Stone '99 Inc.	$519,339

Staff reviewed the bid received from H.R. Doornekamp Construction Ltd. against its own cost estimate and has determined that the bid is of reasonable value and met the requirements as outlined in the RFT documents.

On June 15, 2021 TRCA staff, as well as the engineering consultant for Ashbridges Bay Treatment Plant Landform Project inspected material samples provided by H.R. Doornekamp Construction Ltd. for this contract. Written approval of the material samples was later provided by the engineering consultant on July 9, 2021.

Therefore, H.R. Doornekamp Construction Ltd. was awarded contract No. 10035829 at a total cost not to exceed $422,625, plus applicable taxes, it being the lowest bid meeting TRCA's specifications.

Contract #10035830 – Supply and Delivery of 16,750 tonnes of 4 - 6 tonne Armour Stone

Proponent	Fee (Plus HST)
Atlantis Marine Construction Canada Inc.	$1,239,500
H.R. Doornekamp Construction Ltd.	$1,239,500
GU Contracting Inc.	$1,256,250
Real Landscaping Plus Inc	$1,504,150
CDR Young's Aggregates	$1,574,500
Glenn Windrem Trucking	$1,582,875

Since the bids received from H.R. Doornekamp Construction Ltd. and Atlantis Marine Construction Canada Inc. were of equal value a lottery procedure had to be conducted to break the tie, as per the RFT documents and TRCA's procurement procedures. TRCA staff organized a virtual meeting through Microsoft Teams with a representative for each bidder in attendance on May 7, 2021. H.R. Doornekamp Construction Ltd. was the winner of the lottery between the two firms.

With the tie break completed, staff reviewed the bid received from H.R. Doornekamp Construction Ltd. against its own cost estimate and determined that the bid is of reasonable value and met the requirements as outlined in the RFT documents.

On June 15, 2021 TRCA staff, as well as the engineering consultant for Ashbridges Bay Treatment Plant Landform Project inspected material samples provided by H.R. Doornekamp Construction Ltd. for this contract. Written approval of the material samples was later provided by the engineering consultant on July 9, 2021.

Therefore, H.R. Doornekamp Construction Ltd. was awarded contract No. 10035830 at a total cost not to exceed $1,239,500, plus applicable taxes.

Both contracts have been approved with delegated authority and have been executed, with deliveries of armour stone beginning in September 2021.

Relationship to Building the Living City, the TRCA 2013-2022 Strategic Plan
This report supports the following strategic priorities set forth in the TRCA 2013-2022 Strategic Plan:
Strategy 2 – Manage our regional water resources for current and future generations
Strategy 7 – Build partnerships and new business models
Strategy 12 – Facilitate a region-wide approach to sustainability

FINANCIAL DETAILS
The estimated project cost for construction of the Ashbridges Bay Treatment Plant Landform Project is $96 million net of all applicable taxes ($97.7 million net of HST recoveries).

Funds to support these contracts will be recovered through the service agreement with the City of Toronto and tracked under account code 183-02.

Report prepared by: Alex Barber, extension 5388 and Jet Taylor, extension 5526
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Date: August 23, 2021

Item 8.3

Section III – Items for the Board of Directors Action

TO: Chair and Members of the Board of Directors
Friday, September 24, 2021 Meeting

FROM: Michael Tolensky, Chief Financial and Operating Officer

RE: **DELEGATED AUTHORITY TO DISPOSE OF LAND TO METROLINX FOR FINCH AVENUE WEST LIGHT RAIL RAPID TRANSIT PROJECT**
Status Update Regarding Delegated Authority Granted for Disposition of Toronto and Region Conservation Authority-owned Lands to Metrolinx for the Construction of Traction Power Substation (TPSS) Ductbanks for the Finch West Light Rail Transit (FWLRT) Project, City of Toronto, Humber River Watershed (CFN 65248)

KEY ISSUE
Status update with respect to the delegated authority granted by the Board of Directors on June 25, 2021 for disposition of property located south of Humber College Boulevard, West of Highway 27, in the City of Toronto, Humber River watershed.

RECOMMENDATION

IT IS RECOMMENDED THAT this report be received.

BACKGROUND
Metrolinx requires TRCA-owned lands to construct TPSS Ductbanks for the FWLRT Project*,* located south of Humber College Boulevard, West of Highway 27, in the City of Toronto, Humber River watershed. In response to Metrolinx concerns that the summer meeting hiatus would cause delays and create schedule risk for the FWLRT Project, TRCA staff requested delegated authority during the summer hiatus to dispose of the vacant land to Metrolinx.

At Board of Directors Meeting held on June 25, 2021, Resolution #A157/21 was approved as follows:

> *WHEREAS Toronto and Region Conservation Authority (TRCA) is in receipt of a request from Metrolinx for disposal of land required for the construction of Traction Power Substation (TPSS) Ductbanks for the Finch West Light Rail Transit (FWLRT) Project, located south of Humber College Boulevard, West of Highway 27, in the City of Toronto, Humber River watershed;*
>
> *AND WHEREAS review of the request is ongoing and TRCA staff do not have sufficient information to bring forward final transaction details, including a reference plan defining the specific location and dimensions of the area, and the compensation valuation for the proposed disposition;*
>
> *AND WHEREAS no meetings of the Executive Committee and Board of Directors are scheduled for the months of July and August 2021;*
>
> *AND WHEREAS delaying approval of the land disposition until the September Board of Directors meeting would cause delays and create schedule risk for the FWLRT Project;*

AND WHEREAS it is in the best interest of TRCA in furthering its objectives as set out in Section 20 of the Conservation Authorities Act to cooperate with Metrolinx in this instance;

THEREFORE, LET IT BE RESOLVED THAT the Chief Executive Officer be delegated authority to dispose of vacant land to Metrolinx, consisting of approximately 0.01 ha (0.025 acres), more or less, required for the purpose of construction of ductbanks for the FWLRT Project, located south of Humber College Boulevard, West of Highway 27, in the City of Toronto, Humber River watershed, to be further described in a reference plan to the satisfaction of TRCA, and that compensation be based on fair market value in accordance with TRCA's land disposition policy;

THAT authorized TRCA officials be directed to take the necessary action to finalize the transaction, including obtaining any necessary approvals and the signing and execution of documents;

AND FURTHER THAT staff report back on the land disposal to the Board of Directors at the September 2021 meeting.

TRCA staff have worked with Metrolinx to finalize the transaction details. The transaction will be completed upon confirmation from Metrolinx of the amount of financial compensation for the conveyance in accordance with an appraisal confirming fair market value.

RATIONALE
At the Board of Directors Meeting on June 25, 2021, TRCA staff obtained delegated authority to dispose of TRCA-owned land to Metrolinx to construct Traction Power Substation (TPSS) Ductbanks in response to concerns that the summer meeting hiatus would cause delays and create schedule risk for the FWLRT Project. TRCA staff were to report back to the Board of Directors Meeting to provide an update regarding the property disposition at the September 24, 2021 meeting.

Relationship to Building the Living City, the TRCA 2013-2022 Strategic Plan
This report supports the following strategy set forth in the TRCA 2013-2022 Strategic Plan:
Strategy 4 – Create complete communities that integrate nature and the built environment

FINANCIAL DETAILS
Metrolinx will be required to assume all legal, survey and other costs involved in completing this transaction and will be required to compensate TRCA for the land at fair market value based on an appraisal.

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Date: August 11, 2021

Item 8.4

Section III – Items for the Information of the Board

TO: Chair and Members of the Board of Directors
Friday, September 24, 2021 Meeting

FROM: Michael Tolensky, Chief Financial and Operating Officer

RE: **PROCLAMATION OF THE ONTARIO NOT-FOR-PROFIT CORPORATIONS ACT**

KEY ISSUE
An update on the forthcoming proclamation of the Ontario *Not-for-Profit Corporations Act (ONCA).*

RECOMMENDATION

IT IS RECOMMENDED THAT this report on the forthcoming proclamation of the ONCA be received.

BACKGROUND
Toronto and Region Conservation Authority (TRCA) is a non-share corporation, established as a body corporate under Section 3(4) of the *Conservation Authorities Act (CA Act)*. As of January 1, 1976, TRCA has been registered with Revenue Canada as a charitable organization under the *Income Tax Act.* This makes TRCA subject to the ONCA announced to be proclaimed on October 19, 2021.

RATIONALE
The proclamation of ONCA has implications for TRCA's Board of Directors governance. While there is an overlap in governance requirements between ONCA and recently proclaimed governance sections of the CA Act in respect to increased accountability and transparency, financial auditing, and records management, there are also some features not discussed in the CA Act. For example, ONCA allows a member to appoint a proxy holder or to use alternative means of voting (by mail, telephone or electronic means) should it be permitted in the by-laws.

All nonprofits are expected to transition to the new rules no later than three years after the proclamation (October 19, 2024).

Relationship to Building the Living City, the TRCA 2013-2022 Strategic Plan
This report supports the following strategy set forth in the TRCA 2013-2022 Strategic Plan:
Strategy 7 – Build partnerships and new business models

DETAILS OF WORK TO BE DONE
TRCA staff will report back at a future Board of Directors meeting with a detailed compliance summary and recommendations for next steps, as applicable.

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Date: September 10, 2021

Item 8.5

Section III – Items for the Information of the Board

TO: Chair and Members of the Board of Directors
Friday, September 24, 2021 Meeting
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FROM: Laurie Nelson, Director, Policy Planning

RE: **SUMMARY OF 2021 TRCA POLICY CONSULTATION SUBMISSIONS ON RECENT FEDERAL AND PROVINCIAL POLICY INITIATIVES**

KEY ISSUE
Summary of Toronto and Region Conservation Authority (TRCA) policy consultation submissions on federal and provincial legislative, regulatory and policy initiatives relevant to TRCA interests from January to September 2021, for the information of TRCA Board of Directors.

RECOMMENDATION

WHEREAS to date in 2021, the Province of Ontario posted several legislative, regulatory and policy initiatives on the Environmental Registry of Ontario (ERO) relevant to Toronto and Region Conservation Authority's (TRCA) interests;

WHEREAS from time to time, the federal government requests comments on federal policy initiatives and technical guidance documents relevant to TRCA interests;

WHEREAS TRCA staff submitted letter responses to the provincial and federal governments on their initiatives;

THEREFORE, LET IT BE RESOLVED THAT the TRCA staff report on a summary of completed TRCA policy submissions through September 2021, be received;

AND FURTHER THAT the Clerk and Manager, Policy, so advise municipal partners and Conservation Ontario.

BACKGROUND
Since January 1, 2021, the Province of Ontario released for consultation a number of legislative, policy, and regulatory proposals of interest to TRCA, the majority of which were posted on the Environmental Registry of Ontario (ERO). The Planning Policy and Regulation Business Unit within the TRCA Policy Planning Division is primarily responsible for leading internal reviews of government proposals on a range of matters relevant to TRCA interests.

As in 2020, government initiatives and consultations continued at a steady pace from January 2021 and throughout the spring and summer, despite the COVID-19 Pandemic. During this time, TRCA staff have maintained business continuity in providing digital submissions that integrate the expertise and inter-disciplinary perspectives of TRCA's teams, informed by the successes and challenges staff experience in their day-to-day work with municipalities, proponents and other stakeholders, with emphasis on shared provincial, municipal and TRCA objectives.

Examples of ERO postings have included consultation on Growing the Greenbelt, changes to the *Planning Act* related to Minister Zoning Orders (MZO), strategies and regulations related to invasive species and fisheries management, and updates to Ontario's Water Quantity

Management Framework. These postings were in addition to the *Conservation Authorities Act* (CA Act) ERO posting #019-2986 by the Ministry of Environment, Conservation and Parks (MECP) on the Phase 1 Regulatory Proposals under the CA Act, as reported to the Board of Directors in May and June of 2021. All TRCA provincial policy submissions are vetted through senior staff, approved and signed by the Chief Executive Officer, or designate, prior to submission to ensure alignment with corporate strategic priorities and objectives.

RATIONALE

The outcomes of senior government initiatives can have implications on TRCA's day-to-day work in multiple roles as a resource management agency, a regulator, a public commenting body with delegated authority to represent the provincial interest for natural hazards, a service provider to municipalities and other public agencies, and landowner, in a region experiencing significant growth and associated land use and environmental challenges. Therefore, it is important for TRCA to provide input on government proposals in order to encourage provincial initiatives to align with and support TRCA and municipal partner objectives and interests.

The policy work undertaken to respond to consultations is also important for strengthening relationships and coordination between TRCA and provincial and municipal partners. Provincial government proposals are commonly based on the themes of streamlining and finding efficiencies to stimulate and expedite business activities such as major plans and projects. This has become an even stronger focus given the ongoing economic recovery from the COVID-19 Pandemic. At the same time, the importance of protected greenspace for both physical and mental health has become evident. It is vital for TRCA to highlight its expertise, experience and shared provincial and municipal objectives and issues, to demonstrate TRCA's valuable role in achieving efficiencies and effectiveness that support environmentally responsible and sustainable community building. Accordingly, federal, provincial and municipal staff sometimes reach out to TRCA for information and advice, in recognition of TRCA's expertise in watershed and ecosystem science, and depth of on-the-ground experience in development and infrastructure planning and detailed design.

Summary of Responses

Due to the volume and limited timeline of consultations established through the ERO process, (generally 30 to 45 days), only TRCA submissions on major initiatives are individually reported to the Board of Directors or Executive Committee, e.g., regulatory proposals under the *Conservation Authorities Act*.

For the Board's information, in Table 1 below is a list of provincial policy consultations for which TRCA completed and submitted responses from January to September 2021, with links to the ERO proposals. Recognizing that Board Members may have an interest in TRCA's submissions that are not brought to the Board, the corresponding TRCA letter responses to the ERO proposals are contained as the attachments to this report.

Item 8.5

Table 1-TRCA Submissions to the Environmental Registry of Ontario (ERO) Jan-Sept 2021

ERO Posting	Proposal Summary	Submission Date
Ontario Low-Carbon Hydrogen Strategy (ERO #019-2709) Link: https://ero.ontario.ca/notice/019-2709	The Ministry of the Environment, Conservation and Parks released a discussion paper for public consultation to help us develop Ontario's first ever hydrogen strategy so that we can create local jobs, attract investment and reduce greenhouse gas emissions.	January 18, 2021 Refer to Attachment 1
Proposed Implementation of Updates to Ontario's Water Quantity Management Framework (ERO #019-2017) Link: https://ero.ontario.ca/notice/019-2017	The Ministry of the Environment, Conservation and Parks is moving forward with guidance to help enhance the management of water takings in areas where quantity is a concern and where there are competing demands for water. MECP is also revoking the interim guidance on water bottling renewals at the same time that the enhancements to Ontario's water taking program will be put in place on April 1, 2021.	February 4, 2021 Refer to Attachment 2
Drainage Act Regulatory Proposal (ERO #019-2814) Link: https://ero.ontario.ca/notice/019-2814	The Ministry of Agriculture, Food and Rural Affairs is seeking feedback on a regulatory proposal that would implement the recent amendments to the Drainage Act. The new regulation would reduce burden, streamline approvals and address stakeholder concerns while maintaining environmental standards.	February 7, 2021 Refer to Attachment 3
Statement of Environmental Values for the Ministry of the Environment, Conservation and Parks (ERO #019-2826) Link: https://ero.ontario.ca/notice/019-2826	As committed to in our Made-in-Ontario Environment Plan, the MECP is proposing an amendment to its Statement of Environmental Values (SEV) in order to reflect changes in its mandate, to fulfill a commitment in the Made-in-Ontario Environment Plan with the addition of a climate change section, and to add a five-year review period.	February 20, 2021 Refer to Attachment 4

Proposed changes to Minister's zoning orders and the Planning Act (ERO #019-3233) Link: https://ero.ontario.ca/notice/019-3233	The Ministry of Municipal Affairs and Housing has made changes to the Planning Act so that zoning orders are not subject to the legislative requirement to be consistent with the Provincial Policy Statement.	April 2, 2021 Refer to Attachment 5
Consultation on growing the size of the Greenbelt (ERO #019-3136) Link: https://ero.ontario.ca/notice/019-3136	The Ministry of Municipal Affairs and Housing is seeking feedback on ways to grow the size of the Greenbelt.	April 19, 2021 Refer to Attachment 6 Report to Regional Watershed Alliance, May 2021
Update to the Ministry of Transportation's Statement of Environmental Values (ERO # 019-3422) Link: https://ero.ontario.ca/notice/019-3422	The Ministry of Transportation (MTO) is proposing to update its Statement of Environmental Values (SEV) in order to reflect its current vision, mandate and business, acknowledge the priority of addressing climate change and ensure up-to-date references.	May 10, 2021 Refer to Attachment 7
Proposed changes to certain land division provisions in the Planning Act (ERO #019-3495) Link: https://ero.ontario.ca/notice/019-3495	The Ministry of Municipal Affairs and Housing is proposing changes to the Planning Act related to control of the division of land (subdivision control, plans of subdivision, consents and validations), as well as other housekeeping or consequential changes to the Act.	May 25, 2021 Refer to Attachment 8
Ontario's Strategy to Address the Threat of Invasive Wild Pigs (ERO #019-3468) Link: https://ero.ontario.ca/notice/019-3468	The Ministry of Natural Resources and Forestry has drafted Ontario's Strategy to Address the Threat of Invasive Wild Pigs which outlines a proactive approach to prevent the establishment of invasive wild pigs in the province.	June 4, 2021 Refer to Attachment 9
Regulating 13 invasive species and watercraft as a carrier of invasive species under Ontario's Invasive Species Act, 2015 (ERO #019-3465) Link: https://ero.ontario.ca/notice/019-3465	The Ministry of Natural Resources and Forestry has developed a regulation proposal under the Invasive Species Act, 2015 that would classify 13 species as either prohibited or restricted invasive species, make related changes as a result of the classification of these species, and regulate watercraft as a carrier of invasive species.	June 4, 2021 Refer to Attachment 9 (responses for 019-3468 & 019-3465 were submitted in one letter)

Regulatory Proposals (Phase 1) Under the Conservation Authorities Act (ERO#019-2986) Link: https://ero.ontario.ca/notice/019-2986	The Ministry of the Environment, Conservation and Parks is proposing new regulations to focus conservation authorities on their core mandate by prescribing mandatory programs and services they must provide, give municipalities greater control over what conservation authority programs and services they will fund, consolidate "Conservation Areas" regulations and to require community advisory boards.	June 26, 2021 Refer to Attachment 10 Reports to Board of Directors, May and June 2021
Fisheries Management Zone 16 – Consultation on Planning Approaches (ERO #019-3564) Link: https://ero.ontario.ca/notice/019-3564	The Ministry of Natural Resources and Forestry is seeking feedback on proposed approaches and concepts to inform fisheries management planning for Fisheries Management Zone 16 in southwestern Ontario.	June 28, 2021 Refer to Attachment 11
York Region Wastewater Act (ERO #019-3802) Link: https://ero.ontario.ca/notice/019-3802	The Ministry of the Environment, Conservation and Parks is proposing to put on hold the Environmental Assessment application for the Upper York Sewage Solution. The government intends to establish an Expert Advisory Panel to provide advice on options to address wastewater servicing capacity needs in York Region.	July 2, 2021 Refer to Attachment 12
Greater Golden Horseshoe Transportation Plan - Discussion Paper (ERO #019-3839) Link: https://ero.ontario.ca/notice/019-3839	The Ministry of Transportation released a discussion paper to inform the development of a long-term transportation plan for the Greater Golden Horseshoe. The paper proposes a 30-year vision for mobility in the region, designed to meet collective goals and the transportation challenges of the future, and near-term actions that can be taken now to achieve this vision.	August 28, 2021 Refer to Attachment 13

Also provided for the information of the Board are the following summaries of select provincial and federal policy initiatives and submissions related to TRCA interests.

Federal Consultations

Consultation on the Creation of a Canada Water Agency

Environment and Climate Change Canada (ECCC) released a public Discussion Paper entitled, "Toward the Creation of a Canada Water Agency" in December 2020. In creating a Canada Water Agency (CWA), the Government of Canada acknowledged that freshwater management is a shared responsibility and committed to ensuring that each jurisdiction is respected but that duplication is avoided. Broad input from provinces, territories, Indigenous peoples, stakeholders and the public, was sought. The results of this engagement process were to inform the Government's next steps in implementing the commitment to create a CWA. The Government was not embarking on legislative or regulatory changes through the Discussion Paper.

TRCA submitted comments to ECCC on March 29, 2021, (refer to Attachment 14), in response to the Discussion Paper. Comments centred around TRCA roles as a conservation authority (watershed and partnership-based approach), CWA objectives and opportunities. With respect to coordination, TRCA commended the federal government for extensive work along the Oak Ridges Moraine over the past 20 years. For example, great partnerships were established with the Ontario Geological Survey, conservation authorities and municipalities; we remarked that this work had diminished in recent years and should be re-energized. As well, we commented that the government should provide guidance and financial support to ensure that work is coordinated and optimized and that a robust framework is in place to share data, knowledge, and wisdom with respect to the geology and hydrogeology of Canada. The comments also conveyed that the government should provide standards that should be met by each jurisdiction regarding ecosystem protection, flood management, water quality, etc., and the funding mechanisms to support local authorities in achieving those standards. For example, an update to "How Much Habitat is Enough?" is needed, especially with respect to urban area targets. The amount of natural cover and impervious surface in TRCA watersheds is directly tied to the health of its freshwater waterbodies and hydrologic systems.

The comments described water issues in TRCA's jurisdiction, such as too much water, having experienced record high water levels in the Great Lakes over the past five years, and the expectation that this will continue. At the same time, Ontario has undergone significant drought events over the past 20 years. It was suggested that investment is needed in water storage for use in times of drought; increased water stress is one prediction of a future climate but will not be the main concern based on current science. Better understanding is needed of long-term trends and influences, regional aquifer systems and the annual water budgets of the Great Lakes, so that governments can more accurately assign water use permits that match the available supplies.

Our comments also opined that Canada should be a leader in innovative water treatment technologies that make better use of the additional stormwater generated by urbanization, thereby managing stormwater as a resource rather than a liability. In addition, better understanding of the requirements of the growing aquaculture industry is needed to ensure that freshwater availability does not limit their success. One positive example cited was a successful stormwater treatment at a GTA golf course that produces high-quality irrigation water from a waste product that had previously impacted the natural hydrologic system with excess nutrients.

Responding to unique regional water management challenges by supporting regional centres of expertise was another welcome idea presented in the Discussion Paper that would bring expertise together to focus on issue-specific freshwater science. For example, more study is needed on how future climate will affect water resources. We remarked that TRCA is starting to tackle these issues through watershed planning and suggested that regional forums for discussing these priorities as a Community of Practice would be a helpful role for the CWA to take on. Official endorsement and support of the cross-jurisdictional work done by hydrologic and hydrogeologic practitioners across the Country are needed. TRCA suggested that more opportunities are necessary for these professionals to interact with each other and the academic community to ensure that ongoing research addresses issues that are identified by those who make use of freshwater resources and those that regulate such uses.

Provincial Consultations

Consultation on Growing the Size of the Greenbelt (ERO #019-3136)
This MMAH posting consulted on expanding the size of and enhancing the Greenbelt identifying priorities to:

- Expand the Greenbelt to include lands in and around the Paris Galt Moraine
- Add, expand, and further protect the region's Urban River Valleys

Through our comments, (refer to Attachment 6), TRCA supported in principle, the proposed Study Area of the Paris Galt Moraine being added to the Greenbelt, but as it is located outside of the TRCA's jurisdiction, we deferred to the local CAs in partnership with affected municipalities.

TRCA generally supported the Province's intent to expand Urban River Valleys (URVs). We stated our continued support for the provisions of Section 5.6.1 of the Greenbelt Plan that would enable addition of future lands acquired/dedicated into public ownership that meet provincial criteria for Greenbelt/URV expansion.

TRCA also identified additional potential Greenbelt expansion areas we believe generally align with the Province's criteria for expansion and would be in keeping with the Greenbelt Plan's objectives, vision and goals while further enhancing the quality and extent of existing protections. Examples include major watercourses in our jurisdiction currently excluded from the Greenbelt but linked to existing Greenbelt areas, URVs with direct connections through the Plan's natural heritage, and water resource systems linked through Lake Ontario. We affirmed that substantive consultation with our municipal partners is critical regarding any such expansions, and that these expansions should be considered in the context of the municipal comprehensive review (MCR) process. We offered that should expansions within our jurisdiction be proposed, (ideally after the MCR conformity deadline), TRCA would welcome the opportunity to help delineate the most appropriate boundary expansions based on science and in consultation with affected municipalities.

The comments also included that TRCA has been developing Water Resource System (WRS) data layers to help our municipal partners conform to new provincial policies requiring identification of the WRS. These scientific and systems-based areas (or portions thereof) would more effectively inform future Greenbelt expansions once the Natural Heritage System (NHS) and WRS frameworks are in place and related components of MCR work conclude. In response to the discussion question, "How should the Province balance or prioritize any potential Greenbelt expansion with the other provincial priorities (Growth Management, Natural Heritage and Water Resource Systems, Agriculture, Infrastructure)?" it was TRCA's recommendation that Greenbelt expansions should be informed by science and considered in the context of ongoing MCR processes.

Invasive Species EROs
Under ERO postings for regulating 13 invasive species and watercraft as a carrier of invasive species under Ontario's *Invasive Species Act*, 2015 (ERO #019-3465), and Ontario's Strategy to Address the Threat of Invasive Wild Pigs (ERO #019-3468), the Ministry of Natural Resources and Forestry (MNRF) determined a variety of species to have the potential to, or are already, causing negative impacts to Ontario's natural environment and that regulation under the *Invasive Species Act,* would improve Ontario's ability to prevent their introduction or spread. Under the *Invasive Species Act*, decisions to recommend species for regulation are based on the risk that a species poses to Ontario's natural environment and socio-economic well-being.

Overall, TRCA generally supported the proposals for invasive species management as described in the ERO postings and in the draft Strategy on Invasive Wild Pigs (Refer to Attachment 9). In TRCA's experience, proactive assessment and management of invasive species is required to avoid ecological, economic and societal impacts of these species, particularly in the face of a changing climate. In addition to the proposed species regulation, carrier specific rules and the draft Strategy on Invasive Wild Pigs, TRCA recommended the Ministry undertake ecological risk assessments to determine the appropriate approach for managing 33 species that pose immediate threats to the environmental, social, and economic resilience of Ontario.

Greater Golden Horseshoe Transportation Plan - Discussion Paper (ERO #019-3839)
On June 29, 2021, the Ministry of Transportation (MTO) released the Greater Golden Horseshoe (GGH) Transportation Plan Discussion Paper ("the Paper") for comment. The Paper proposes a 30-year vision for mobility designed as a safe, seamless, and accessible transportation system for all Ontarians. It also sets out current and future transportation challenges and illustrates and describes ongoing and conceptual actions to help overcome them, including innovative approaches to policy solutions and new ways to partner, procure and deliver infrastructure and related services. Feedback from the ERO posting will inform the development of the forthcoming GGH Transportation Plan ("the Plan"), which is targeted for release later in 2021.

TRCA commented that we generally support the Paper's long-term vision for mobility across the GGH, particularly as it relates to a more resilient and environmentally sustainable transportation system that will mitigate environmental impacts and adapt and respond to climate change risks (refer to Attachment 13). We conveyed that we believe that to optimize transportation infrastructure investments requires an integrated approach of complete community building that employs active transportation, avoids, or mitigates and remediates natural hazards, and conserves and enhances greenspace, thereby improving mobility and reducing transportation-related environmental and human health impacts. In addition to detailed commentary specific to sections of the Paper, TRCA provided comments organized under the following themes and recommendations:

- integrate or cross-reference policies and objectives of the proposed Plan with other provincial policy goals to ensure transportation system planning, land use planning and transportation investment are coordinated effectively
- consider additional innovative, sustainable transportation solutions such as integrating transit hubs with linkages to active transportation in areas outside highly urban areas, and exploring opportunities to improve the state of natural hazards or natural heritage connectivity through new infrastructure projects
- emphasize protection of the natural system to avoid and mitigate climate change impacts
- codify an ecosystem compensation process to ensure no net lost of the natural heritage system and strive, where possible, for a net gain (e.g., TRCA's Guideline for Determining Ecosystem Compensation which has been incorporated into the Metrolinx Vegetation Guideline, 2020)
- reference the importance of managing the risk associated with natural hazards and require that, where possible, new, replaced, upgraded and/or transportation infrastructure be carefully site and designed to avoid, mitigate and remediate risks associated with flooding, erosion or slope instability
- enable implementation of sustainability initiatives, cross-referencing future policies with

actions and associated impacts and/or co-benefits to help ensure policies are comprehensive and inclusive (e.g., referencing the Metrolinx Sustainability Strategy)
- promote a connected/integrated active transportation network: TRCA's Trail Strategy for the Greater Toronto Region (and Trail Strategy Data) can help provide the foundation for existing and planned active transportation routes across our jurisdiction, as well as potential strategic points of synergy with broader trail networks and major transportation infrastructure projects and mobility hubs.
- that MTO commit to TRCA's Voluntary Project Review (VPR) process for transportation projects in our jurisdiction.

Relationship to Building the Living City, the TRCA 2013-2022 Strategic Plan
This report supports the following strategies set forth in the TRCA 2013-2022 Strategic Plan:
Strategy 2 – Manage our regional water resources for current and future generations
Strategy 4 – Create complete communities that integrate nature and the built environment
Strategy 8 – Gather and share the best sustainability knowledge
Strategy 12 – Facilitate a region-wide approach to sustainability

FINANCIAL DETAILS
Staff are engaged in this policy analysis work per the normal course of duty, with funding support provided by TRCA's participating municipalities to account 120-12. No additional funding is proposed to support the policy analysis work associated with the preparation of these comments.

DETAILS OF WORK TO BE DONE
TRCA staff will continue to monitor federal policy consultations, the Environmental Registry of Ontario and the Province of Ontario News' Website to ensure TRCA is aware of, and where appropriate, participates and comments on legislative, regulatory, policy and technical guidance initiatives affecting TRCA interests.

Staff will keep the Board of Directors and Committees of the Board informed of TRCA submissions at regular intervals and will monitor the outcomes of future decision notices, and report on the implications of legislative, regulatory and policy initiatives as appropriate. Staff will also update TRCA policies and procedures as required and facilitate training to reflect legislative and policy changes affecting TRCA.

Report prepared by: Mary-Ann Burns, extension 5763; Matthew Wianecki, extension 5364
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Date: September 9, 2021
Attachments: 14

Attachment 1: TRCA Submission on ERO#019-2709
Attachment 2: TRCA Submission on ERO#019-2017
Attachment 3: TRCA Submission on ERO#019-2814
Attachment 4: TRCA Submission on ERO#019-2826
Attachment 5: TRCA Submission on ERO#019-3233
Attachment 6: TRCA Submission on ERO#019-3136
Attachment 7: TRCA Submission on ERO#019-3422
Attachment 8: TRCA Submission on ERO#019-3495

Item 8.5

Attachment 9: TRCA Submission on ERO#019-3468 and 019-3465
Attachment 10: TRCA Submission on ERO#019-2986
Attachment 11: TRCA Submission on ERO#019-3564
Attachment 12: TRCA Submission on ERO#019-3802
Attachment 13: TRCA Submission on ERO#019-3839
Attachment 14: TRCA Submission on Creation of a Clean Water Agency

Attachment 1: TRCA Submission on ERO#019-2709

Chief Executive Officer

Toronto and Region Conservation Authority

January 18, 2021

BY E-MAIL ONLY (hydrogen@ontario.ca)

Mr. Michael Bishop
Ministry of Environment, Conservation and Parks
Climate Change Program Development
135 St. Clair Ave W
Toronto, ON M4V 1P5

Dear Mr. Bishop:

Re: Ontario Low-Carbon Hydrogen Strategy - discussion paper (ERO #019-2709)

Thank you for the opportunity to comment on the Ministry of Environment, Conservation and Parks' (MECP) Environmental Registry (ERO) posting on the Ontario Low-Carbon Hydrogen Strategy (the Hydrogen Strategy) discussion paper to help the ministry develop Ontario's first ever hydrogen strategy. Toronto and Region Conservation Authority (TRCA) commends the Ministry for taking on this important project and believes that the Strategy is a crucial step in helping Ontario achieve its climate mitigation goals as well as many other important sustainability outcomes.

TRCA conducts itself in accordance with the objects, powers, roles and responsibilities set out for conservation authorities (CA) under the *Conservation Authorities Act* and the MNRF Procedural Manual chapter on CA policies and procedures for plan review and permitting activities. TRCA is:

- A public commenting body under the *Planning Act* and *Environmental Assessment Act (EAA)*;
- An agency delegated the responsibility to represent the provincial interest on natural hazards under Section 3.1 of the Provincial Policy Statement;
- A regulatory authority under Section 28 of the *Conservation Authorities Act*;
- A service provider to municipal partners and other public agencies;
- A Source Protection Authority under the *Clean Water Act*;
- A resource management agency; and
- A major landowner in the Greater Toronto Area.

In these roles, and as stated in "A Made-In-Ontario Environment Plan," TRCA works in collaboration with municipalities and stakeholders to protect people and property from flooding and other natural hazards, and to conserve natural resources. TRCA is dedicated to managing the natural resources and risks to life and property from natural hazards for the municipalities we serve. Climate change poses a significant risk to the natural resources we manage and could significantly impact the risks to life and property from natural hazards. TRCA works closely with our municipal partners and other stakeholders to help mitigate and adapt to climate change in both new and existing developments and infrastructure.

At TRCA we strongly believe that as a society we can only achieve long-term environmental sustainability by addressing social and economic sustainability as synergistic requirements. To this end, we work with our municipal partners to incorporate environmental, social and economic considerations into our decisions and program delivery. For example, TRCA's Partners in Project Green (PPG) program is a collaborative initiative with municipal partners to engage the business community in environmental, social, and economic sustainability. Similarly, our Sustainable Neighbourhood Action Program (SNAP) is a place-based sustainability program, engaging neighbourhoods in tangible sustainability actions.

Government Proposal

We understand that MECP is seeking input on a discussion paper on the development of Ontario's first low-carbon hydrogen strategy, to better understand the needs of the sector, including consumers, better understand the challenges of supporting a complex hydrogen market, and consider ways to enable the private sector to expand adoption of hydrogen and support regional growth. The preliminary vision is to leverage existing strengths to develop Ontario's hydrogen economy, creating local jobs and attracting regional investment while reducing greenhouse gas emissions. This opportunity to comment is a pre-consultation, and the comments received will help inform the strategy. Some of the topics MECP is seeking feedback on include:

- The vision for Ontario's hydrogen strategy
- Supporting the Environment Plan by reducing greenhouse gas (GHG) emissions through low-carbon hydrogen
- Generating economic development and jobs by building a hydrogen industry involving all regions of Ontario to create jobs and facilitate economic recovery, seek strategic partnerships and support innovation
- Promoting energy resilience by considering the value of domestic hydrogen for Ontario's energy bills and evolving energy system
- Reducing barriers and enabling action in order to attract investment and create a level playing field between technology options
- Using hydrogen where and when it makes sense, focusing on areas that are most likely to become cost-effective.

General Comments

Overall, the discussion paper is excellent and provides good context for the development of the Hydrogen Strategy. Below are some strategic insights, comments, and recommendations for MECP's consideration, in addition to a detailed table of responses to the questions posed in the discussion paper (Table 1).

The context for the Hydrogen Strategy would be strengthened by addressing the need to achieve net-zero carbon emissions. The development of a Hydrogen Strategy is an important signal to business and investors that Ontario is serious about the hydrogen economy, however, the need for a hydrogen economy is driven by the need to achieve net-zero carbon emissions. The

UNFCCC's Race To Zero initiative (https://unfccc.int/climate-action/race-to-zero-campaign#eq-1) has 120 countries and a wide variety of businesses, cities, regions, universities, committed to net-zero emissions. Together, these actors represent 25% of global emissions and 50% of global gross domestic product. If Ontario were to adopt a net-zero carbon goal, it would further strengthen the government's message concerning a low-carbon economy. Adopting this goal may also be beneficial to Ontario in attracting federal funding in support of low-carbon initiatives.

The discussion paper mentions "cost effective hydrogen" but we recommend that this requirement be strengthened. Canada has some of the least expensive hydrogen in the world that is created from natural gas. By addressing opportunities for carbon capture, utilization and storage (CCUS), Ontario, like Alberta, could produce "blue" hydrogen which is significantly more cost competitive but does not have as low a carbon footprint as "green" hydrogen. Blue hydrogen can help make the transition to green hydrogen more cost competitive and, at the same time, promote the carbontech sector – technologies that turn captured carbon into commercial products – and associated economic development, and help achieve shorter term GHG emissions targets (see the Pembina Institute paper on Carbontech, https://www.pembina.org/pub/carbontech-innovation-system-canada).

We recommend that the work of The Transition Accelerator (https://transitionaccelerator.ca/) be included to inform the Hydrogen Strategy. The Transition Accelerator is an organization working to accelerate the adoption of transformative technologies and approaches to reduce GHG emissions. Research papers available on The Transitional Accelerator website would be valuable assets in the development of Ontario's Hydrogen Strategy. This organization provided valuable input to the development of Canada's National Hydrogen Strategy and promotes a "node" based approach along with government, business, academic, and non-profit collaboration that would work well in Ontario. The National Hydrogen Strategy has adopted this approach (calling nodes "Hubs").

TRCA recommends that The Transition Accelerator approach to developing hydrogen nodes be utilized in Ontario. We recommend examining Bruce County, Sarnia, the Greater Toronto and Hamilton Area, Sudbury and Sault Ste. Marie as the key nodes for developing market demand for hydrogen, to eventually be linked by hydrogen pipeline in the medium term, and to Alberta and Quebec in the longer term. These nodes could also be "sandboxes" where new policies and approaches are piloted in advance of rolling them out across Ontario. TRCA suggests that the QUEST innovation-sandbox model (https://questcanada.org/project/innovation-sandboxes-project/) be reviewed as an approach that could help Ontario.

Finally, TRCA thanks MECP for choosing this path to a hydrogen-focused and low-carbon economy. As mentioned earlier, Ontario cannot achieve environmental sustainability without socio-economic sustainability. Our Partners in Project Green program, working in partnership with municipalities and the Greater Toronto Airport Authority, is currently engaged with thousands of businesses in the Greater Toronto Area on sustainability issues. We would be glad to meet with staff on the Hydrogen Strategy project to see how our programs can help MECP succeed in developing and implementing the Hydrogen Strategy.

Attachment 1: TRCA Submission on ERO#019-2709

Table 1. TRCA responses to Ontario Low-Carbon Hydrogen Strategy Discussion Paper questions; our main recommendations are indicated in **bold**.

DISCUSSION QUESTION	TRCA COMMENTS
Vision	
1. Do you support Ontario's efforts to create a hydrogen strategy?	Yes, moving toward sustainable low-carbon fuels is an important environmental and economic step for Ontario in achieving net-zero carbon emissions.
2. How would you refine the vision statement?	Energy resilience is included in the principles but consider adding it to the vision. *Example*: Leverage our existing strengths to develop Ontario's hydrogen economy, creating local jobs and attracting investment while reducing greenhouse gas (GHG) emissions and increasing energy resilience.
3. What should be the key outcomes of Ontario's hydrogen strategy?	The broader case for hydrogen has been made many times in a variety of documents. Drawing on what others have done, it is important that the Ontario Hydrogen Strategy lays out a framework and next steps for proceeding with action in Ontario. **We highly recommend that MECP reviews the work of The Transition Accelerator and their approach to creating hydrogen nodes and collaborative action, or, as the national Strategy refers to them, Hydrogen Hubs.** https://transitionaccelerator.ca/
4. How should the hydrogen strategy define and measure success?	There are several key performance measures that should be considered: • Level of hydrogen production in Ontario (energy content, weight or volume) for grey, blue and green hydrogen (and import if applicable) • Geographic distribution of hydrogen usage and how it is being used (industrial process, energy production, consumer use, and others) • Annual monetary investment in hydrogen infrastructure (by type: production, distribution, end use) • Annual monetary investment in hydrogen research and development • Annual GHG emissions reductions and carbon offsets created (carbon capture and storage may be applied to existing grey hydrogen production and capital expenditure funded through sale of offsets)
Reducing greenhouse gas emissions	
5. What are Ontario's key technology, regulatory, and business opportunities in developing low-carbon hydrogen?	**Consider linking the Hydrogen Strategy with helping Ontario get to net-zero carbon emissions**. Linking with the broader goal allows the Hydrogen Strategy to be positioned as part of a broader low-carbon economy. This is important as many organizations may not yet see

Attachment 1: TRCA Submission on ERO#019-2709

DISCUSSION QUESTION	TRCA COMMENTS
	themselves as having a role to play in the hydrogen economy (even as an end user) but can envision participating in the low-carbon economy. **It may also be important to address Carbontech (https://www.pembina.org/pub/carbontech-innovation-system-canada) as the carbon capture, utilization and storage (CCUS) sector is developing in Ontario and would complement the development of blue hydrogen and the cost-effective transition to green hydrogen.**
6. What is the potential for hydrogen to contribute to Ontario's 2030 greenhouse gas emission reduction target?	The breadth of potential uses suggests that it could play a very important role in achieving provincial GHG emissions targets. As technology and markets develop, hydrogen has the potential to play important roles in reducing emissions in the transportation sector (especially emissions from heavy-duty vehicles) and reducing grid emissions, as fuel in peaking plants and in improving grid power quality, and as a process fuel for industry (e.g., steel, cement, and many others). In the longer term as costs and distribution infrastructure increase, it can have an important role as a passenger vehicle fuel or for residential home heating. In the short term, Carbontech for carbon capture and storage to turn grey hydrogen into blue could generate significant GHG emissions reductions. TRCA is aware that the north shore of Lake Erie has some potential for carbon storage in deep oil and gas wells, which could support reducing GHG emissions from hydrogen production.
7. What additional environmental benefits should be considered in the development of the strategy (for example during hydrogen production)?	Using hydrogen as a substitute for transportation fuels such as diesel can improve air quality, which is a major ecological, health, and environmental justice issue in urban and industrial areas. Analysis of environmental benefits could include quantifying the net anticipated reduction in GHG emissions of a fully implemented Hydrogen Strategy (accounting for life cycle analysis of hydrogen production and distribution, and GHG emissions offset through hydrogen use), and resulting reduced impacts on Ontario's environment of mitigating climate change.
Generating economic development and jobs	
8. What role can hydrogen play in various regions and sectors? AND 9. What actions can Ontario take to help Ontario companies get	**TRCA highly recommends looking at The Transition Accelerator and their node approach to building a hydrogen economy. There may be several important nodes in the province each of which have different technology, policy, and incentive requirements. Consulting with industry and leadership in each of these nodes to**

DISCUSSION QUESTION	TRCA COMMENTS
ready to meet expected international demand (for example research and development, innovation, procurement)?	**develop an individualized road map would be critical for long term success.** Key nodes could include Bruce County, Sarnia, GTA and Hamilton, Sudbury and Sault Ste. Marie. • Bruce County requirements would center on using off-peak electricity to generate green hydrogen, and the need to connect with markets. • Sarnia's requirements might focus on CCUS to address GHG emissions from existing hydrogen production, and developing additional local demand for hydrogen. • GTA and Hamilton include a wide breadth of industries that could use hydrogen, including steel, cement, power, food and beverage and transportation, and thus a different set of policy, technology, and incentive requirements. • Sudbury requirements would need to address mining and associated industry characteristics.
Promoting energy resilience	
11. How can hydrogen support a reliable and affordable energy system, including energy storage?	**The key to an affordable energy system using hydrogen is to start with development of a low-cost blue hydrogen product and developing an associated market. As green hydrogen becomes more affordable outside of niche uses, the market can be transitioned to green hydrogen.**
12. What are the barriers and opportunities for hydrogen in the energy system?	**TRCA highly recommends looking at The Transition Accelerator and their work on Alberta's hydrogen nodes.**
Reducing barriers and enabling action	
13. How can the provincial government best support partnerships with the private sector, academia and other government / levels of government?	**The government can best support these partnerships by applying the hydrogen node approach and developing working groups for each node that includes, government, business and NGOs to guide and participate in action. TRCA currently has a collaborative program in the GTA in partnership with the Greater Toronto Airport Authority (Partners in Project Green) that is developing the largest eco-business zone in North America. The program engages with key government and business organizations and could be used to facilitate the development of a GTA and Hamilton Hydrogen Node. We would be pleased to meet with MECP staff to explore this opportunity.**
15. What are the best opportunities to cost-effectively	**Generating low-cost blue hydrogen and associated markets is likely the most effective approach to initiating a hydrogen market in Ontario. Discussions with existing hydrogen production facilities**

DISCUSSION QUESTION	TRCA COMMENTS
support hydrogen across Ontario while respecting tax payers?	**and organizations in the Carbontech sector and academia would be key to initiating this opportunity. This is likely the best approach to initiate larger market demand for hydrogen.** Green hydrogen will have small niche markets where it makes sense to pay \$3 to \$5 per kilogram of hydrogen. These markets are worth pursuing but are unlikely to be the path to a broader hydrogen market in the short or medium term. One example of a niche market is the work the National Renewable Energy Laboratory (NREL) in the United States is conducting with electrolysers for hydrogen production as a tool to improve electrical grid power quality. Electrolysers can be used to strategically to improve power quality, which generates value for the grid; the by-product is hydrogen production. This hydrogen can be sold to market or used in a fuel cell to further stabilize the electrical grid.
Using hydrogen where and when it makes sense	
16. What potential feedstocks and stages of the hydrogen supply chain (production, storage and distribution, and end-use) do you think Ontario is best positioned to develop and lead in and which uses have the greatest potential for cost reduction?	Please see previous answer (#15) on blue hydrogen. **TRCA emphasizes the imperative to build on existing markets for hydrogen (production and use), as this will undoubtably be the best low-cost path to a broader hydrogen market. This approach will help create the needed hydrogen infrastructure to eventually support the many diverse end-use hydrogen technologies that are only viable once hydrogen infrastructure is in place. This approach will also enhance Ontario's growth in the Carbontech sector (associated with CCUS).** **In terms of other feedstocks, TRCA recommends creating a hierarchy for hydrogen sources to prioritize. Similar to waste management, priority could be given to hydrogen sources from food and organic waste and forestry waste over standing forest biomass. Further, if forest biomass is utilized, it will be important to examine life cycle carbon emissions, impacts on ecological services, and overall sustainability of utilizing standing or downed forest biomass, and impose conditions to ensure long-term sustainability and net GHG emissions reductions.**
17. What are the main risks of hydrogen use in Ontario and are there opportunities for the government to decrease these risks?	A major risk of hydrogen use is safety as with any other gaseous fuel source. Hydrogen is highly flammable and is colourless and odorless, requiring specialized systems to detect and prevent leaks. The government can reduce such risks by establishing stringent safety standards for the production, storage and distribution and end-use of hydrogen.

DISCUSSION QUESTION	TRCA COMMENTS
18. Considering that low-carbon hydrogen is expected to be more competitive over time, what should be the timeframe for Ontario's hydrogen strategy?	**The overall strategy should look out 10 years in detail and 20 years at a high level. The time frames may differ between the different nodes, if the nodes approach is employed by MECP.** **TRCA also suggests that MECP incorporate the QUEST innovation – sandbox approach (https://questcanada.org/project/innovation-sandboxes-project/) as a way to test programs, policies, and incentives before rolling them out more broadly in the province. This approach might also help accelerate hydrogen market development.**

Thank you once again for the opportunity to provide comments on the Ontario Low-Carbon Hydrogen Strategy discussion paper. Should you have any questions, require clarification on any of the above, or wish to meet to discuss our remarks, please contact the undersigned at 416.667.6290 or at john.mackenzie@trca.ca.

Sincerely,

<Original Signed by>

John MacKenzie, M.Sc.(PI) MCIP, RPP
Chief Executive Officer

BY E-MAIL
cc:

TRCA: Laurie Nelson, Director, Policy Planning
Darryl Grey, Director, Education and Training
Bernie McIntyre, Senior Manager, Corporate Sustainability and Community Transformation
Noah Gaetz, Senior Manager, Ecosystem and Climate Science

Attachment 2: TRCA Submission on ERO#019-2017

February 4, 2021

Mr. Brent Taylor
Ministry of the Environment, Conservation and Parks
Water Policy Branch
40 St. Clair Avenue West
Toronto, ON M4V 1M2

BY E-MAIL ONLY (waterpolicy@ontario.ca)

Dear Mr. Taylor:

Re: Proposed Implementation of Updates to Ontario's Water Quantity Management Framework (ERO #019-2017)

Thank you for the opportunity to comment on the Ministry of Environment, Conservation and Parks (MECP) Environmental Registry (ERO) posting on proposed implementation of updates to Ontario's water quantity management framework. We understand that MECP is seeking input on draft guidance to help manage water taking in areas where water quantity is a concern and where there are competing demands for water. We also understand that MECP is proposing to remove Ontario's interim guidance on bottled water, which was implemented in 2017 as a temporary measure for renewals of existing bottled water permits during the moratorium for new and increasing bottled water takings, and will be in place until April 1, 2021.

The Toronto and Region Conservation Authority (TRCA) conducts itself in accordance with the objects, powers, roles and responsibilities set out for conservation authorities (CAs) under the *Conservation Authorities Act* (CA Act) and the MNRF Procedural Manual chapter on CA policies and procedures for plan review and permitting activities. TRCA is:

- A public commenting body under the *Planning Act* and *Environmental Assessment Act*;
- An agency delegated the responsibility to represent the provincial interest on natural hazards under Section 3.1 of the Provincial Policy Statement;
- A regulatory authority under Section 28 of the CA Act;
- A service provider to municipal partners and other public agencies;
- A Source Protection Authority under the *Clean Water Act*;
- A resource management agency; and
- A major landowner in the Greater Toronto Area.

In these roles, and as stated in the *Made-In-Ontario Environment Plan*, TRCA works in collaboration with municipalities and stakeholders to protect people and property from flooding and other natural hazards, and to conserve natural resources. TRCA provides technical support to its municipal partners through Memorandums of Understanding and Service Level Agreements in implementing the natural heritage, natural hazard and water resource policies of municipal and provincial plans. In addition, as a conservation land manager, TRCA undertakes planning, design and construction of natural heritage restoration projects and flood and/or erosion remediation projects in coordination with public or private landowners, to protect life, property, and infrastructure and to improve environmental conditions.

Proposal

We understand the government's proposed Draft Water Quality Implementation Guidance would support implementation of recently proposed updates to the Water Taking and Transfer Regulation (Ontario Regulation 387/04) to enable area-based water quantity management and priorities of water use.

In June 2020, MECP proposed enhancements to Ontario's water taking program, including:

- requiring water bottling companies to have the support of their host municipalities for new and increasing bottled water takings;
- establishing priorities of water use in the province that can guide water taking decisions;
- assessing and managing multiple water takings together in areas of the province where water sustainability is a concern; and
- making water taking data available to the public to increase transparency of how Ontario manages water resources.

Information on the proposed enhancements, the results of the ministry's water quantity management review, and the assessments completed by independent experts as part of the review, were included in a previous related ERO posting #019-1340, Updating Ontario's Water Quantity Management Framework, for which TRCA submitted comments in our letter to the Water Policy Branch dated July 31, 2020.

We understand the current proposal would enable MECP to assess and manage water resources and the impact of multiple water users to guide management actions more effectively in areas experiencing water quantity stress. While applying to permitted water takers, it is expected to provide broader benefits by promoting the sustainability of water resources and water security for all water users in an area. Additionally, it would set out priorities of water use to be taken into account when MECP considers whether to renew, cancel, or amend existing permits; this would be in instances where there are competing demands for water among established users that cannot be resolved through other means.

General Comments

With TRCA's roles, responsibilities, and experience in mind, we offer the following comments on MECP's Draft Water Quantity Implementation Guidance and the proposed regulatory amendments. Key points are in **bolded text.**

TRCA supports the proposed Implementation Guidance as it would enable area-based water quantity management strategies and appropriate priorities of water use. TRCA believes this comprehensive approach is preferrable to the previous approach, which focused on a single industry (i.e., water bottling) and effectively represented a cap on the overall management of the water taking permitting process. TRCA agrees that the province's water quantity management framework needs to be more robust and capture the holistic impact of multiple water uses and takings to properly assess sustainability. Having this direction implemented through regulation and a provincial guidance document is a positive step towards advancing this shared goal and will improve transparency and certainty for all stakeholders.

CAs apply a science-based approach when considering the cumulative impacts of water takings on areas experiencing water stress, including through the issuance of permits under the CA Act, development of watershed plans, and in our roles as source protection authorities. We are pleased to see that the Guidance document makes distinct reference and connection to watershed planning (pages 6 and 11) as it aligns with this science-based, local watershed perspective on water resources. TRCA would welcome the opportunity to share our watershed planning data, expertise, and experience to assist the Province in determining the need for and preparing area-based water taking strategies to better assess and manage water quantity within TRCA's jurisdiction. To this end, we note that the draft Guidance states that CAs *may* have a collaborative role (pages 5, 6 and 10) and as local stakeholders could be consulted to help shape the contents of a water taking management strategy (i.e., monitoring and assessment). Nonetheless, it is not clear what would trigger CA engagement and to what extent CAs may be involved. For instance, would CAs be engaged on work related to water quantity risk evaluation under the *Clean Water Act* that we have been involved in the past? What sort of data and application-specific information would be provided to CAs?

In TRCA's review of Permits to Take Water (PTTW), the accompanying information is typically very limited. CAs' expertise in watershed planning and local watershed conditions and management warrants our engagement in the development of area-based water taking management strategies within the respective CAs' jurisdictions. On page 11, the guidance says, "During the development of a strategy, engagement with affected water users, local stakeholders (e.g., conservation authorities) . . . would be needed." **Accordingly, we recommend that the draft Guidance more specifically direct and enable pre-consultation with the respective CA for Permits to Take Water and the development of area-based water taking strategies.** This would contribute to streamlining and better inform cumulative impact assessment in instances where a PTTW and/or an area-based assessment and a CA permit were all required for the same project.

TRCA is also pleased to see in the proposed regulation amendments and the draft Guidance that environment and drinking water continue to be categorized as the first and highest priority for water use to resolve competing demands for water among established water takers due to a shortage of water in an area.

The following comments are organized by the ERO proposal's areas of change we have selected for input. As above, **bolded text** indicates key suggestions and recommendations for MECP's consideration.

Draft Implementation Guidance	
Section	**Comments**
Draft Guidance to support area-based water quantity management	
Area-based water taking management strategy	**TRCA supports MECP's approach of an area-based water taking management strategy.** This action addresses our previously stated concern that the assessment of cumulative effects represents an existing gap in the overall management of the water taking permitting process.
Considerations for initiating a water taking management strategy	MECP should solicit feedback from Source Protection programs as a valuable foundation of background information to support the Ministry's decision-making process.
Preliminary assessment	The preliminary assessment should include insight from the Provincial Groundwater Monitoring Program, the Drinking Water Source Protection Program and regional monitoring information from CAs' monitoring data.
Preparing a water taking management strategy	TRCA supports the proposed process.
Engaging water users, local stakeholders, and Indigenous communities on a water taking management strategy	TRCA supports the proposed process.
Aligning a water taking management strategy with other provincial policies and programs	The strategy should consider policies included in Source Protection Plans, such as the Credit Valley, Toronto and Region and Central Lake Ontario (CTC) Policy DEM-6, which proposes a regional groundwater management system.
Draft guidance to support priorities of water use	
What are the priorities of water use?	TRCA supports the proposed process.
Priority 1 – Environment and drinking water (equally)	Priority 1 discusses the water balance requirements for natural functions of an ecosystem being one of the highest priorities. However, one of the terms used in Priority 4 (the lowest priority) is "natural features" and landscaping. Please consider revising the term "natural features" to better indicate its form, e.g., "landscaped feature". The current term is

Draft Implementation Guidance	
Section	**Comments**
	similar to natural ecological features, such as wetlands, and therefore, it may be misconstrued that wetlands could be considered a Priority 4 "natural feature."
Priority 4 – Other	See comment on Priority 1
When do the priorities of water use apply?	TRCA supports the process for determining when to implement water use priorities.
How do the priorities of water use apply?	TRCA supports the process for determining when to implement water use priorities.
Other considerations for applying priorities of water use	TRCA supports the considerations put forward by MECP.

Thank you once again for the opportunity to provide comments on proposed implementation of updates to Ontario's water quantity management framework. Should you have any questions, require clarification on any of the above, or wish to meet to discuss our remarks, please contact the undersigned at 416.667.6290 or at john.mackenzie@trca.ca.

Sincerely,

<Original Signed by>

John MacKenzie, M.Sc.(Pl), MCIP, RPP
Chief Executive Officer

BY E-MAIL

cc:

TRCA: Laurie Nelson, Director, Policy Planning
Sameer Dhalla, Director, Development and Engineering Services
Don Ford, Senior Manager, Hydrogeology and Source Water Protection

February 5, 2021

BY E-MAIL ONLY (sarah.peckford@ontario.ca)

Sarah Peckford
Ministry of Agricultural, Food and Rural Affairs
Food Safety and Environmental Policy Branch
1 Stone Road West
Ontario Government Building, 2nd floor, Southwest
Guelph, ON
N1G 4Y2

Dear Ms. Peckford:

Re: Drainage Act Regulatory Proposal (ERO #019-2814)

Thank you for the opportunity to comment on the Ministry of Agricultural, Food and Rural Affairs' (OMAFRA) Environmental Registry (ERO) posting on the Drainage Act Regulatory Proposal.

The Toronto and Region Conservation Authority (TRCA) conducts itself in accordance with the objects, powers, roles, and responsibilities set out for conservation authorities (CAs) under the *Conservation Authorities Act* (CA Act) and the MNRF Procedural Manual chapter on CA policies and procedures as:

- A public commenting body under the *Planning Act* and *Environmental Assessment Act*;
- An agency delegated the responsibility to represent the provincial interest on natural hazards under Section 3.1 of the Provincial Policy Statement;
- A regulatory authority under section 28 of the CA Act;
- A service provider to municipal partners and other public agencies;
- A resource management agency; and
- A major landowner in the Greater Toronto Area.

In these roles, TRCA works in collaboration with municipalities and stakeholders to protect people and property from flooding and other natural hazards, and to conserve natural resources. As stewards of the land, the agricultural community is a key partner in achieving the long-term health of our watersheds.

Proposal

We understand that a new Minister's Regulation is proposed that would implement the amendments to the *Drainage Act* under the *COVID-19 Economic Recovery Act*, 2020, in order to:

- Provide a simplified process for minor improvements to municipal drains;
- Simplify the process for approving updates to engineer's reports for changes to the design made during construction; and
- Adopt the "Drainage Act and Conservation Authorities Act Protocol" (DART Protocol) by reference.

Please note that TRCA previously commented on related ERO posting # 019-1197 in our letter to you, dated February 19, 2020; we note that in the ERO Decision Notice for this proposal it states that OMAFRA will be considering an expansion of the DART Protocol to continue to streamline approvals with the CA Act while maintaining environmental protections. TRCA looks forward to being notified of any future initiatives and consultation in this regard, in coordination with Conservation Ontario, and other CAs.

General Comments

TRCA continues to support the government's initiative to streamline review processes to facilitate drainage critical for agricultural productivity and the production of food. Sustainable agricultural practices are associated with numerous ecosystem goods and services, such as food, fibre and bioenergy production, maintenance of water quality and quantity, soil conservation, soil structure and fertility maintenance, nutrient recycling, pollination, pest control, biodiversity maintenance and carbon sequestration.

TRCA appreciates the government's acknowledgement that the new regulation may better facilitate projects that provide flood protection with environmental co-benefits such as reduced erosion and nutrient loss, including those that incorporate green infrastructure principles by using the "DART" protocol to apply for CA permits. Implementation of the DART protocol has improved regulatory certainty, reduced burden, and streamlined permitting requirements under section 28 of the CA Act for routine maintenance and repair of municipal drains. Through this new regulation, we hope that the DART protocol, and any refinements to it, continues to benefit landowners that depend on municipal drains and municipalities liable for the drainage work, while meeting CA permitting requirements.

Additionally, TRCA is pleased to see that the proposed streamlining measures for municipal drain improvements projects will not result in a reduction or removal of the existing environmental protections and CA permitting requirements, regardless of whether projects are minor or major.

TRCA Responses to Questions in the Drainage Act Regulatory Discussion Paper (1,4,5,6)

Key points are in **bolded text**.

1) Do you agree with the proposed minor improvement criteria?

TRCA generally supports the proposed criteria as it will help simplify the process to expedite requests for minor improvements to municipal drains. However, for projects that meet these criteria and can follow one of the two streamlined processes, the Discussion Paper (p.3) indicates that this could include a municipality sending notice to the CA (including for updates to engineer's reports). We note that the Q&A provided by OMAFRA staff following their January 2021 Drainage Act Webinar acknowledged that CAs need to be notified early on because, “there are instances where comments aren’t incorporated appropriately,” but maintained that “regulatory agencies are notified as required” and, “there should be no issues because they have been involved throughout the process.” In TRCA’s experience, this is not always the case. Timely notification and pre-consultation enable CA permitting requirements to be identified early and facilitate an efficient review process by ensuring submissions of complete applications. This is of particular importance given that, under the proposed new regulation, on-site meetings and pre-consultation with approval agencies would no longer be required, the timeline for an engineer’s report to be completed would be 90 days (formerly 1 year), and the proposed eligibility criteria for streamlining projects makes no explicit mention of the potential need for conditions of environmental approvals.

Therefore, **TRCA recommends that greater emphasis be placed on the need to consult with CAs upfront in the project review process and that consideration be given to the development of guidance materials that would provide a more fulsome disclosure of information and requirements where CA permits may be required.**

4) Are there other opportunities to further reduce burden for minor improvements?
The Discussion Paper indicates that,

> *“pre-approved designs for straightforward minor improvement projects would be developed through a collaborative process for inclusion in a future protocol that could be incorporated by reference. It would take time for the ministry to develop a protocol for the second process. In the meantime, the first process would be available.”*

To assist applicants, guidance should be provided that clearly articulates what is required in engineer’s reports required to support a minor improvement project. This additional guidance would enhance certainty for all stakeholders and contribute to efficient and effective review processes.

5) Are the proposed criteria for updating an engineer’s report appropriate?
TRCA is supportive of a simplified process to update the engineer’s report to account for any changes made during construction. This could be a practical measure and an improvement in the process. **TRCA suggests that any design changes from the permitted/approved design should be in conformance with any conditions of the initially permitted design**.

In addition, during the OMAFRA Webinar, it was conveyed that **engineer’s reports would include how environmental approvals that affect the physical design and operation of the drain are to be addressed. This requirement was not clear in the materials provided in the ERO and therefore we recommend providing clear direction through the proposed regulation**.

6) What new protocols would you prioritize?
The Discussion Paper indicates that the regulation would enable an expanded DART protocol related to pre-approved engineered designs for minor improvements. Please consider prioritizing green infrastructure for any pre-approved engineering designs for minor improvements to incentivize

landowners to employ best management practices. **To ensure they are consistent with CA regulatory requirements and to leverage CA expertise in this regard, CAs should be consulted on these pre-approved designs.** To this end, we note that OMAFRA has committed to working with other ministries, regulatory agencies, CAs, municipalities, farming and indigenous organizations to develop new protocols. As above, we look forward to collaborating on any revisions and/or expansions of the DART protocol with OMAFRA and other stakeholders to support compliance with *Drainage Act* and CA Act requirements.

Thank you once again for the opportunity to provide comments on the Drainage Act Discussion Paper. Should you have any questions, require clarification on any of the above, or wish to meet to discuss our remarks, please contact the undersigned at 416.661.6600, Ext. 5281 or at laurie.nelson@trca.ca.

Sincerely,

' Original signed by -

Laurie Nelson, MCIP, RPP
Director, Policy Planning

BY E-MAIL
cc:
TRCA: John MacKenzie, Chief Executive Officer
Sameer Dhalla, Director, Development and Engineering Services

February 20, 2021

BY EMAIL ONLY (Diane.Blachford@ontario.ca)

Diane Blachford
Strategic Policy and Partnerships Branch
438 University Avenue, 15th Floor
Toronto, Ontario M7A 1N3

Dear Ms. Blachford:

Re: Statement of Environmental Values for the Ministry of the Environment, Conservation and Parks (ERO #019-2826)

Thank you for the opportunity to comment on the Ministry of the Environment, Conservation and Parks' (MECP) proposed new Statement of Environmental Values (SEV). We understand MECP is proposing an amendment to its SEV in accordance with the Made-in Ontario Environment Plan to reflect changes in its mandate, to add a climate change section, and a five-year review period.

The Toronto and Region Conservation Authority (TRCA) conducts itself in accordance with the objects, powers, roles and responsibilities set out for conservation authorities (CA) under the *Conservation Authorities Act* and the Ministry of Natural Resources and Forestry Procedures Manual chapter on CA policies and procedures for plan review and permitting activities, as follows:

- A public commenting body under the *Planning Act* and *Environmental Assessment Act*;
- An agency delegated the responsibility to represent the provincial interest on natural hazards under Section 3.1 of the Provincial Policy Statement;
- A regulatory authority under section 28 of the *Conservation Authorities* Act;
- A service provider to municipal partners and other public agencies;
- A Source Protection Authority under the *Clean Water Act*;
- A resource management agency; and
- A major landowner in the Greater Toronto Area.

In these roles, TRCA works in collaboration with municipalities and stakeholders to protect people and property from flooding and other natural hazards, and to conserve natural resources.

Government Proposal

The ERO posting explains that the *Environmental Bill of Rights*, 1993 (EBR) requires each prescribed ministry to develop and publish a Statement of Environmental Values (SEV) which the ministry must consider when making decisions that might significantly affect the environment. The EBR requires that the ministry's SEV explain:

- how the purposes of the EBR are to be applied when decisions that might significantly affect the environment are made in the ministry, and
- how consideration of the purposes of the Act should be integrated with other considerations, including social, economic, and scientific considerations, that are part of decision-making in the ministry.

The EBR provides that the Minister may amend the SEV from time to time. The Ministry of the Environment, Conservation and Parks is proposing to amend their SEV to:

- fulfill a commitment in the Made-in-Ontario Environment Plan with the addition of a new section on climate change
- ensure the SEV remains up to date with the addition of a five-year review period
- update the ministry name, vision, and mandate to reflect the ministry's expanded responsibilities for parks and conservation reserves, conservation authorities and species at risk and their habitat
- make minor administrative changes to align SEV language with language in the EBR, improving language throughout, and updating the prescribed ministries and MECP website links
- make additional language changes in some sections to be more consistent with Environment Plan language
- update language from "Aboriginal" to "Indigenous" to reflect current terminology used in the United Nations Declaration on the Rights of Indigenous Peoples, by the Ministry of Indigenous Affairs (Ontario), and by Indigenous and Northern Affairs Canada.

General Comments

TRCA supports the legislative requirements of the *Environmental Bill of Rights, 1993* (EBR) and its established processes to ensure the public is informed, engaged, and consulted on matters of environmental significance, and provide for government accountability in environmental decision making. Another key stipulation of the EBR is each Minister's responsibility to take every reasonable step to ensure that the SEV is considered whenever decisions that might significantly affect the environment are made in the Ministry (s.11), and referenced in section 3 of the SEV. In addition to the foundational components of the SEV, we welcome the proposed new amendments, particularly the monitoring section to enhance consistent application of the SEV and the consultation section to ensure robust public engagement processes.

Detailed comments

For the Ministry's consideration, TRCA staff offer the following detailed comments specific to some of the sections of the proposed SEV. Key points are in **bolded** text.

3. Application of the SEV

As it develops Acts, regulations, and policies, MECP will apply a principle that, *"…considers the cumulative effects on the environment; the interdependence of air, land, water and living organisms; and the relationships among the environment, the economy and society."* TRCA appreciates the objectives to consider cumulative effects and the synergistic connections between environment, economy, and society, however, the statements could benefit from more detail on how cumulative effects in particular will be considered. In addition, given the importance of avoiding cumulative impacts to the environment and the Ministry's scope of review for all projects in Ontario under its purview, it is in an ideal position to assess cumulative impacts and therefore, could go beyond consideration to adopt a stronger approach. **TRCA recommends the statements in the SEV for considering cumulative effects be more directive to Ministry staff on how to assess cumulative impacts, e.g., noting location, scale, and timing of a project relative to other projects in the same sub-watershed, sensitivity of the local environment vs. adjacent environments, comparing the predicted effects of a proposed Ministry initiative relative to others' initiatives affecting the same projects or processes.**

MECP indicates that, "*in the event that significant environmental harm is caused, the Ministry will work to ensure that the environment is rehabilitated to the extent feasible."* A more robust description of what constitutes feasible rehabilitation work would enhance this commitment, especially given the subjectivity of the terminology. **TRCA recommends striving for rehabilitation to be undertaken to a high functioning state where appropriate, or at minimum, to an improved state over the previous condition**.

The section lists a number of ways the Ministry works to protect, restore, and enhance the natural environment. **TRCA recommends adding reference to how the Ministry is managing Ontario's provincial parks and conservation reserves in a manner that protects, restores, and enhances the natural environment.** This list also states that policies, legislation, regulations, and standards will be developed to protect the environment and human health. In the interest of achieving shared objectives, **TRCA recommends adding a point on collaboration with other ministries with closely related mandates (e.g., MNRF) and those with mandates that have potential to affect the environment (e.g., MMAH, MTO, MOI).**

7. Climate Change

TRCA is pleased to see the new section on reducing greenhouse gas emissions and building partnerships to improve local climate resilience and ensure climate mitigations and resilience are reflected in relevant policies and programs. We firmly believe that a comprehensive approach is needed to support our communities and partners in dealing with climate change. We support MECP's commitment to work collaboratively to enhance local efforts and ensure the impacts of climate change will be addressed through relevant policy and programs and would welcome opportunities for working with MECP to achieve common values and optimize efficiencies. TRCA has demonstrated leadership in both climate change mitigation (e.g., reducing harm to individuals, and building resilient natural systems and watersheds) and adaptation (e.g. conservation, eco-efficiencies and human health benefits), as part of the Ontario Climate Consortium, and through our work on the Don Mouth Naturalization and Flood Protection Project, our Partners in Project Green and Sustainable Neighbourhood Action Program (SNAP) initiatives.

The section states that MECP will, "*work with individuals, businesses, communities, municipalities, non-governmental organizations and Indigenous communities to identify the threats from climate change to Ontario's environment and evaluate opportunities to advance the province's core climate* *change goals while fostering a prosperous economy and society in Ontario*." **TRCA recommends that conservation authorities be added to the list of partners in this section given our roles, tied closely to climate change, of protecting people and property from natural hazards and conserving natural resources.**

Thank you once again for the opportunity to provide comments on the Statement of Environmental Values for the Ministry of the Environment, Conservation and Parks. Should you have any questions, require clarification on any of the above, or wish to meet to discuss our remarks, please contact the undersigned at 416.661.6600, Ext. 5281 or at laurie.nelson@trca.ca.

Sincerely,

- Original signed by -

Laurie Nelson, MCIP, RPP
Director, Policy Planning

BY E-MAIL
cc:
TRCA: John MacKenzie, Chief Executive Officer
Sameer Dhalla, Director, Development and Engineering Services
Anil Wijesooriya, Director, Restoration and Infrastructure

Attachment 5: TRCA Submission on ERO#019-3233

April 2, 2021

BY E-MAIL ONLY (planningconsultation@ontario.ca)

Planning Consultation
Provincial Planning Policy Branch
777 Bay Street, 13th floor
Toronto, ON
M7A 2J3

RE: Proposed Changes to Minister's Zoning Orders and the Planning Act (ERO #019-3233)

Thank you for the opportunity to comment on the Ministry of Municipal Affairs and Housing's (MMAH) Environmental Registry of Ontario (ERO) posting on proposed changes to the *Planning Act* so that certain Minister's zoning orders (MZOs) do not have to be consistent with the Provincial Policy Statement (PPS).

TRCA conducts itself in accordance with the objects, powers, roles, and responsibilities set out for conservation authorities (CAs) under the *Conservation Authorities Act* and the Ministry of Natural Resources and Forestry Procedural Manual chapter on CA policies and procedures for plan review and permitting activities. TRCA is:

- A public commenting body under the *Planning Act* and *Environmental Assessment Act*;
- An agency delegated the responsibility to represent the provincial interest on natural hazards under Section 3.1 of the PPS;
- A regulatory authority under Section 28 of the Conservation Authorities Act;
- A service provider to municipal partners and other public agencies;
- A Source Protection Authority under the *Clean Water Act*;
- A resource management agency; and
- A major landowner in the Greater Toronto Area.

In these roles, and as stated in the "A Made-In-Ontario Environment Plan," TRCA works in collaboration with municipalities and stakeholders to protect people and property from flooding and other natural hazards, and to conserve natural resources. Through Memorandums of Understanding and Service Level Agreements, TRCA provides technical support to its provincial and municipal partners in implementing municipal growth management policies. Further, TRCA recognizes the importance of efficiency, certainty, transparency and accountability in planning and design review processes, so that development and infrastructure projects can occur in a timely and environmentally sustainable manner.

Government Proposal

We acknowledge that the *Planning Act* gives the Minister (of MAH) the authority to zone the use of land in Ontario, and that Minister's zoning orders (MZOs) can be used to protect provincial interest. Moreover, we recognize that, under the *Planning Act*, an MZO must be consistent with policy statements issued under the *Planning Act* (e.g., PPS) that are in effect on the date of the decision. We understand that, through Schedule 3 of the proposed Bill 257 (*Supporting Broadband and Infrastructure Expansion Act*, 2021) the *Planning Act* would be amended, such that an MZO need not be consistent with the PPS. Further, the changes would provide that any existing MZOs never had to be consistent with the PSS and that the proposed amendment would not apply to lands located within the Greenbelt Area.

The government's stated intent of the proposed changes is that they would permit the Minister to take other considerations into account when making decisions to support strong communities, a clean and healthy environment, and the economic vitality of the Province. Further, the ERO posting states that MZOs are a critical tool to support and expedite the delivery of government priorities such as transit-oriented communities, affordable housing, long-term care homes and strategic economic recovery projects by removing potential barriers and delays. These changes would ensure that the Minister, acting at their discretion, has the authority to provide their complete support for these critical projects.

General Comments

TRCA understands the importance of stimulating growth as part of the economic recovery from the COVID-19 crisis using the MZO provisions under the *Planning Act*, on a limited basis. However, the changes being proposed under Schedule 3 of Bill 257 would be contrary to the purposes of the *Planning Act,* as articulated through section 1.1, and would effectively disregard the objectives of the Province of Ontario's land use planning framework.

Many of the government's considerations and priorities as stated above are reflected in the recently updated PPS 2020, with the policies grouped into three main areas: Building Strong and Healthy Communities, Wise Use and Management of Resources and Protecting Public Health and Safety. The PPS recognizes the synergistic relationships between environmental, economic, and social factors in land use planning. The proposed amendments under Schedule 3 of Bill 257 ignore these important relationships except for lands in the Greenbelt. Such wholistic policy considerations should not be binding only for Greenbelt lands. It is particularly important for provincial interests such as protection and restoration of the natural environment be achieved not only for communities in the Greenbelt but also for urban, built up areas undergoing infill and redevelopment where greater demands are placed on natural resources for passive and active recreation and there is greater risk for water quality, quantity (including stormwater management/drainage issues), loss and degradation of natural habitats.

In section 4.0 of the PPS, Implementation and Interpretation, sub-section 4.6 states:

> *The official plan is the most important vehicle for implementation of this Provincial Policy Statement. Comprehensive, integrated and long-term planning is best achieved through official plans. Official plans shall identify provincial interests and set out appropriate land use designations and policies. To determine the significance of some natural heritage features and other resources, evaluation may be required. In order to protect provincial interests, planning authorities shall keep their official plans up-to-date with this Provincial Policy Statement. The policies of this Provincial Policy Statement continue to apply after adoption and approval of an official plan.*

MZOs requested by a municipality's Council on a site-by-site basis and approved by the Province as of right are not held to the test of official plan policies meant to protect provincial interests. MZOs occurring outside the normal development approvals framework under the *Planning Act*, limits critical public, agency, and stakeholder input. There are no requirements for public notice, public consultation, or appeal provisions associated with MZO powers, overriding municipal official plans, zoning and associated public and agency consultation that all serve to ensure provincial interests are being met.

Connection to CA Permits under the Conservation Authorities Act

In conjunction with the recent legislative changes through Schedule 6 of Bill 229, this proposal would affect TRCA's permitting role under Section 28 of the CA Act. Within CA regulated areas, CAs are now required to issue a permit for development on lands subject to an MZO (outside the Greenbelt), which the Authority may have otherwise not issued based on our science-based approach to decision making, and which may also conflict with provincial and municipal policy.

TRCA has and continues to work in collaboration with our regional and local municipalities to successfully advance a coordinated review and approval process on various sites subject to the MZO process. These include Mayfield West and the Canadian Tire Distribution Warehouse in the Town of Caledon, and the Block 34E – Phase 1 lands in the City of Vaughan. With these projects, the natural heritage features or natural hazards were appropriately identified and impacts avoided, mitigated, or compensated for in cooperation with municipalities and the Ministry of Natural Resources and Forestry (MNRF).

However, in the absence of the collaborative exercises noted above, we are concerned that MZOs may continue to authorize development contrary to provincial and municipal policies and CAs' regulatory requirements, particularly if the proposed changes are enacted. The proposed removal of the requirement to consider the PPS in MZO areas (outside the Greenbelt), in combination with the recent changes made to the CA Act , indicates that lands which have long since been protected from development in the interest of the public (e.g., Provincially Significant Wetlands, flood plains, valley lands and public greenspace, etc.) may now be developed in support of specific interests taking priority over other essential considerations in the public interest as expressed through the PPS.

TRCA acknowledges the importance of removing barriers to building more affordable housing and long-term care facilities and stimulating economic and job growth, especially during times of much needed economic recovery due to the COVID-19 pandemic. However, through our Board of Directors, we have articulated our view that such priorities should not come at the expense of the fundamental principles for "protecting what is valuable" in the Growth Plan or ensuring the appropriate technical and planning process takes place to ensure consistency between the *Planning Act* and S.28 of the *CA Act*

In our experience, we continue to pay a price for historic land use and development decisions that allowed for development in hazardous lands and environmentally sensitive areas done without the contemporary science-based knowledge of the wide-spread environmental, social, and economic impacts that would result, nor the corresponding legislative, policy, and planning structure necessary to mitigate them. Schedule 3 of Bill 257 has the potential to perpetuate and assign validity to similar development decisions, in stating that MZOs were never meant to be consistent with provincial policy.

The upfront comprehensive studies, pre-consultation with review and approval agencies, and public consultation are key components of good planning and are arguably a more effective means of creating certainty for time sensitive and context sensitive economic development. The municipal implementation of official plan policies consistent with the PPS should continue to the be "most important vehicle for implementation of the Provincial Policy Statement." Accordingly, it is TRCA's preference to work with municipalities and applicants to facilitate technically sound development proposals through the current, well-established municipal plan review and CA permitting process that respects provincial, municipal and TRCA policies and requirements.

RECOMMENDATION:

Based on the above, and consistent with TRCA's submission dated January 30, 2021 to the Province on the enhanced MZO provisions, (ERO#019-2811), TRCA recommends:

- **That Schedule 3 be withdrawn from Bill 257 and that all land use planning decisions, including those associated with MZOs, be consistent with the Provincial Policy Statement.**

If Schedule 3 of Bill 257 is approved, TRCA recommends**:**

- To ensure the potential risk to public health and safety or property from natural hazards can be mitigated, that the Minister of Municipal Affairs and Housing consult with TRCA if an MZO is being considered within a regulated area under the *Conservation Authorities Act.*

- That where a municipality relies on TRCA for expert technical input related to natural heritage matters, that the Minister consult with TRCA.

- That a streamlined process be considered for MZOs which allows for public notice and input.

Thank you once again for the opportunity to provide comments on the proposed amendments to the *Planning Act* so that an MZO is not required and deemed to never have been required to be consistent with the Provincial Policy Statement. Should you have any questions, require clarification on any of the above, or wish to meet to discuss our remarks, please contact the undersigned at 416.661.6600, extension 5281 or at laurie.nelson@trca.ca.

Sincerely,

- Original signed by -

Laurie Nelson, MCIP, RPP
Director, Policy Planning

BY E-MAIL
cc:

TRCA: John MacKenzie, Chief Executive Officer
Sameer Dhalla, Director, Development and Engineering Services

April 19, 2021

Greenbelt Consultation
Provincial Planning Policy Branch
777 Bay Street, 13th floor
Toronto, ON M7A 2J3

BY E-MAIL ONLY (greenbeltconsultation@ontario.ca)

RE: CONSULTATION ON GROWING THE SIZE OF THE GREENBELT (ERO #019-3136)

Thank you for the opportunity to comment on the Ministry of Municipal Affairs and Housing's (MMAH) Environmental Registry of Ontario (ERO) posting consulting on ways to grow the size and further enhance the quality of the Greenbelt.

TRCA conducts itself in accordance with the objects, powers, roles, and responsibilities set out for conservation authorities (CAs) under the *Conservation Authorities Act* (CA Act) and MNRF Procedural Manual chapter on CA policies and procedures for plan review and permitting. TRCA is:

- A public commenting body under the *Planning Act* and *Environmental Assessment Act*;
- An agency delegated the responsibility to represent the provincial interest on natural hazards under Section 3.1 of the Provincial Policy Statement (PPS);
- A regulatory authority under Section 28 of the CA Act;
- A service provider to municipal partners and other public agencies;
- A Source Protection Authority under the *Clean Water Act*;
- A resource management agency; and
- A major landowner in the Greater Toronto Area.

In these roles, and as stated in the "A Made-In-Ontario Environment Plan," TRCA works in collaboration with municipalities and stakeholders to protect people and property from flooding and other natural hazards, and to conserve natural resources. Through Memorandums of Understanding and Service Level Agreements, TRCA provides technical support to its provincial and municipal partners in implementing municipal growth management policies. Further, TRCA recognizes the importance of efficiency, certainty, transparency and accountability in planning and design review processes, so that development and infrastructure projects can occur in a timely and environmentally sustainable manner.

GOVERNMENT PROPOSAL

We understand that the government is consulting on expanding the size of and enhancing the Greenbelt, with the following identified as priorities:

- Lands in and around the Paris Galt Moraine
- Ideas for adding, expanding, and further protecting the region's Urban River Valleys (URVs)

Regarding potential Greenbelt expansions, the following principles are articulated, although the ERO is soliciting input regarding “other potential areas to grow the Greenbelt as well as other priorities”.

- **No consideration of removal requests or land exchanges**
- **No consideration of policy changes** (existing protections will not be reduced).
- **Supports Greenbelt Plan objectives, vision, and goals** (protects agricultural land base and ecological and hydrological features, areas, and functions; only publicly owned lands in URVs).
- **Follows Existing Amendment Process** (as per *Greenbelt Act, 2005*)
- **Connects physically and/or functionally to the current Greenbelt** (continuous broad band of protected land built upon the Greenbelt’s systems approach, with direct connections throughout the Plan’s natural heritage, water resource or agricultural systems; no unconnected islands of Greenbelt land).
- **Considers impacts on existing provincial priorities** (e.g., as outlined in PPS, Growth Plan).

DISCUSSION QUESTIONS

TRCA provides the following comments in response to the discussion questions posted through this ERO. Key comments are in **bold** text.

1. *What are your thoughts on the initial focus area of the Study Area of the Paris Galt Moraine?*
2. *What are the considerations in moving from a Study Area to a more defined boundary of the Paris Galt Moraine?*

The Paris Galt Moraine provides essential hydrological and ecological functions similar to the Oak Ridges Moraine, including functioning as a groundwater recharge zone that sustains a vital supply of drinking water for residents and a groundwater storage and discharge area that supports cold water headwater stream habitat. However, it is outside of TRCA’s jurisdiction and as such, we defer to the local CAs, in partnership with affected municipalities.

3. *What are your thoughts on the initial focus area of adding, expanding and further protecting URVs?*

While TRCA generally supports the Province’s intent to grow URVs, especially from an educational and awareness-raising standpoint, current Greenbelt policies related to URVs only apply to public lands. By virtue of being exclusively on publicly owned lands, URVs are largely protected through other policy means. In addition to being protected by existing provincial policies that address natural heritage and hydrologic features and areas (i.e., PPS, Growth Plan, Source Protection Plans) and CA policies and associated regulations, URV lands are typically already designated for protection in official plans (OPs) as parks, open space, recreation, conservation and/or environmental protection. Subsequently, any expansion of the URVs to include public lands would not necessarily result in additional land being better protected from future development impacts. **Although outside the purview of this consultation, TRCA notes that a provincial review of the current URV policies could help better achieve the Province’s objective of expanding and enhancing the Greenbelt.**

Further to the above, we note that adding/expanding URVs at this time may not capture the outcomes of any refinements to existing URV boundaries being undertaken through ongoing Municipal Comprehensive Reviews (MCRs) to ensure all publicly owned lands are included, and any lands that may have been acquired since URVs were added to the Greenbelt. Moreover, we note that this consultation may not capture future lands transferred into public ownership (including those acquired by CAs) containing contributing natural features that would otherwise enhance Greenbelt policy intent. We therefore continue to support the provisions of Section 5.6.1 of the Greenbelt Plan that would allow future lands acquired/dedicated into public ownership which meet provincial criteria for Greenbelt/URV expansion, (e.g., working with conservation authorities and requests from municipalities).

4. *Do you have suggestions for other potential areas to grow the Greenbelt?*

TRCA has identified areas we believe generally align with the Province's criteria for expansion and would be in keeping with the Plan's objectives, vision and goals while further enhancing the quality and extent of existing protections. Examples of these areas include, but are not limited to:

- Major watercourses in our jurisdiction currently excluded from the Greenbelt but linked to existing Greenbelt areas, URVs with direct connections through the Plan's natural heritage, and water resource systems linked through Lake Ontario.
- Relatively small, isolated pockets, primarily consisting of prime agricultural land containing and/or adjacent to natural features fully encapsulated by (but outside) larger swaths of the Greenbelt, which if enveloped by the Greenbelt would form and further enhance a continuous broad band of protected land built upon the Greenbelt's systems approach and is supported by science.
- Provincially owned lands within the natural heritage system of current OPs that, if expanded, would link existing Greenbelt areas across watershed corridors as part of a larger, connected system.
- Stretches of former Lake-Iroquois shoreline between existing URVs, which represent largely east-west wildlife habitat movement corridors and areas of increased groundwater recharge and discharge functions.

Although specific locations and additional details for these examples can be provided, we recognize that advocating for their inclusion into the Greenbelt may be premature in light of ongoing MCRs and without substantive consultation with our municipal partners regarding any such expansions. Should expansions within our jurisdiction be proposed, (ideally after the MCR conformity deadline), TRCA would welcome the opportunity to help delineate the most appropriate boundary expansions based on science and in consultation with affected municipalities.

As elaborated on in our response to Question 5, TRCA has been collaborating with our municipal partners to provide updated science-based Natural Heritage System (NHS) mapping to inform municipal OP updates through the MCR process. TRCA has also been developing Water Resource System (WRS) data layers to help our municipal partners conform to new provincial policies requiring identification of the WRS. These scientific and systems-based areas (or portions thereof) would more effectively inform future Greenbelt expansions once the NHS and WRS frameworks are in place and related components of MCR work concludes. TRCA would be pleased to meet with the Province to discuss our approach to developing these layers.

5. *How should the Province balance or prioritize any potential Greenbelt expansion with the other provincial priorities (Growth Management, Natural Heritage and Water Resource Systems, Agriculture, Infrastructure)?*

Greenbelt expansions should be informed by science and considered in the context of ongoing MCRs. TRCA commends the Province for exploring opportunities to expand and enhance the Greenbelt. However, until MCRs are complete, the implications of Greenbelt expansion on other provincial priorities (as acknowledged by the province through this ERO) cannot be fully understood, particularly in relation to updated NHS and WRS mapping, Land Needs Assessment (LNA), long-term infrastructure planning and the implementation of the Agricultural System.

Using our science-based approach, TRCA has been working diligently with our partner upper, single- and lower-tier municipalities to identify key issues related to our watersheds and the natural environment through our involvement in their MCR conformity and OP review work. To date, we have shared reporting that consolidates watershed studies, their findings, and key current and future challenges facing our watersheds and provided recommended policy updates to inform land use, source water protection, land needs and infrastructure planning, as well as broader input to guide future collaborative work between municipalities and CAs.

As per our response to Question 4, TRCA has been developing updated WRS and NHS mapping which we are actively sharing with our municipal partners to inform refinements to their local systems. For example, updated information includes existing and potential (i.e., restoration areas) natural cover while building in new information, including both terrestrial and aquatic habitat needs for a single integrated system. It also considers climate vulnerability for both terrestrial and aquatic species, ecological connectivity, and other new science. Of note, a new additional data layer includes areas that contribute to ecosystem function that may be within the built environment. In these areas, additional measures, such as low impact development or urban tree canopy would help improve ecosystem resilience based on a contributing function.

6. *Are there other priorities that should be considered?*

Protection beyond URVs - The current consultation provides the opportunity to explore other potential areas to grow and enhance the Greenbelt. In this context and considering Section 3.2.6.3 (External Connections) of the Greenbelt Plan, we note the potential to expand wildlife movement protection and enhancement along regional corridors, as recommended by the Central Lake Ontario CA (CLOCA). **Based on CLOCA's scientific rationale, TRCA notes that east-west stretches of the shoreline between URVs within TRCA's jurisdiction could also be added to included within the URV designation to reinforce the ecological importance of publicly owned lands on this landscape.**

Climate Change – The PPS was recently updated to include enhanced policy direction to prepare for the impacts of a changing climate. **Growing the Greenbelt will assist the Province with achieving some of its objectives related to climate change, a consideration which should be acknowledged in the context of other provincial priorities pertaining to growth management.** TRCA is currently working with our municipal partners (e.g., Durham Region) to bring some of the latest climate science forward in identifying natural heritage climate change vulnerabilities. This information could inform how to build a more robust and climate-resilient municipal NHS through the MCR process, which could influence Greenbelt expansion and enhancement considerations.

Thank you once again for the opportunity to provide comments on the government's consultation on growing the size of the Greenbelt. Should you have any questions, require clarification on any of the above, or wish to meet to discuss our remarks, please contact the undersigned at 416.667.6290 or at john.mackenzie@trca.ca.

Sincerely,

<Original Signed by>

John MacKenzie, M.Sc.(Pl) MCIP, RPP
Chief Executive Officer

BY E-MAIL
cc TRCA: Laurie Nelson, Director, Policy Planning
Sameer Dhalla, Director, Development and Engineering Services

Attachment 7: TRCA Submission on ERO#019-3422

Chief Executive Officer

May 10, 2021

Cheryl Davis
Ministry of Transportation - Environmental Policy Office
777 Bay Street, Suite 700
Toronto, Ontario M7A 2J8

BY EMAIL ONLY (**cheryl.davis@ontario.ca**)

Re: Update to the Ministry of Transportation's Statement of Environmental Values (ERO # 019-3422)

Thank you for the opportunity to comment on the Ministry of Transportation's (MTO) proposed new Statement of Environmental Values. We understand that MTO is proposing to update its Statement of Environmental Values in order to reflect its current vision, mandate and business, acknowledge the priority of addressing climate change, and ensure up-to-date references.

The Toronto and Region Conservation Authority (TRCA) conducts itself in accordance with the objects, powers, roles and responsibilities set out for conservation authorities (CA) under the *Conservation Authorities Act* and the Ministry of Natural Resources and Forestry Procedures Manual chapter on CA policies and procedures for plan review and permitting activities, as follows:

- A public commenting body under the *Planning Act* and *Environmental Assessment Act*;
- An agency delegated the responsibility to represent the provincial interest on natural hazards under Section 3.1 of the Provincial Policy Statement;
- A regulatory authority under section 28 of the *Conservation Authorities* Act;
- A service provider to municipal partners and other public agencies;
- A Source Protection Authority under the *Clean Water Act*;
- A resource management agency; and
- A major landowner in the Greater Toronto Area.

In these roles, and as stated in the Made-in-Ontario Environment Plan, conservation authorities work in collaboration with municipalities and stakeholders to protect people and property from flooding and other natural hazards, and to conserve natural resources.

Government Proposal

The ERO posting explains that the *Environmental Bill of Rights*, 1993 (EBR) requires each prescribed ministry to develop and publish a Statement of Environmental Values (SEV) that the ministry must consider when making decisions that might significantly affect the environment. The EBR requires that the ministry's SEV explain:

- how the purposes of the EBR are to be applied when decisions that might significantly affect the environment are made in the ministry, and
- how consideration of the purposes of the Act should be integrated with other considerations, including social, economic and scientific considerations, that are part of decision-making in the ministry.

The EBR provides that the Minister may amend the SEV from time to time. MTO is proposing to amend their SEV to:

- update the ministry's vision, mandate and priorities;
- including reference to consider mobility, connectivity and access related impacts and measures to better assess alternatives and provide more evidence-based recommendations;
- reference that states the ministry will examine the Statement of Environmental Values every five years and/or whenever there is a significant change in mandate;
- a section to acknowledge the priority of addressing climate change;
- updated Indigenous section to recognize the perspectives and contributions of Indigenous peoples to a healthy environment;
- update language to ensure consistency with other OPS SEV documents; and,
- ensure all language and references are up-to-date and current.

General Comments

TRCA routinely advises major public infrastructure providers who are exempt from TRCA's regulation through a voluntary review process for environmental guidance on planning and designing infrastructure projects in TRCA's watersheds. It is this experience of applying TRCA's expertise in natural hazards, natural heritage, and water resource management for protection of the infrastructure and the environment, which informs our comments on the MTO SEV.

Generally, TRCA supports the proposed SEV as it espouses principles of environmental sustainability that align with TRCA's vision, mission and objectives for The Living City. The SEV could benefit, however, from more specifics about how MTO can put into action its view that the environment is an integral component of transportation planning, policy, and management of the provincial highway system (section 2, p.3 of the SEV)

Detailed Comments

For the Ministry's consideration, TRCA recommends the following revisions to selected sections of the proposed SEV with suggested deletions in strikethrough ~~text~~ and suggested additions in **bolded text**.

2. Ministry Vision and Priorities

"*The Ministry is focused on delivering the following specific priorities: increasing transit ridership* ***and use of active transportation facilities;*** *promoting a**n integrated** multi-modal transportation network that supports the efficient movement of goods and people."*

A. The Natural Environment

"*Advance key priorities such as improving public transit* ***and active transportation networks*** *in order to make it a* ***more*** *viable alternative to the single-occupant passenger car thereby helping to manage congestion and reduce gridlock and reducing transportation-related air emissions."* This comment is in recognition of the fact that public transit is already a viable alternative to the passenger car. We appreciate the likely intent of the statement is to improve transit to make it an *attractive* alternative to the car. Therefore, another suggestion would be to replace "(more) viable" with "**more attractive**".

This section also states that the Ministry will strive to, "*advance key priorities such as modernizing our environmental approach to all construction/maintenance activities to: reduce transportation-related discharges of contaminants to water; improve salt management practices; promote the efficient and prudent use of water and energy in our activities; conserve resources by using recycled and non-traditional construction materials;* ***avoid impacts on natural features and functions; proactive maintenance of erosion and sediment controls; require construction timing that is proactive to avoid congestion.****"*

"When planning or facilitating the development of transportation facilities, the Ministry will strive to ***avoid natural hazards (flood and erosion) and seek opportunities for natural hazard mitigation and remediation where avoidance is not possible****; protect* ***natural*** *habitats in support of conserving biodiversity, whenever possible and practical* ***and apply the mitigation hierarchy to avoid, minimize, mitigate and compensate for any unavoidable impacts to natural features and functions****."*

B: Environmental Concerns in Decision-Making

This section outlines that the Ministry believes, "*environmental considerations are integral to its activities, including policy and project development, and the operation and maintenance of* ***multi-modal*** *transportation systems and facilities. Consideration of environmental impacts will be integral to provincial transportation planning, design, construction, operation, and maintenance process****, and recognized as a priority through effective implementation of the results of environmental assessment processes*** *~~implemented through an EA process~~." This section also outlines that "the purposes of the EBR will be integrated into the Ministry's strategic planning, day-to-day activities,* ***and day-to-day*** *and long-term decision-making, as a commitment to environmental protection." We also recommend adding that,* ***"The Ministry will collaborate with partner ministries, municipalities, conservation authorities and other public agencies for achieving shared objectives of developing an environmentally responsible, integrated and connected multi-modal system."*** This would complement the SEV section on Public Engagement that commits to a planning process that is open to comment by the public, stakeholders, and transportation partners.

D: Research and Development

This section outlines that the Ministry believes, "*research and development ~~is~~* ***are*** *important to the protection, enhancement and care of the environment. To put this value into action, the following measures will be taken: the Ministry will continue to research and develop environmentally compatible transportation technologies and methods; and the Ministry will continue to develop environmentally sensitive procurement, design, construction, and maintenance techniques." We also recommend adding:* ***"To leverage the research and development of partner public agencies with shared interests and thereby optimize the use of sound environmental data that assists in planning and designing sustainable transportation infrastructure."***

E: Education and Promotion

"The Ministry believes that environmental considerations are integral to its activities, including the operation of transportation facilities. Raising the awareness of its partners and the general public regarding environmental issues is an important component of environmental protection. The Ministry will: strive to create an environmentally skilled and informed workforce ***and ensure qualified environmental professionals are employed as appropriate."*** *"Seek to influence its partners (federal, provincial, municipal, business, etc.) to be aware of the environment in their respective decision-making processes."* The underlined phrase could be modified to be clearer; perhaps revise to: **"Seek to promote the importance of the environment in collaborative decision-making with partners** (federal, provincial, municipal, **conservation authorities,** business, etc.)."

3. Application of the SEV

This section states that the Ministry will apply the following principles as it develops Acts and policies for a sustainable transportation system that is: "*affordable, operates efficiently, offers choice of transportation mode, and supports a vibrant economy* ***and healthy and active lifestyles****.*" And, "**avoids,** *minimizes****, mitigates and compensates for*** *the environmental impacts of transportation infrastructure and operations.*"

4. Integration with other Considerations

The section states that, "*the Ministry is committed to delivering infrastructure improvements through strategic investments and creating a policy environment that encourages all modes of transportation to contribute to Ontario's economic growth* ***and the health and well-being of Ontarians*** *in an environmentally responsible way. The Ministry will encourage mitigating pollution,* ***protecting natural*** *habitat preservation,* ***conserving*** *energy and resource****s*** ~~*conservation*~~ *in those sectors where it provides policy direction or programs*." **The Ministry will similarly follow a collaborative partnership approach that seeks opportunities for co-locating transportation systems with other infrastructure or development projects to minimize environmental impacts, enhance efficiencies and reduce costs.**

8. Climate Change

This section outlines that the Ministry, "*will continue to work with individuals, businesses, communities, municipalities,* ***conservation authorities****, non-governmental organizations and Indigenous communities to identify the threats from climate change to Ontario's transportation infrastructure,* ***reduce greenhouse gas emissions, and mitigate and adapt for climate change impacts,*** *while fostering a prosperous economy,* ~~*and*~~ *society* ***and enhance climate resiliency*** ~~*in the face of climate change*~~*."*

9. Greening of Internal Operations and Energy Conservation

This section includes that, *"The Ministry believes in the environmentally responsible conservation and consumption of natural resources. The Ministry will support the Government of Ontario's initiatives to conserve energy,* ~~*and*~~ *water,* ***air quality*** *and* ~~*to wisely use our air and land*~~ ***natural*** *resources in order to generate environmental, health, and economic benefits for present and future generations."* **To this end, the Ministry will follow the Envision (or similar) platform in the design, construction and operation of its facilities and will report on achievements through a publicly available annual report.**

Thank you once again for the opportunity to provide comments on the Statement of Environmental Values for the Ministry of Transportation. Should you have any questions, require clarification on any of the above, or wish to meet to discuss our remarks, please contact the undersigned at 416.667.6290 or at john.mackenzie@trca.ca.

Sincerely,

<Original Signed by>

John MacKenzie, M.Sc. (Pl), MCIP, RPP
Chief Executive Officer

BY E-MAIL

cc:

TRCA: Laurie Nelson, Director, Policy Planning
Sameer Dhalla, Director, Development and Engineering Services
Anil Wijesooriya, Director, Restoration and Infrastructure
Beth Williston, Associate Director, Infrastructure Planning and Permits

Attachment 8: TRCA Submission on ERO#019-3495

Chief Executive Officer

Toronto and Region Conservation Authority

May 25, 2021

BY E-MAIL ONLY (planningconsultation@ontario.ca)

Planning Consultation
Provincial Planning Policy Branch
777 Bay Street, 13th floor
Toronto, ON M7A 2J3

RE: PROPOSED CHANGES TO CERTAIN LAND DIVISION PROVISIONS IN THE PLANNING ACT (ERO #019-3495)

Thank you for the opportunity to comment on the Ministry of Municipal Affairs and Housing's (MMAH) Environmental Registry of Ontario (ERO) posting consulting on proposed changes to the P*lanning Act* related to certain land division provisions.

TRCA conducts itself in accordance with the objects, powers, roles and responsibilities set out for conservation authorities under the *Conservation Authorities Act* and MNRF Procedural Manual chapter on CA policies and procedures for plan review and permitting. TRCA is:

- A public commenting body under the *Planning Act* and *Environmental Assessment Act*;
- An agency delegated the responsibility to represent the provincial interest on natural hazards under Section 3.1 of the Provincial Policy Statement (PPS);
- A regulatory authority under Section 28 of the Conservation Authorities Act;
- A service provider to municipal partners and other public agencies;
- A Source Protection Authority under the *Clean Water Act*;
- A resource management agency; and
- A major landowner in the Greater Toronto Area.

In these roles, and as stated in the "A Made-In-Ontario Environment Plan," TRCA works in collaboration with municipalities and stakeholders to protect people and property from flooding and other natural hazards, and to conserve natural resources. Through Memorandums of Understanding and Service Level Agreements, TRCA provides technical support to its provincial and municipal partners in implementing municipal growth management policies. Further, TRCA recognizes the importance of efficiency, certainty, transparency and accountability in planning and design review processes, so that development and infrastructure projects can occur in a timely and environmentally sustainable manner.

GOVERNMENT PROPOSAL

We understand that the Province is consulting on proposed changes to the *Planning Act* related to the division of land (subdivision control, plans of subdivision, consents, and validations), as well as other housekeeping or consequential changes to the Act.

We further understand that the changes proposed in this ERO posting would be enabled through Schedule 24 of *Bill 276, Supporting Recovery and Competitiveness Act, 2021*.

COMMENTS

TRCA supports the Province's intention to expedite and improve consenting authority procedures and administrative actions related to land division provisions in the *Planning Act* and reduce related costs for municipalities, landowners, leaseholders, purchasers of land and real estate and legal professionals. The following comments are provided for consideration.

Where a land division application under the *Planning Act* contains components of the natural system such as natural heritage features or natural hazards in a conservation authority regulated area, as a commenting agency, TRCA generally requests that these lands be excluded from the severed parcel and that they remain with the retained parcel so as not to fragment ownership of the natural system; TRCA generally recommends to the approval authority that these lands be protected through available mechanisms (e.g., conditions of approval, dedication into public ownership, conservation easement). We understand that under the proposed amendments, a municipality would be enabled to impose requirements and "stop the clock" on non-decision appeals where an application is amended by an applicant. We note that the issue of notice of an amended application is not dealt with in the proposed amendments and TRCA recommends that such provision be added. If the application is amended, commenting agencies should have the opportunity to review the amendment for their interests as well as the municipality. As noted above, TRCA would like to ensure that an amended application is not contemplating future development within conservation authority regulated hazards and features.

Moreover, we note that the existing 53(35) requires the Land Planning Appeal Tribunal (LPAT) to issue notice if the LPAT is going to make a decision on an amended application, and it would therefore be appropriate for the same requirement to apply for an amended application that is not under appeal.

Therefore, **TRCA recommends that the planning approval authority should be directed to require notice of an amended application be provided to commenting agencies** in order to avoid conflict and delay in the review and approval process.

Thank you once again for the opportunity to provide comments on the government's consultation on proposed changes to certain land division provisions in the *Planning Act*. Should you have any questions, require clarification on any of the above, or wish to meet to discuss our remarks, please contact the undersigned at 416.667.6290 or at john.mackenzie@trca.ca.

Sincerely,

<Original Signed by>

John MacKenzie, M.Sc.(PI) MCIP, RPP
Chief Executive Officer

BY E-MAIL
cc:

TRCA: Laurie Nelson, Director, Policy Planning
Sameer Dhalla, Director, Development and Engineering Services

Chief Executive Officer

Toronto and Region Conservation Authority

June 4, 2021

BY E-MAIL ONLY (invasive.species@ontario.ca)

Public Input Coordinator
MNRF - Fish and Wildlife Policy Branch
300 Water Street
P.O. Box 7000
Peterborough, ON
K9J 8M5

RE: Regulating 13 invasive species and watercraft as a carrier of invasive species under Ontario's Invasive Species Act, 2015 (ERO #019-3465), and Ontario's Strategy to Address the Threat of Invasive Wild Pigs (ERO #019-3468)

Thank you for the opportunity to comment on the two Ministry of Natural Resources and Forestry (MNRF) Environmental Registry of Ontario (ERO) postings as noted above.

TRCA conducts itself in accordance with the objects, powers, roles and responsibilities set out for conservation authorities under the *Conservation Authorities Act* and MNRF Procedural Manual chapter on CA policies and procedures for plan review and permitting. TRCA is:

- A public commenting body under the *Planning Act* and *Environmental Assessment Act*;
- An agency delegated the responsibility to represent the provincial interest on natural hazards under Section 3.1 of the Provincial Policy Statement (PPS);
- A regulatory authority under Section 28 of the Conservation Authorities Act;
- A service provider to municipal partners and other public agencies;
- A Source Protection Authority under the *Clean Water Act*;
- A resource management agency; and
- A major landowner in the Greater Toronto Area.

In these roles, and as stated in "A Made-In-Ontario Environment Plan," TRCA works in collaboration with municipalities and stakeholders to protect people and property from flooding and other natural hazards, and to conserve natural resources. Through Memorandums of Understanding and Service Level Agreements, TRCA provides technical support to its provincial and municipal partners in implementing municipal growth management policies. Our municipal partners rely on TRCA's assistance for implementing the natural heritage policies of the Provincial Policy Statement by conserving and restoring natural heritage resources through our mandate under the *Conservation Authorities Act*. In our role of conserving natural resources, TRCA works with municipalities and other stakeholders to manage invasive species to the extent possible in a highly urbanized jurisdiction.

GOVERNMENT PROPOSAL

We understand that under the *Invasive Species Act*, 2015, decisions to recommend species for regulation are based on the risk that a species poses to Ontario's natural environment and socio-economic well-being. The Act directs that these risks be identified through species-specific ecological risk assessments, the experiences of other jurisdictions, and public consultation.

Further, we understand that the Province has determined the species listed below have the potential to, or are already, causing negative impacts to Ontario's natural environment and that regulation under the *Invasive Species Act* would improve Ontario's ability to prevent their introduction or spread. The Province is seeking feedback on the proposed species and carrier specific rules, and on Ontario's Strategy to Address the Threat of Invasive Wild Pigs.

Prohibited Invasive Species

Prohibited species cannot be brought into Ontario, deposited, released, possessed or transported in Ontario and cannot be propagated, bought, sold or traded in Ontario.

Species proposed to be regulated as prohibited invasive species are:

Marbled crayfish	Procambarus virginalis
Red Swamp crayfish	Procambarus clarkii
New Zealand mud snail	Potamopyrgus antipodarum
Tench	Tinca tinca (fish)
Prussian carp	Carassius gibelio (fish)
European frogbit	Hydrocharis morsus-ranae (aquatic plant)
Mountain pine beetle	Dendroctonus ponderosae

Restricted Invasive Species

Restricted species cannot be deposited or released in Ontario and cannot be brought into a provincial park or conservation reserve. In addition, the ministry may prescribe additional prohibitions for certain restricted species through regulation that would reduce the risk of that species being introduced or spread further in Ontario, while also allowing some activities to occur.

Species proposed to be regulated as restricted invasive species are:

- Yellow floating heart — *Nymphoides peltata* (aquatic plant)
- Fanwort — *Cabomba caroliniana* (aquatic plant)
- Bohemian knotweed — *Reynoutria ×bohemica* (terrestrial plant)
- Giant knotweed — *Reynoutria sachalinensis* (terrestrial plant)
- Himalayan knotweed — *Koenigia polystachya* (terrestrial plant)
- Pig — *Sus scrofa*

In summary, the following rules would apply to pigs under the proposal:

1. prohibit the release of any pig into the natural environment
2. prohibit bringing a live pig into a provincial park or conservation reserve
3. prohibit hunting wild pigs with exceptions for activities to protect property from damage caused by wild pigs
4. over a two-year period, phase-out the import, possession, transport, propagation, buying, selling, leasing, or trading of live Eurasian wild boar and their hybrids

To support efforts to capture and remove a pig that is present in the wild, it is also proposed to apply Section 23 - Declaration of an invaded place and Section 27 – Actions to control or eradicate invasive species of the Invasive Species Act to pigs. More information on the plan to address the threat of pigs as an invasive species, and how the regulatory proposal supports this objective is in Ontario's Strategy to Address the Threat of Invasive Wild Pigs.

Proposed Rules for Overland Movement of Watercraft as a Carrier of Invasive Species:
Prior to transporting a watercraft overland, a person would be required to:

- remove drain plugs and drain all water from the watercraft, excluding drinking water, water in marine sanitary systems, and water used for engine cooling in a closed system.
- take reasonable measures to remove aquatic plants from the watercraft, watercraft equipment, and any vehicle or trailer used to transport the watercraft.

The watercraft, trailer and watercraft equipment must be free of all aquatic organisms before being placed into any body of water.

TRCA COMMENTS

TRCA generally supports the proposals for invasive species management as described in the ERO postings and in the draft Strategy on Invasive Wild Pigs. In TRCA's experience, proactive assessment and management of invasive species is required to avoid ecological, economic and societal impacts of these species, particularly in the face of a changing climate. Aggressive action to monitor and control invasive species in the near term can mitigate long-term impacts.

Strong consideration should be given to the geographical distribution of species and carriers selected for regulation. Invasive species of concern may be different in terms of their impact and current pervasiveness depending on geography and dominant land use. For example, most dominantly urban regions have specific invasive species (e.g., Norway maple (*Acer platanoides*), garlic mustard (*Alliaria petiolate*), common buckthorn (*Rhamnus cathartica*)) and pathways/carriers that are much more problematic in these regions as compared to the other parts of the province. Despite their relatively limited established ranges, these species may have significant implications on provincial goals and objectives, and it is therefore critical that additional species be reviewed for potential regulation. Partnering with local and regional municipalities along with conservation authorities will provide this information and guidance.

TRCA staff are active in the field across our nearly 3,500 km^2 jurisdiction. Staff observations and experience have informed the identification of multiple non-native plants as existing or emerging threats in our jurisdiction. For example, a few years ago Miscanthus sp. was typically observed growing in ditches near residential areas where it had been planted as a garden plant and was rarely documented in non-landscaped areas. Now, staff more commonly observe this non-native invasive plant located relatively far from residential areas. This development justifies assessment of the risk Miscanthus sp. poses to the natural environment and economy.

Another example is Norway maple (*Acer platanoides*). TRCA works with our municipal partners on invasive species management. Based on TRCA data, Norway maple is the second most dominant sub-canopy forest layer in Toronto ravines after Manitoba maple (*Acer negundo*) and is targeted for strategic removal from ravines by the City of Toronto and TRCA. Meanwhile, Norway maple sales by private industry to municipalities continue, so that public dollars are used for acquiring and for removing the species at the same time. As Norway maple was heavily planted and promoted by the Province in the 1970s and those trees are now seed producers whose progeny is clearly successfully in Toronto's ravines, a risk assessment should be a straight-forward exercise.

TRCA would therefore support prohibition under the *Invasive Species Act* of additional species beyond those currently proposed by MNRF but recognizes that under the Act, ecological risk assessments to determine the appropriate approach for managing each of the species must first take place. The recommended species for regulation are listed below.

i. Amur silver grass (*Miscanthus sacchariflorus*)
ii. Chinese silver grass (*Miscanthus sinensis*)
iii. Common buckthorn (*Rhamnus cathartica*)
iv. Curly-leaved pondweed (*Potamogeton crispus*)
v. English ivy (*Hedera helix*)
vi. Flowering rush (*Butomus umbellatus*)
vii. Garlic mustard (*Alliaira petiolate*)
viii. Giant hogweed (*Heracleum mantegazzianum*)
ix. Goutweed (*Aegopodium podagraria*)
x. Himalayan balsam (*Impatiens glandulifera*)
xi. Japanese barberry (*Berberis thunbergii*)
xii. Japanese chaff flower (*Achyranthes japonica*)
xiii. Japanese stiltgrass (*Microstegium vemineu*)
xiv. Kudzu (*Pueraria montana*)
xv. Norway maple (*Acer platanoides*), with appropriate notification to the horticultural industry
xvi. Oriental/Asiatic bittersweet (*Celastrus orbiculatus*)
xvii. Periwinkle (*Vinca minor*)
xviii. Purple loosestrife (*Lythrum salicaria*)
xix. Rough manna grass (*Glyceria maxima*)
xx. Sea buckthorn (*Hippophae rhamnoides*)
xxi. Tree of heaven (*Ailanthus altissima*), as it is the preferred host for the spotted lanternfly (*Lycorma delicatula*) which is currently a regulated species under the federal *Plant*

Protection Act

xxii. Water lettuce (*Pistia stratiotes*)
xxiii. White mulberry (*Morus alba*)
xxiv. Wild chervil (*Anthriscus sylvestris*)
xxv. Wild parsnip (*Pastinaca sativa*)
xxvi. Winged burning bush (*Euonymus alatus*)
xxvii. Winged euonymus (*Euonymus alatus*)
xxviii. Winter creeper euonymous (*Euonymus fortune*)
xxix. Yellow archangel (*Lamiastrum galeobdolon*)
xxx. Amur honeysuckle (Lonicera maackii)
xxxi. Tatarian honeysuckle (Lonicera tatarica)
xxxii. Morrow honeysuckle (Lonicera morrowii)
xxxiii. Bell's honeysuckle (Lonicera xbella)

TRCA RECOMMENDATION

In light of the above, TRCA recommends that, in addition to the proposed species regulation, carrier specific rules and the draft Strategy on Invasive Wild Pigs, the Ministry undertake ecological risk assessments to determine the appropriate approach for managing the 33 species listed above, which pose immediate threats to the environmental, social, and economic resilience of Ontario.

Thank you once again for the opportunity to provide comments on the government's consultation on invasive species management. Should you have any questions, require clarification on any of the above, or wish to meet to discuss our remarks, please contact the undersigned at 416.667.6290 or at john.mackenzie@trca.ca.

Sincerely,

<Original signed by>

John MacKenzie, M.Sc.(Pl) MCIP, RPP
Chief Executive Officer

BY E-MAIL
cc:

TRCA: Laurie Nelson, Director, Policy Planning
Anil Wijesooriya, Director, Restoration and Infrastructure
Sameer Dhalla, Director, Development and Engineering Services

Attachment 10: TRCA Submission on ERO#019- 2986

June 26, 2021

BY E-MAIL ONLY (ca.office@ontario.ca)

Liz Mikel
Ministry of the Environment, Conservation and Parks
Conservation and Source Protection Branch
40 St. Clair Avenue West, Floor 10
Peterborough, ON M4V 1M2

RE: Regulatory proposals (Phase 1) under the Conservation Authorities Act (ERO #019-2986)

Thank you for the opportunity to comment on the Ministry of Environment, Conservation and Parks (MECP) Environmental Registry of Ontario (ERO) posting on the Phase 1 Regulatory proposals under the *Conservation Authorities Act* (CA Act). The following comments were approved by Toronto and Region Conservation Authority's (TRCA) Board of Directors on June 25, 2021.

Toronto and Region Conservation Authority
With almost five million people living within our jurisdiction, 75% of which live within 2 km of a TRCA owned or managed property, TRCA's covers nine watersheds and over 70 km of the collective Lake Ontario Shoreline stretching from Mississauga to Ajax and across the Oak Ridges Moraine from Mono in the west to Uxbridge in the east. Some of Canada's largest and fastest growing municipalities, including Toronto, Markham, and Vaughan are located entirely within TRCA's jurisdiction which spans six upper-tier and 15 lower-tier municipalities. TRCA is the largest non-governmental landowner within the jurisdiction, owning and managing 16,860 ha which function primarily to protect residents and provide treasured public greenspace for existing and new communities.

TRCA with and on behalf of its government and agency partners advances flood infrastructure, trails and restoration projects, and works with our partner municipalities, agencies and applicants to ensure timely issuance of well over 1,000+ development and infrastructure permit approvals annually, while protecting the environment, and safeguarding our communities from the risks of flooding and erosion. We are also experts at ensuring our watersheds and the Lake Ontario shoreline are protected, restored, and made more resilient to impacts of climate change including more extreme weather events through our shoreline design and construction expertise. TRCA, its Board of Directors, and its various subcommittees of the Board, provide advice to the Province and partner municipalities on their initiatives including projects and plans. TRCA also provides advice to municipal, provincial, and federal governments on policy initiatives which has involved TRCA staff serving on government committees including CEO and senior staff involvement in the Province's CA Act Working Group.

Although TRCA is often referred to as the largest of Ontario's 36 conservation authorities, it is vital to recognize that TRCA is in a field of its own, as exemplified by the following 2020 statistics:

- TRCA's revenues of $162M were more than five times larger than the second largest conservation authority;
- Only nine conservation authorities had revenues that exceeded $10M and TRCA's revenues were equal to the combined revenues of the other eight; and
- The remaining 27 conservation authorities had combined revenues below $100M, an average less than $4M per authority.

As such, while the perspectives and recommendations reflected in TRCA's response usually align with that of Greater Golden Horseshoe conservation authorities, they may not always be consistent or similar to those of Conservation Ontario or other conservation authorities. Accordingly, the issues prevalent for our organization, due to the scale, size and pressures of our jurisdiction, can be substantially different from our counterparts.

Government Proposal
MECP has posted a "REGULATORY PROPOSAL CONSULTATION GUIDE: Regulations Defining Core Mandate and Improving Governance, Oversight and Accountability of Conservation Authorities" on the ERO. The purpose of the Consultation Guide is to provide a description of the proposed regulations and solicit feedback that will be considered by the Ministry when developing the proposed regulations. The Guide does not include draft regulations. This first phase of the Ministry's process is focused on the proposed regulations related to:

- the mandatory programs and services to be delivered by conservation authorities;
- the proposed agreements that may be required with participating municipalities to fund non-mandatory programs and services through a municipal levy;
- the transition period to establish those agreements;
- the requirement to establish community advisory boards; and
- the Minister's section 29 regulation relating to conservation authority operation and management of lands owned by the authority.

As noted on the ERO, in the coming months, MECP will be consulting on the second phase of proposed regulations under the CA Act, including:

- Municipal levies governing the apportionment of conservation authority capital and operating expenses for mandatory programs and services and for non-mandatory programs and services under municipal agreement. This would also set out provisions pertaining to municipal appeals of conservation authority municipal levy apportionments, including who would hear those appeals.
- Standards and requirements for the delivery of non-mandatory programs and services.

It is our understanding that there will be a future ERO posting by the Ministry of Natural Resources and Forestry (MNRF) regarding the permitting regulation under section 28 of the CA Act. We would strongly encourage the MNRF posting or consultation guide to be released shortly so these compendium pieces can be considered together prior to regulations being finalized and approved.

General Comments
TRCA continues to support the provincial requirement for three types of programs and services that conservation authorities provide: (1) legislated as mandatory by the Province, (2) provided on behalf of municipalities, and (3) those that TRCA undertakes to further its objectives under the CA Act. TRCA views these in the context of the Act's purpose of, "providing for the organization and delivery of

programs and services that further the conservation, restoration, development and management of natural resources in watersheds in Ontario." In our early discussions with partners, we note that the four categories as described in the Guide has caused some potential confusion and may not be required as both the CA and municipality must be in agreement to provide the service or program. Based on this early feedback from our municipal partners we would encourage the government to maintain only three categories in a future regulation.

Mandatory Programs and Services
In June 2019, the *More Homes, More Choice Act,* 2019, amended the CA Act to identify the categories of mandatory programs and services that conservation authorities are required to provide, where applicable in their specific jurisdictions. The *Protect, Support and Recover from COVID-19 Act (Budget Measures),* 2020, re-enacted this provision. Mandated by the Province, these programs and services may be funded by provincial grants and/or conservation authority self-generated revenue (e.g., user fees) and/or municipal levy. CAs can levy participating municipalities to fund budgeted (revenue) shortfalls. The following comments and recommendations are provided to inform the development of the regulations for the proposed scope of mandatory programs and services as set out and described in the Consultation Guide.

A. Mandatory Programs and Services Related to the Risks of Natural Hazards
It is proposed by MNRF that each conservation authority would be required to implement a program or service to help manage the risk posed by the natural hazards within their jurisdiction, including flooding, erosion, dynamic beaches, hazardous sites as defined in the Provincial Policy Statement (PPS), 2020 and low water/drought as part of Ontario's Low Water response. This program shall be designed to:

- identify natural hazards;
- assess risks associated with natural hazards including impacts of climate change;
- manage risks associated with natural hazards; and
- promote public awareness of natural hazards.

Managing risks associated with natural hazards may include prevention, protection, mitigation, preparedness, and response.

The detailed list of mandatory programs and services related to the risk of natural hazards as proposed in the Consultation Guide generally aligns with current TRCA programs and services for this category. It includes the administration of permits issued under section 28.1 of the CA Act, (sections 28.1 and 28.1.2 once proclaimed) and associated enforcement activities. The delineation and mapping of regulated natural hazards (e.g., flood plain, hazardous lands and hazardous sites) and features (e.g., wetlands, river or stream valleys defined or undefined) are critical to the implementation of this program. Wetland mapping has not been captured within the list and should be included. The inclusion of wetland mapping would recognize that managing risks associated with natural hazards includes the identification and protection of natural features such as wetlands.

The section in the Guide related to the role of CAs in land use planning requires clarification and should be expanded to capture all the activities TRCA undertakes in support of our municipal, provincial, agency and industry partners. TRCA conducts itself in accordance the MNRF Procedural Manual chapter, "Policies and Procedures for Conservation Authority Plan Review and Permitting Activities." Accordingly, TRCA is a public commenting body under the *Planning Act* and *Environmental Assessment Act*; an agency delegated the responsibility to represent the provincial interest on natural hazards under Section 3.1 of the Provincial Policy Statement (PPS); a service provider in accordance with a municipal Memorandum of Understanding (MOU); a regulator under section 28 of the CA Act; a Source Protection Authority under the *Clean Water Act*; a resource management agency; and a landowner. In these roles, and as stated in the “Made in Ontario Environment Plan,” conservation authorities work in collaboration with municipalities and stakeholders to protect people and property from flooding and other natural hazards, and to conserve natural resources.

In absence of more specific details, the reference to “Provincial One Window Planning Service protocols”, could be interpreted to limit the role of CAs and depart from the MNRF Policies and Procedures noted above, the Conservation Ontario/Ministry of Natural Resources/Ministry of Municipal Affairs and Housing Memorandum of Understanding, and current streamlined Plan Input and Plan Review services provided to our municipal partners and public agencies - much of which is embedded in existing MOUs between TRCA, partner municipalities, and neighbouring CAs. The Provincial Policy Statement (PPS) under the *Planning Act* was updated in 2020 and the following statement was added to Section 3.0: “Mitigating potential risk to public health or safety or of property damage from natural hazards, including the risks that may be associated with the impacts of a changing climate, will require the Province, planning authorities, and conservation authorities to work together.” Retaining and recognizing current practices including the ability to independently appeal decisions related to natural hazards to the Ontario Land Tribunal (OLT), (formerly LPAT) is critical to managing the risks associated with natural hazards and upholding the PPS, as well as other relevant provincial plans (e.g., A Place to Grow: Growth Plan for the GGH). We would appreciate staff reviewing the above protocols in the context of preparing both the updated MNRF and MECP regulations to ensure these well-established functions are accurately captured.

The section on operation and maintenance of water control and erosion control structures, should include acquisition or construction costs of such infrastructure. The technical studies required for rehabilitation/restoration or repair of infrastructure typically include an ecological component and given the important role of natural cover in watershed management usually include a natural heritage study component. In addition, natural heritage considerations are also a factor or information requirement in many provincial legislative or regulatory requirement approvals required to upgrade water control infrastructure, e.g., MECP *Endangered Species Act*, *Environmental Protection Act,* Environmental Compliance Approval, or MNRF *Lakes and Rivers Improvement Act* permissions. Mitigating natural hazards through both structural and non-structural measures and a recognition of the need to consider natural heritage matters as part of this work should be included in the list.

In the Consultation Guide, conservation authority input and review on municipal land use planning matters outside of natural hazard policies, such as natural heritage policies, is used as an example of a non-mandatory program and service that a municipality may request and would require a CA-Municipal MOU. Like natural hazards, the natural heritage aspects of a watershed know no political boundaries and so it would make sense, instead, for municipalities to be required to utilize CAs for natural heritage planning services (providing CA input and review on land use planning matters for natural hazards and natural heritage on the municipality’s behalf). For most of our partners, TRCA’s existing MOU or service level agreements include such a role. Based on our observations and experience of our CA partners in the GGH, there is a cost risk to the taxpayers by making natural heritage non-mandatory. For example, we have observed that it is far more costly to the municipal taxpayer for their municipality to procure private consulting natural heritage services to inform municipal initiatives than to work with their CA partners.

In most cases, once retained, private natural heritage consultants end up reaching out to CAs to obtain data and confirm findings and thus end up engaging CAs resulting in double the effort, more costs for staff time that the municipality must cover, and a resulting inefficient use of taxpayers' dollars. By working directly with a CA to leverage their existing data, a municipality is receiving a comprehensive service, the full benefit of watershed/science-based approach (and a level playing field) that has influence over the environment in its neighbouring jurisdiction just as it does with the environment in its own boundaries. In current practice in our jurisdiction, TRCA's municipal partners appreciate the watershed-based perspective and holistic environmental expertise including natural heritage expertise of TRCA in commenting on land use planning matters.

We note that ice management plans and services (preventative or remedial) should be appropriate for the circumstances of the individual CA. In TRCA's jurisdiction, our focus is on the technical advisory elements of ice management and response, while our municipal partners operationalize the response (e.g., responsible for standby equipment).

Recommendations:

- **That CAs retain the ability to represent the provincial interest related to section 2 of the *Planning Act* and the Natural Hazards policies of the PPS for all applications under the *Planning Act*, input into the review of applications for new and amended Special Policy Areas, and to independently appeal decisions related to natural hazards to the OLT when appropriate to ensure that the provincial interest is met.**
- **That the Province ensure provincial standards, as referenced in this section of the Guide, are current to ensure consistency amongst CAs. More specifically, the MNRF Hazard Technical Guides for natural hazards (flooding, erosion, Great Lakes) and Special Policy Area Procedures need to be updated to reflect current science, technology and best management practices, the urban context (e.g., redevelopment, infill, community revitalization, etc.), address gaps or deficiencies, and provide guidance on incorporating climate change in natural hazard management.**
- **That wetland mapping be added to the list of information needed to support CAs in the implementation of s. 28 permitting responsibilities.**
- **That the ecological components identified in a study to manage natural hazards (e.g., rehabilitation/restoration or repair of infrastructure) be included.**
- **That the ecological and hydrological components (natural heritage aspects) to prevent new hazards from being created and existing hazards from being aggravated, and to avoid adverse environmental impacts, also be included (conservation authority input and review on municipal land use planning matters outside of natural hazards, specifically natural heritage policies).**

B. Mandatory Programs and Services Related to the Management of Conservation Authority Land

The mandatory programs and services related to the conservation and management of lands owned or controlled by a conservation authority, including any interests in land registered on title, relate to the conservation authority as the owner of its land and also to land owned by others where the conservation authority has an "interest" or right related to that other person's property, as granted by the property owner (e.g., "conservation easements" that may protect a natural heritage feature or 'access easements' that may enable a conservation authority to develop trails that cross another landowner's property).

Each conservation authority will be required to implement the mandatory programs and services as set out in the Consultation Guide related to the conservation and management of lands owned or controlled by the authority, including any interests in land registered on title, within their jurisdiction.

Generally, the scope of activities in the Consultation Guide related to the conservation and management of conservation authority land are supported and align with current TRCA programs and services. It should be clarified throughout the Guide that while CA land is considered private, it benefits the public at large. Often, these acquired lands are contiguous river and stream systems that form essential corridors and connections through communities that protect natural heritage, as well as natural hazards and provide economic value through a myriad of ecosystem services. Further, through public access, these lands provide base level open space for passive use, such as trails. The provision of services and infrastructure to accommodate public access is currently not identified as a mandatory activity and TRCA sees this as an important required clarification, especially in our jurisdiction where our system of lands, trails, and amenities often provide important active transportation and regional scale linkages for larger networks (e.g., The Great Lakes Waterfront Trail, the Humber River Trail, segments of the Trans Canada Trail, etc.).

The administration of the s. 29 Minister's Regulation of "Conservation Areas" is included within the scope of this category. TRCA's detailed comments and recommendations are provided in a separate section below related to the proposed s. 29 Regulation.

Recommendation:

- **That maintenance of conservation parks and lands for safe public access and use be included as a mandatory activity provided by CAs as through the provision of safe access, we are ensuring public infrastructure is accessible and emergency routes through conservation lands are provided.**

C. Mandatory Programs and Services Related to Source Protection Authority responsibilities under the Clean Water Act, 2006

Under the *Clean Water Act,* 2006 conservation authorities are required to exercise and perform the powers and duties of a drinking water source protection authority. Each conservation authority therefore would be required to implement programs and services related to those responsibilities as source protection authorities under the *Clean Water Act, 2006.*

The scope of mandatory programs and services related to source protection appears to be consistent with the current responsibilities of the Toronto and Region Source Protection Authority for the Credit Valley-Toronto and Region-Central Lake Ontario (CTC) Source Protection Region. The Province has funded this program since its inception. It will be important to understand MECP's intent with respect to continued financial support for this program so that municipalities are informed of any potential budget implications.

Recommendation:

- **That TRCA supports the inclusion of programs and services related to source protection. Sustained and adequate funding is required to enable CAs and municipalities to carry out the legislated duties under the *Clean Water Act*.**

D. Lake Simcoe Region Conservation Authority duties, functions, and responsibilities under the Lake Simcoe Protection Act, 2008 – Not applicable to TRCA

E. Mandatory Programs and Services Related to Conservation Authority Responsibilities Under an Act Prescribed by Regulation – Not applicable to TRCA

F. Mandatory Programs and Services Prescribed in Regulation (Within the Year after the Transition Period for Municipal Funding Agreements for Non-Mandatory Programs and Services)

The CA Act also allows for the prescribing of 'other' programs and services not listed in previous mandatory categories. These 'other' programs and services must be prescribed within a year after the end of the transition period for municipal funding agreements for non-mandatory programs and services. The Ministry is proposing to prescribe the following as mandatory programs and services:

1. Core Watershed-based Resource Management Strategies
2. Provincial Water Quality and Quantity Monitoring, including:
   a. Provincial stream monitoring program
   b. Provincial groundwater monitoring program

Core Watershed-based Resource Management Strategies

To capture the value of the broader watershed and resource management perspective that CAs have, MECP is proposing that each conservation authority be required to develop a core watershed-based resource management strategy that documents the current state of the relevant resources within their jurisdictions in the context of the mandatory programs and services described in the Guide. This strategy can provide a means to develop an improved integrated process with a longer-term perspective and inform an adaptive management approach to address issues or threats such as mitigating the risks from the impacts of natural hazards. A successful strategy should also help ensure effective and efficient use of funding, especially of the municipal levy. The ministry provides examples, using three tables in the Guide, of how mandatory programs and services would be incorporated in the strategy, as well how non-mandatory programs and services could be incorporated, subject to an MOU/agreement.

The value and addition of core watershed-based resource management as a prescribed mandatory program and services is a very positive aspect of the Ministry's proposal and aligns with the collaborative work of CAs, partner municipalities and stakeholders, as stated in the Made-In-Ontario Environment Plan, to focus and deliver on the CA "core mandate of protecting people and property from flooding and other natural hazards and conserving natural resources." While the Guide indicates the strategy would principally focus on water resources, equally important in the management of natural hazards is protecting, restoring, and enhancing the natural environment. Water resources and natural heritage systems are intrinsically linked in watershed management and recognized as such in provincial policy and plans, as well as municipal and CA policies.

By assisting our municipal partners in the growth management planning process, TRCA advocates for sub-watershed planning and updated watershed plans to protect resources, address downstream risks, and facilitate integrated infrastructure and development planning to accommodate approved growth in designated settlement areas in our jurisdiction as part of this Core Watershed-based Resource Management Strategy. This implementation piece for these Strategies is missing from the Consultation Guide. Based on our experience of successfully working with industry, stakeholders and government agencies, greater certainty for all stakeholders involved in the growth planning process can be achieved through the completion of science-based watershed and subwatershed studies. TRCA's recently released Watershed and Ecosystem Reporting Hub identifies the current conditions and explains the importance of different environmental indicators for understanding watershed and ecosystem health within the watersheds and the waterfront in TRCA's jurisdiction. TRCA's Carruthers Creek Watershed Plan approved by Durham Region Council on June 23, 2021, is our most recent plan to helps guide future decision-making for this watershed by the Region of Durham, City of Pickering, Town of Ajax, TRCA, and watershed residents and other stakeholders. These are two examples that demonstrate the integration of mandatory and non-mandatory activities related to core-watershed resource management.

Recommendations:

- **That TRCA supports the addition of Core-watershed Resource Management Strategies as prescribed mandatory programs and services.**
- **That it be recognized that water resources systems and natural heritage systems are intrinsically linked in watershed management, as per provincial policies and plans.**
- **That it be recognized that these Strategies can be used to inform municipal growth planning to achieve shared municipal-CA goals in watershed management.**
- **That provincial staff review recently completed TRCA and partner supported projects including the Watershed and Ecosystem Reporting Hub and the Carruthers Creek Watershed Plan to inform any future guidance and work on regulations.**
- **That it be clarified that the three tables provided in the Consultation Guide (pages 18-20) are examples of programs and/or activities and potential funding mechanisms and will not be included in the regulation. The lists are not complete, nor do they recognize all potential funding arrangements.**

Provincial Water Quality and Quantity Monitoring

At this time, the Ministry is proposing mandatory programs and services for conservation authorities related to water quality and groundwater quantity monitoring to be prescribed in this category with the possibility of additional programs and services prescribed later within the timeframe enabled by the CA Act.

All 36 conservation authorities currently participate in the Provincial Water Quality Monitoring Network (stream water quality) and in the Provincial Groundwater Monitoring Network (groundwater levels and chemistry). The Ministry manages the water monitoring programs by providing technical leadership, coordination, guidance, data administration, laboratory analysis, instrumentation, and training to support the conservation authority role in this work. Conservation authorities install and maintain equipment, collect samples/data, and send samples to the Ministry laboratory for chemical analysis.

Recommendation:

- **That TRCA supports the addition of the provincial water quality and groundwater monitoring programs as prescribed mandatory programs and services.**

Non-Mandatory Conservation Authority Programs and Services
Conservation authorities will be required to have mutually agreed upon Memorandums of Understanding (MOUs) or other such agreements (service contracts) with their participating municipalities for the funding of non-mandatory programs and services to be delivered on behalf of, and at the request, of a municipality, through a funding mechanism chosen by the municipality. Within our jurisdiction TRCA has MOU or other agreements in place with most of its municipal and agency partners regarding the services we deliver and undertakes regular pre-budget meetings to confirm funding and priorities. However, TRCA is supportive of the intent of the province to ensure updated agreements are in place between CAs and municipal partners to further clarify funding for programs and services.

Regulation for Municipal Agreements and Transition Period
MECP is proposing to proclaim sections 21.1.1, 21.1.2 and 21.1.4 of the CA Act and develop one Minister's regulation that would establish standards and requirements for entering into agreements for municipal funding of non-mandatory programs and services, including municipal programs and services under section 21.1.1 funded by revenue that is not from a municipal levy, and other programs and services under section 21.1.2 funded through a municipal levy.

The regulation would also govern the matters to be addressed in each authority's transition plan. Conservation authorities would be required to submit copies of their transition plan to the Minister for information purposes (not approval) by a date to be set out in the proposed regulation, and to its participating municipalities and to make the plans available to the public online (e.g., on a conservation authority's website).

MECP is proposing January 1, 2023, as the prescribed date by which municipal agreements must be in place for authorities to use or continue to use the levy powers to fund non-mandatory programs and services. To achieve this timeline and process, MECP is proposing that: the transition plan be completed by December 31, 2021; quarterly reporting during the fiscal year 2022 on the status and progress made in attaining agreements; and all CA/municipal agreements in place and funding reflected in authority budgets for 2023.

The Ministry is proposing to authorize the granting of extensions to the prescribed date for completing municipal agreements where an authority, with the support of one or more participating municipalities in the authority, submits a written request for the extension to the timeline/prescribed date.

Through engagement with our partner municipalities on non-mandatory programs and services as directed by the Board, TRCA is at the forefront of meeting what is envisioned in the Consultation Guide, as we continue to establish comprehensive, updated MOUs and to refine existing municipal-CA agreements, where required. Staff regularly report to the TRCA Board of Directors on the status and progress being made on this work. However, to meet the budgeting process for 2023, it will be critical for TRCA, with the support of its municipal partners, to advance the completion of this work as early in 2022 as possible to provide certainty in meeting shared municipal-TRCA objectives and avoid the need to request an extension. This will include ensuring that MOUs are considered in a timely way by municipal partners at relevant committee and Council meetings in 2021 and early 2022 at the latest.

Recommendations:

- **That the proposed regulation contain high-level direction and principles for developing MOUs that provide CAs and municipalities with the flexibility and latitude to negotiate mutually beneficial agreements.**
- **That the Ministry proclaim the regulation in a timely manner for CAs to meet the prescribed timelines for the transition plan and execution of municipal agreements.**
- **That the Ministry encourage municipal Council consideration of the updated MOUs and SLAs at the earliest opportunity to ensure the prescribed timelines can be achieved.**

Regulation to Require "Community" Advisory Boards

The Province is proposing to proclaim a provision of the CA Act related to advisory boards and to develop a Lieutenant Governor in Council (LGIC) regulation to require conservation authorities to establish community advisory boards, that can include members of the public, to provide advice to the authority. The government is also proposing to make a Minister's regulation to provide greater clarity that conservation authority by-laws are applicable to the community advisory boards.

In recognition of the variation in the circumstances of individual conservation authorities, the government is considering an approach to structure the conservation authority community advisory boards with minimal prescribed requirements applied to all the boards, while enabling local flexibility of some aspects of the community advisory board to reflect a conservation authority's circumstances and to accommodate a conservation authority's preferences for their use of the community advisory board. The government would defer other specific details related to the composition, activities, functions, duties, and procedures of the community advisory board to a Terms of Reference document, which would be developed and approved by each authority and reiterated in the authority's by-laws. This Terms of Reference could be amended over time, to ensure the most relevant issues and solutions are considered by the community advisory board and that the membership of the board has the necessary skills to carry out those tasks.

Under the current provisions of the CA Act, TRCA currently has two advisory boards: Partners in Project Green (PPG) and the Regional Watershed Alliance (RWA). Each of these advisory boards have a comprehensive Terms of Reference, which are incorporated into TRCA's Administrative By-law. The role, composition, and function of the existing RWA closely aligns with the description in the Guide of the government's proposal to create a 'community' advisory committee. TRCA's Board of Directors also recently approved the establishment of a multi-stakeholder Natural Science and Education Committee and associated Terms of Reference.

Recommendations:

- **That the general functions of a community advisory board shall be to provide advice to the conservation authority on the authority's strategic plans and community-oriented programs and services.**

- **That the requirements for the process to establish an advisory board acknowledge/recognize that where existing CA advisory boards or committees involving members of the public already perform such functions, a CA is not required to establish a new community advisory provided the substantive requirements of the regulation are met.**

Section 29 Minister's Regulation (CA Landholdings)

Once the new section 29 of the *Conservation Authorities Act* is proclaimed, a Minister's regulation is proposed to consolidate the current individual authority section 29 'Conservation Areas' regulations regarding activities on lands owned by conservation authorities into one regulation. MECP is intending for the Minister's regulation to be broadly consistent with the policy principles and provincial content that has been used in the past. The current regulations will continue until such time as the new Minister's regulation replaces them.

Current section 29 regulations manage activities on all authority owned land including the use by the public of the lands and services available; the prohibition of certain activities; setting fees for access and use of lands including recreational facilities; administrating permits for certain land uses; and protecting against property damage and for public safety.

The administration of section 29 is included as a mandatory program and service related to the management of land owned by CAs. Throughout the review of the CA Act, TRCA requested the Province to enhance the section 29 regulatory enforcement and compliance provisions to be consistent with the protections afforded under the *Provincial Parks and Conservation Reserves Act* to adequately protect our 16,860 ha, (owned and managed), public landholdings. There is no indication in the Consultation Guide that any substantial changes to the section 29 regulation are being proposed and as such, this aspect of the Ministry's proposal remains a concern to TRCA.

As urbanization pressures increase and the population expands within our communities, municipal by-law and police forces are strained resulting in a growing responsibility on CAs to preserve, protect and manage use of valuable greenspaces and regulated areas. These pressures occurred prior to, but have increased during the COVID-19 pandemic. Currently, TRCA participates on various committees comprised of municipal and enforcement related agencies to coordinate enforcement and compliance efforts to leverage their enforcement tools (e.g., municipal by-laws, etc.) where feasible given the limitations under the CA Act. However, a long-term solution and modernization of the s. 29 enforcement provisions are urgently needed to improve compliance, ensure public and CA officer safety, and effectively deter undesirable activities and behaviours on TRCA landholdings. The following examples demonstrate some of the enforcement provisions required within the s. 29 regulation.

<u>Vehicle operator to stop</u>

The lawful ability to stop vehicles involved in the commission of vehicle related offences on CA-owned lands is an effective public and staff safety and compliance tool. Current CA regulations do not fully encompass the range of moving vehicle violations occurring on our lands (i.e., excessive speeds, unsecured passengers, unlawful operation of ATVs and snow machines, and in extreme circumstances, intoxicated driving). The addition of this provision within the CA Act will allow CA officers to effectively address these undesired activities and public safety issues.

<u>Searches and Seizures</u>

The addition of both search and seizure provisions is necessary for CA officers to properly protect and conserve the ecological integrity of CA-owned lands. Offenders involved with illegal hunting and the commercial harvesting of flora (i.e., American Ginseng, Fiddleheads, Leeks) from these protected areas is increasing, and CA officers have no current ability to, upon reasonable grounds, search and seize items gained in the commission of these offences. The lack of these provisions allows offenders to leave these lands with their illegal harvests and return to re-engage in the activity with the knowledge that CA officers are unable to effectively stop the continuation of an offence and secure the required evidence pertaining to the offence. Without these provisions, it further incentivizes offenders to return to the lands to re-engage without appropriate consequences for their actions.

Require Identification

The ability to require an individual to identify themselves involved in the commission of an offence will enable officers to lawfully obtain the appropriate information and hold offenders accountable for their actions or behaviours on our lands. It will assist with investigations and reduce individuals from evading appropriate enforcement actions for public safety and/or ecological destruction of CA landholdings.
In addition, the un-proclaimed s. 30 enforcement and compliance provisions (e.g., stop orders, etc.) associated with s. 28 of the CA Act should be expedited and proclaimed.

S.28 Stop Orders

This provision needs to be enacted to provide TRCA officers the ability to stop activities in a timely manner and reduce the significant impacts of flooding, erosion, and other natural hazards that may jeopardize the health and safety of persons and the destruction of property. It will also provide officers with the necessary tools and ability to protect sensitive features and reduce the devastating effects associated with unlawful destruction of our Provincially Significant Wetlands and other ecologically sensitive features. It also holds parties accountable for failure to comply with a stop order through significant penalties. In numerous instances, including in a recent example within the Natural Heritage System of the Greenbelt Plan, TRCA enforcement officers were unable to stop the destruction of a Provincially Significant Wetland due to the lack of powers as compared to MECP provincial officers.

Recommendations:

- **That the Ministry convene a working group with staff from the Province, Association of Municipalities of Ontario (AMO)/municipalities, CAs and enforcement agencies to identify a long term, sustainable strategy that will enable CAs to fulfill their obligations to monitoring and enforcement action on CA-owned lands or managed lands where applicable, as established under s. 29 of the CA Act. Compliance and enforcement tools must be available to CAs to protect and manage CA-owned lands, safeguard the health and safety of the public and CA officers, protect the environment, and reduce/avoid the potential for a devasting occurrence that would cause harm to life and property.**
- **That if amendments to the CA Act, as opposed to the regulation, are required to facilitate enhancements to s. 29, the Ministry enable such amendments in a timely manner through all available legislative mechanisms including future bills on the CA Act or related legislation.**
- **That, while not part of this ERO posting, the Province expedite consultation on Section 28 (permitting) regulatory proposals and the enactment of all Section 30 provisions including Stop Orders to deal with enforcement matters such as large-scale filling and development activities in highly sensitive and risk regulated areas.**

Thank you once again for the opportunity to provide comments on the "REGULATORY PROPOSAL CONSULTATION GUIDE: Regulations Defining Core Mandate and Improving Governance, Oversight and Accountability of Conservation Authorities." Should you have any questions, require clarification on any of the above, or wish to meet to discuss our remarks, please contact the undersigned at 416.667.6290 or at john.mackenzie@trca.ca.

Sincerely,

<Original Signed by>

John MacKenzie, M.Sc.(PI) MCIP, RPP
Chief Executive Officer

Attachment 11: TRCA Submission on ERO#019-3564

Chief Executive Officer

Toronto and Region Conservation Authority

June 28, 2021

BY E-MAIL ONLY (FMZ16@ontario.ca)

Gillian Holloway
MNRF - ROD - Regional Resources Planning Team
300 Water Street
Peterborough, Ontario
K9J 3C7

RE: Fisheries Management Zone 16 – Consultation on Planning Approaches (ERO #019-3564)

Thank you for the opportunity to comment on the Ministry of Natural Resources and Forestry (MNRF) Environmental Registry of Ontario (ERO) posting "Fisheries Management Zone 16 – Consultation on Planning Approaches."

TRCA conducts itself in accordance with the objects, powers, roles and responsibilities set out for conservation authorities under the *Conservation Authorities Act* and MNRF Procedural Manual chapter on CA policies and procedures for plan review and permitting. TRCA is:

- A public commenting body under the *Planning Act* and *Environmental Assessment Act*;
- An agency delegated the responsibility to represent the provincial interest on natural hazards under Section 3.1 of the Provincial Policy Statement;
- A regulatory authority under Section 28 of the *Conservation Authorities Act*;
- A service provider to municipal partners and other public agencies;
- A Source Protection Authority under the *Clean Water Act*;
- A resource management agency; and
- A major landowner in the Greater Toronto Area.

In these roles, and as stated in "A Made-In-Ontario Environment Plan," conservation authorities work in collaboration with municipalities and stakeholders to protect people and property from flooding and other natural hazards, and to conserve natural resources. Through Memorandums of Understanding and Service Level Agreements, TRCA provides technical support to its provincial and municipal partners in implementing municipal growth management policies. Our municipal partners rely on TRCA's assistance for implementing the natural heritage and water resource policies of the Provincial Policy Statement and provincial plans, including for fish and fish habitat, by conserving and restoring natural resources through our mandate under the *Conservation Authorities Act*. Further, TRCA's Regional Watershed Monitoring Program has collected long-term data since 2001 on water quantity and quality as well as biological and habitat data. Each of TRCA's nine watersheds are surveyed for fish communities and habitat features on a regular basis to evaluate the health of fish communities and how they are changing over time. TRCA previously assisted MNRF in the development of Fisheries Management Plans and can continue to support the Ministry by providing data that can be used to inform the Ministry's development of strategies for Fish Management Zones within TRCA's jurisdiction. TRCA is pleased to provide input on the current proposal to meet shared provincial-municipal-CA objectives for sustaining healthy aquatic resources.

GOVERNMENT PROPOSAL

TRCA understands that the primary unit for fisheries planning, management and monitoring are Fisheries Management Zones, and that fisheries management planning aims to document the current state of the fisheries as well as the goals, objectives and management actions intended to maintain or move the zone closer to a desired future state.

We further understand that for this initiative, public consultation is not required but that MNRF is seeking public feedback on planning approaches to inform fisheries management in Fisheries Management Zone (FMZ) 16. In particular, the focus of this proposal is on how to develop the administrative and consultation framework needed to move forward with fisheries management planning in FMZ 16.

Across the province, 20 FMZs have been established based on biological, climatic, and social considerations. The April 2021 Discussion Paper accompanying the ERO posting, "Towards a Planning Approach for Fisheries Management Zone (FMZ) 16," states that, "Planning at the FMZ level enables sustainable management of fisheries in Ontario through a planning process that is responsive to the individual needs and nature of each zone. Long-term goals for recreational fisheries are typically established at the FMZ level and supported by objectives and management actions for the fisheries within each zone." Situated in southwestern Ontario and encompassing the Greater Toronto Area, the ERO posting acknowledges that fisheries management is a unique challenge in FMZ 16 as it supports the largest urban population of any zone, along with the highest proportion of resident anglers of any zone in Ontario.

The current provincial approach to fisheries management at the zone level focuses on developing an FMZ fisheries management plan. Key planning components include the formation of an advisory council, writing of a background report and development of an FMZ plan. In the Fall of 2017, MNRF conducted Listening Sessions to launch fisheries management planning in FMZ 16. The intent of the sessions was to ask interested parties for advice on what planning for FMZ 16 should include and consider.

TRCA COMMENTS

In addition to providing a summary of feedback heard at the Listening sessions, the Discussion Paper presents several concepts that build on the feedback received through the Listening Sessions. The concepts are described to stimulate discussion and solicit feedback that will help inform government direction toward developing a planning approach for FMZ 16. As the Paper states, there are 19 CAs within FMZ 16. FMZ 16 includes the majority of TRCA's jurisdiction excepting the Duffins and Carruthers watersheds. In response to the Discussion Paper Questions (*questions are italicized*), TRCA provides the following responses for MNRF's consideration. Where **main points or recommendations are stated, we have bolded the text** for your reference.

Q.1 Do you feel that this Discussion Paper captures the key themes or priority areas for consideration with respect to fisheries management in FMZ 16? a) Yes or no b) If not, why? Do you have any other suggestions to improve Fisheries Management in FMZ 16?

Subsequent to MNRF listening sessions in late 2017, TRCA sent correspondence dated January 5, 2018, to Ms. Emily Gryck of the Ministry's Regional Operations Division (enclosed), outlining TRCA's comments and opinions. Many of these have been summarized in Table 1 of the Discussion Paper and we appreciate that our comments were considered, however, it is unclear how some of these themes will be dealt with moving forward.

There are also concerns that were raised that have been deemed outside of the FMZ planning process as per the "additional information" section of the Discussion Paper. None the less, the success of the implementation of the FMZ management recommendations rests on addressing these concerns. In our January 2018 memo, TRCA noted that developing a Terms of Reference for FMZ 16 planning would be helpful in determining the scope of an FMZ Plan. There is little mention in the Discussion Paper about the specific goals MNRF would like to accomplish as part of these plans. Regarding FMZs in general, the provincial webpage states:

FMZs help the province manage the individual needs and nature of each zone by customizing catch limits and seasons to:

- *allow more fishing in thriving fisheries*
- *protect vulnerable fisheries*
- *re-establish fish populations*
- *adjust fishing seasons for different climates*

It would be helpful for stakeholders to provide better informed input if the discussion paper included these or other goals or objectives specific to FMZ 16 intended to be met through implementation of a plan. As well, it would be helpful to relate the objectives to the concepts presented in the Paper and to explain how each stakeholder, in their various roles, could contribute to meeting the objectives. For example**, conservation authority watershed plans could provide useful data to inform the first three bullets above but could also speak to conditions and issues specific to the watersheds of the FMZ and any associated objectives.**

Further, a description is needed as to how the Zone 16 Fish Management Plan's goals relate to and/or could be implemented through other relevant provincial, municipal, and federal initiatives. This would assist stakeholders in understanding how the proposed concepts would work within the policy and regulatory framework affecting fish and fish habitat such as:

- The recent federal proposal for a Canada Water Agency with possible watershed-based regional centers.
- Municipal and conservation authority watershed and sub-watershed planning to inform development and infrastructure planning as required in the provincial Growth Plan.

An FMZ Plan applies to a vast area with a number of related management plans already in place, so it should align with related federal and provincial initiatives as well as more local scale planning documents such as watershed plans and existing fisheries management plans that were done for smaller areas. Management recommendations in the FMZ Plan, should echo those listed in local scale plans and describe how the differently scaled plans interact, similar to how watershed plans help to inform municipal official plans and work together to achieve common goals and objectives. This would encourage consistent approaches, enhance clarity and certainty for stakeholders, and work to strengthen adherence to the FMZ Plan.

This discussion paper refers to key themes affecting the health of the fishery such as good quality habitat for fish populations, including water quality, however, it is unclear how some of these themes will be addressed. For example, **future direction is needed to agencies collecting water quality data about what their roles would be in addressing water quality issues as part of fisheries management.**

Further information is required about Science and Monitoring for FMZ16. For example, does MNRF consider their broad-scale monitoring program sufficient to assess the fishery across FMZ16? Does the broad-scale monitoring program have a stream monitoring component? If not, how will additional fisheries information be incorporated into the planning?

Q.2 Of the themes identified in Table 1 (Summary of Listening Session Feedback), which themes in your opinion are most important for consideration with respect to fisheries management in FMZ 16? Please list your top three choices. Are there any other important themes that should be considered? If yes, please list the concept and explain why it is important.

They are all important. This is difficult to answer without knowing how all of the various roles and responsibilities would be distributed, as indicated in our responses to question 1.

There are comments that were raised that have been deemed outside of the FMZ planning process as per the "additional information" section of the discussion paper. None the less the success of the implementation of the FMZ management recommendations rests on addressing these concerns. For example, **the recommendation of greater enforcement presence is imperative for managing fisheries given that contraventions of fisheries legislation, either on an individual or cumulative basis, can cause irreparable harm.** The Discussion Paper summarizes the concerns that will not be addressed through this FMZ planning process but does not provide an alternative to addressing these concerns.

Although some of the following is captured in the table under various headings, **we recommend more specifics be considered on these topics**.

- **Water quality** (including water temperature): Non-point source stormwater runoff, from both rural and urban areas, is impacting the quality of fish habitat. Excess nutrients from agriculture and road salt from urban areas, and increased water temperatures due to impervious cover and tree removal are some of the main concerns for this FMZ. The salinization of freshwater in urban areas is happening at a rapid rate; it threatens not only fish habitat but drinking water supplies. Water quality is essential to fish management.

- **Species-at-risk**: The discussion paper is focused on recreational fisheries, but the entire fish community needs to be considered as part of a management plan. Most species-at-risk are not part of the recreational fishery and therefore will not receive benefits from a plan focused on recreational fishing. The impacts of recreational fishing (including stocking) on species-at-risk need to be considered. Also, we should not wait for species to have an official species-at-risk designation. Brook Trout is an example of a fish which does not have a species-at-risk title, but it is rapidly losing its habitat in FMZ16.

- **Science and Monitoring**: Conservation authorities conduct a large amount of local fisheries monitoring. This data needs to be considered in the development of the FMZ16 plan. Further clarification regarding MNRF's role and future planning with regard to data collection, storage (e.g., database) and consolidation would be helpful.

- **Wetlands**: Though loosely captured in the Ecosystem Approach theme, wetlands and their management should be more prominent in the development of the plan. Overall ecosystem health as well as the specific health of the aquatic system and fishery is dependent upon wetlands and the functions they provide. Strong connections between the plan and current and future directions in wetland management within FMZ16 should be made. As with other issues impacting the fishery in FMZ16, wetlands and links to their management should be made at a scale based on the threats at hand. For example, total wetland cover and rates of historical loss are extremely variable throughout FMZ16. The impact of urbanization and infrastructure development is largely driving these differences.

Q.3 In this discussion paper, MNRF has presented concepts to address the feedback received with respect to the appropriate scale for fisheries management in FMZ 16:

a) Planning at a zone level
b) Planning at a Great Lakes watershed level
c) Planning at a scale reflective of the management issue

Which concept do you think is best suited for fisheries management in FMZ 16? Are there other concepts that could also be considered? What are some of the opportunities of these other concepts?

Option c, "planning at a scale reflective of the management issue" is best suited for fisheries management in FMZ 16. Options a and b would create an area so large that it would be difficult to manage effectively; management decisions created to address an issue in one location may be unnecessary or disruptive in another location. A risk with option c, however, may be that if there are so many different fishing regulations on a small scale, the public might be challenged to understand which regulations apply where.

It is noted in Table 1 Summary of Listening Session feedback (Watershed Management and Scale of Planning) that the Discussion Paper is seeking confirmation and additional feedback on how to best manage the fisheries in FMZ 16. **One concept that aligns with management reflective of the scale of the issue is to manage the resources at a watershed scale, or alternatively, at the conservation authority jurisdictional scale.** Conservation authorities have established linkages and channels of communication with stakeholders at the local watershed and sub-watershed scales and are uniquely positioned to apply

FMZ recommendations in the Plan Input, Plan Review and CA permitting processes, including infrastructure planning and design review that falls under an environmental assessment process. As a result of their monitoring, CAs often have a high-level understanding of the concerns and opportunities affecting fisheries at the watershed scale, so that directly or indirectly, some CAs are typically involved with all of the topics listed in Table 1. **The monitoring data that CAs collect, study of our watersheds, our established network of communication and partners, and integration into the broader land use process, can all be used to engage stakeholders for watershed scale solutions.** Operating at this smaller scale would also likely make it easier to develop a governance model and implement the proposed FMZ plan.

Working at a watershed scale may also lend itself to helping establish adherence to the FMZ and its enforcement. This smaller scale, compared to an entire zone level or great lakes watershed level approach, often results in higher uptake from local stakeholders as they may be experiencing issues and concerns firsthand. In turn, the solutions affect the stakeholders at the local scale where the effects of their decisions and the benefits of the solutions are more visible and directly impact where the stakeholders operate day to day. The CA or watershed scale approach would also recognize the socio-economic diversity of FMZ 16, its unique planning environment that encompasses a variety of stakeholders.

Some issues/concerns operate at broader scales than the watershed and span multiple CA jurisdictions. However, operating at the watershed scale with cross organizational communication can help illuminate how different jurisdictions are affected by a common problem and therefore lead to a more holistic solution. Operating at higher scales may leave local scale concerns unaddressed.

As part of their watershed planning processes, CAs assess future conditions and stressors (e.g., urbanization and climate change), which would be helpful to informing the climate change component of Table 1. The Background Report referenced in the Discussion Paper seems to be focused on existing conditions; there does not appear to be a clear way of assessing future stressors through the proposed FMZ planning process presented thus far, although it is noted to be in scope.

Overall, operating at a watershed scale and integrating this FMZ into more local scale land use planning process, policies, and guidance documents would provide a direct mechanism to implementing the FMZ plan. In 2017, the MNRF published a document titled, “The Brook Trout in Ontario” that outlined the current and future threats to the fishery. These threats can also be applied more broadly to the fisheries present in FMZ 16. Most of these threats are anthropogenic and have roots in land use planning, such as habitat fragmentation. There is an opportunity to have this FMZ influence the aquatic ecosystem if it aligns itself with more local scale documents that influence the land use planning and infrastructure review processes.

Q.4 In this discussion paper, MNRF has also presented concepts to address the feedback received to help establish an effective method to engage and collaborate with interested parties in FMZ 16:

a. Collaborative advisory committee
b. Inter-agency Committee

Which concept do you think is best suited for fisheries management in FMZ 16? Are there alternative concepts that could also be considered? What are some of the opportunities of these other concepts?

An inter-agency Committee would be best suited as it would allow for long term partnerships, timely coordination of roles and responsibilities, and information exchange that will enable effective and efficient planning and implementation across multiple spatial and temporal scales.

An Inter-agency Committee would be appropriate given some of the shared roles outlined above and in the discussion paper, particularly now that MECP is responsible for species-at-risk. In addition, connections to other Ministry decision-making could also be beneficial. An example is the Carruthers Creek watershed, where TRCA developed a watershed plan to inform how the watershed (and associated Redside Dace population) would respond, in part, to a settlement area boundary expansion in the headwaters of the watershed. This is a planning decision that could have an impact on fisheries, so these decisions need to be coordinated at the provincial and municipal scales. Perhaps periodically, the Inter-agency Committee could be brought together with a broader Collaborative Advisory Committee to discuss issues and how best to address them.

Thank you once again for the opportunity to provide comments on the Ministry of Natural Resources and Forestry Environmental Registry of Ontario posting “Fisheries Management Zone 16 – Consultation on Planning Approaches”. Should you have any questions, require clarification on any of the above, or wish to meet to discuss our remarks, please contact the undersigned at 416.667.6290 or at john.mackenzie@trca.ca.

Sincerely,

<Original Signed by>

John MacKenzie, M.Sc.(Pl) MCIP, RPP
Chief Executive Officer

Enclosure

BY E-MAIL
cc:

TRCA: Laurie Nelson, Director, Policy Planning
Sameer Dhalla, Director, Development and Engineering Services
Laura Del Giudice, Associate Director, Watershed Planning & Ecosystem Science
Brad Stephens, Senior Manager, Planning Ecology

January 5, 2018

BY E-MAIL: FMZ16@ontario.ca

Ms. Emily Gryck
Regional Planning Biologist
Regional Operations Division, Southern Region
Ministry of Natural Resources and Forestry
4th Floor South Tower, 300 Water St.
Peterborough ON K9J 3C7

Dear Ms. Gryck:

Re: TRCA comments regarding the proposed MNRF FMZ 16 Plan

Thank you for the opportunity to provide input on the proposed Fisheries Management Zone (FMZ) 16 Plan. For many decades, Toronto and Region Conservation Authority (TRCA) has been involved in a diversity of programs and projects throughout its nine watersheds and the coastal area of Lake Ontario that are located within FMZ 16 as well as FMZs 17 and 20. These programs and projects include (but are not limited to) watershed monitoring and research initiatives, watershed planning and reporting functions, engagement and outreach programs, remediation and restoration projects, and development application review and approvals. Since 1989 as per Lake Ontario Monitoring Programs, and since 2001 as part of our Regional Watershed Monitoring Program (RWMP), TRCA has been providing data to the province. Having a deep understanding of our watersheds and coastal Lake Ontario ecosystems and the issues that they face, such as increased growth pressures and climate change, we can offer a great deal of knowledge and experience on the merits of the FMZ 16 planning initiative.

TRCA is located in the Greater Golden Horseshoe, which is subject to the policies of the Growth Plan, including the requirement for watershed plans. TRCA is one of the Conservation Authorities that is fortunate to have existing watershed plans and fisheries management plans, the development of which was financially supported by our municipal partners. It is important to note that TRCA is currently planning to develop new or updated watershed plans to assist our municipal partners in meeting the obligations of the amended Growth Plan (2017), which also requires the inclusion of aquatic systems planning.

Staff from TRCA were pleased to be able to attend the listening session held in December 2017. In addition to the comments provided at that listening session, attached are some additional comments from staff at TRCA in response to the questions you posed.

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Watershed Planning Linkages:

1) How do you view watershed-based fish plans aligning with an FMZ 16 Plan?

- The FMZ 16 Plan needs to support the goals and objectives of local watershed-based fish plans (FMPs) and watershed plans and defer to local scale planning processes in order to address localized scale issues.

2) In areas with no watershed fish plans, how do we manage the watershed/zone together?

- In the absence of a watershed fish plan, the utility of a broad scale FMZ 16 Plan is limited for local decision making relevant to a watershed. If possible, we might manage together by advocating the need to develop a local watershed fish plan. Alternatively, co-management might be achieved if the FMZ 16 Plan provided a framework that helped support the management decisions made locally.

3) Do you see the watershed plans staying the same OR is there a need to modify the focus?

- It was unclear through the discussion session if this question was referring to specific watershed plans or the fisheries management plans. Regardless of which plan this is referring, the focus of the fisheries management plans or watershed plans should not change.

Issues and Concerns:

4) What challenges do you see in the development of an overarching plan?

- The FMZ 16 encompasses a large geographical area, and one of the challenges this plan will face is how it can be structured to address watershed or more local scale issues regarding fisheries management. For example, TRCA's RWMP data shows that fish communities change within a stream by a distance as small as 100 meters. At the large scale that being proposed, it will be a challenge to address concerns at more local scales (e.g. management of drains, land use changes, establishment of stormwater criteria, prioritizing remedial / restoration works, etc.).

- FMZ 16 encompasses not only lotic systems but the lentic coastal portion of several great lake systems. One of the challenges facing this plan is how to manage this fishery consistently across overlapping FMZs while still incorporating the influences, concerns, and local scale issues arising from the adjacent great lake FMZs. For example, migratory fish such as Salmonids use both the lentic and lotic systems which transgress FMZ 16 into other FMZs. Since FMZ 16 also includes portions of Lake Ontario within the TRCA jurisdiction it is imperative that the FMZ 16 Plan takes into account the coastal influences of Lake Ontario on the watersheds and vice versa.

- TRCA has concerns of the utility of this plan for the purposes of decision making at the local scale. Conversely, we see great value in local information being available to inform more broad scale planning. Through this process, we feel it is important to ensure that the broad scale FMZ 16 Plan does not hinder or constrain more local scale planning.

- Another challenge will be to integrate this plan into existing plans, policies, and guidance, such as fisheries management plans and watershed plans. The connection to the new provincial Watershed Planning Guidance document currently being developed by MOECC and MNRF is not clear and further explanation of the connections and linkages would help provide guidance regarding more local scale aquatic ecosystem management concerns.

- Another challenge is the availability and quality of the data across the zone and inconsistency between sampling methods and protocols used. Efforts should be made to advocate for standardized approaches for data collection following recognized Provincial standards and to support the collection of as much data as possible at the watershed or local scale to aid in effective decision making.

- Similarly, the apparent lack of Provincial support for robust data management processes for storing, managing, and analyzing local data for use in broad scale analysis and communication (e.g. data storage tool) is concerning. An example currently exists (i.e. the Flowing Waters Information System (FWIS)) that could be enhanced or accelerated to facilitate this process through direct support from MNRF.

- At such a broad scale, there may be challenges in developing a governance model to develop and implement the proposed plan.

5) *What opportunities do you see for better fisheries management?*

- This planning initiative provides the opportunity to build this plan using the most recent local fisheries monitoring data, which would ensure that local scale issues are considered within the context of this plan.

- An opportunity exists for this new FMZ 16 Plan to align with and support the goals, objectives, and recommendations set out in more local scale planning documents, such as watershed plans or fisheries management plans. Furthermore, this plan can advise of best management practices that, if implemented, would assist in meeting the goals and objectives outlined in local scale resource planning documents.

- The proposed FMZ 16 Plan provides the opportunity to undertake broad scale analysis, and share the results to help fill knowledge gaps and improve our understanding of local scale aquatic system responses and relationships to various pressures and management actions. This would be in keeping with the Provincial Fish Strategy goal #4 *policy and management informed by science and information*, and ultimately improve the scientific basis and longevity of this plan. In addition, broad scale analysis and communication would achieve a number of other goals listed in the Fish Strategy, including *healthy ecosystems* and *public awareness / understanding*.

- This plan can be a warehouse for communicating the various provincial management regulations and tools that apply across this scale. For example, fisheries timing windows, fishing regulations, species at risk regulated habitat zones, and stocking locations could be consolidated in this plan to allow for easy referencing. It would also be very useful if the data and findings of this FMZ 16 Plan were included in an online mapping platform that enables reference at multiple scales.

- Other opportunities for the plan include strategically planning for how and who will be implementing this plan and whether or not additional resources or tools are required to ensure adherence to the plan. For example, fishing regulations may be a specific tool for fisheries management in FMZ 16. TRCA receives a lot of public complaints regarding individuals violating the rules set out in the current fishing regulations in this zone. Specifically, TRCA receives complaints in areas of the Humber River and Rouge River watersheds during salmon and trout spawning seasons. However, as a Conservation Authority, TRCA does not have the authority to enforce fishing regulations. The success of implementing the FMZ 16 Plan is tied to the resources available to enforce it.

6) How do you see a broad scale plan addressing these issues?

- Please refer to question five above.

Watershed Monitoring and Data Collection:

7) What data monitoring information can be shared for the background document development?

TRCA has watershed specific data collected through the RWMP. This data is collected on a three-year rotation following the Ontario Stream Assessment Protocol. TRCA also has Lake Ontario waterfront data which is collected yearly. The data includes fish community presence data, habitat data, benthic macroinvertebrate data, and water temperature data. TRCA submits its fish collection data every year back to MNRF according to the fish collection license obligations. Water quality data also exists for our nine watersheds. Further data sharing or collection needs can be discussed at a future date should the need arise. TRCA would like the opportunity to enhance our partnership with MNRF regarding monitoring and support the mutually beneficial monitoring needs of MNRF Aurora and other conservation authorities.

Engagement:

8) How do CAs wish to be engaged throughout the FMZ 16 planning process?

TRCA appreciated the opportunity to participate in the FMZ 16 Plan listening sessions on December 14 2017. Moving forward, TRCA would like to continue to be engaged in consultation processes relating to this initiative, including the *discussion paper, the draft and final background report, and the council member selection process*. For the discussion paper and background document, TRCA suggests that a “terms of reference” or table of contents be shared and agreed upon prior to the writing process of these documents.

Thank you for your time and consideration. TRCA is eager to continue to be engaged in order to help ensure the development of the FMZ 16 Plan proceeds in conjunction with the development of local watershed plans and aquatic management plans in a mutually supportive way. TRCA looks forward to the opportunity to discuss this further and be of any further assistance to MNRF throughout this process.

Sincerely,

Scott Jarvie
Associate Director
Environmental Monitoring and Data Management
Restoration and Infrastructure Division
Toronto and Region Conservation Authority
Tel: (289) 268 3941 Email: sjarvie@trca.on.ca

July 2, 2021

BY EMAIL ONLY

Dorothy Moszynski
dorothy.moszynski@ontario.ca
MECP - Environmental Assessment Branch
135 St. Clair Avenue West
Toronto, Ontario M4V 1P5

Re: York Region Wastewater Act (ERO #019-3802)

Thank you for the opportunity to comment on the York Region Wastewater Act posted by the Ministry of the Environment, Conservation and Parks (MECP). We understand MECP is soliciting public comment on proposed legislation, that if passed would put on hold the Environmental Assessment application for the Upper York Sewage Solution. The government intends to establish an Expert Advisory Panel to provide advice on options to address wastewater servicing capacity needs in York Region.

The Toronto and Region Conservation Authority (TRCA) conducts itself in accordance with the objects, powers, roles, and responsibilities set out for conservation authorities (CA) under the *Conservation Authorities Act* and the MNRF Procedural Manual chapter on CA policies and procedures for plan review and permitting activities, as follows:

- A public commenting body under the *Planning Act* and *Environmental Assessment Act*;
- An agency delegated the responsibility to represent the provincial interest on natural hazards under Section 3.1 of the Provincial Policy Statement;
- A regulatory authority under section 28 of the *Conservation Authorities Act*;
- A service provider to municipal partners and other public agencies;
- A Source Protection Authority under the *Clean Water Act*;
- A resource management agency; and
- A major landowner in the Greater Toronto Area.

In these roles, and as stated in the Made in Ontario Environment Plan, conservation authorities work in collaboration with municipalities and stakeholders to protect people and property from flooding and other natural hazards, and to conserve natural resources.

Government Proposal

The ERO posting notes that more information from technical and other experts is needed to better understand the significant environmental, technical, social, and financial implications of any wastewater servicing solution for York Region. As a result, the Province is proposing legislation (Bill 306, which has been carried through First Reading), that would put a hold on any decision on the Upper York Sewage Solution Environmental Assessment application and plans to establish an Expert Advisory Panel to provide advice to the government concerning all options to provide additional wastewater capacity to accommodate anticipated future growth in York and Durham Regions.

TRCA understands that if implemented, the proposed legislation would:

- Put a hold on any decision under the *Environmental Assessment Act* in respect of the application for the Upper York Sewage Solutions Undertaking that was submitted for approval by the Regional Municipality of York.
- Put a hold on any actions to advance the Upper York Sewage Solutions Undertaking.
- Allow the Lieutenant Governor in Council (LGIC) to repeal the provision that puts the application on hold.
- Prevent the commencement or continuation of any action or proceeding in respect of the enactment of the Bill.

TRCA Comments

As a watershed-based resource management agency, source protection authority, and in TRCA's commenting and regulatory roles, we assist municipalities and development proponents in facilitating sustainable infrastructure planning, design and construction of municipal sewage works affecting TRCA watersheds and regulated areas. Further, TRCA supports our partner municipalities, including York and Durham regions, in their responsibilities for growth management (development) and water and wastewater servicing, planning and design (infrastructure), based on our multi-disciplinary expertise in watershed planning and water resources management. This work also contributes to meeting provincial policies for preparing for the impacts of a changing climate, for watershed planning to inform infrastructure planning, and through application of the mitigation hierarchy, natural hazard management, and the siting, planning and design of resilient infrastructure.

TRCA notes that MECP proposes to establish an Expert Advisory Panel on options for additional wastewater capacity to accommodate future growth in York and Durham Regions. Based on TRCA's roles and technical expertise in watershed-based science as described above, TRCA would be pleased to discuss how our experts, and scientific networks, existing monitoring programs and data might be leveraged by MECP to provide advice to the Panel, if established, within the context of supporting York and Durham regions interests in TRCA's jurisdiction.

TRCA Recommendation

That MECP officials meet with conservation authority officials to discuss their potential roles in providing watershed-based science and expertise, within the context and scope of their roles and jurisdiction, to the government's proposed Expert Advisory Panel.

Thank you once again for the opportunity to provide comments on the proposed York Region Wastewater Act posted by the Ministry of the Environment, Conservation and Parks. Should you have any questions, require clarification on any of the above, or wish to meet to discuss our remarks, please contact the undersigned at 416.667.6290 or at john.mackenzie@trca.ca.

Sincerely,

<Original Signed by>

John MacKenzie, M.Sc.(PI) MCIP, RPP
Chief Executive Officer

BY E-MAIL

cc:	Rob Baldwin, Chief Administrative Officer, Lake Simcoe Region Conservation Authority
TRCA:	Laurie Nelson, Director, Policy Planning
	Sameer Dhalla, Director, Development and Engineering Services
	Beth Williston, Associate Director, Infrastructure Planning and Permits
	Rehana Rajabali, Associate Director, Engineering Services

Attachment 13: TRCA Submission on ERO#019-3839

August 27, 2021

BY EMAIL ONLY (**Katerina.Downard@ontario.ca**)

Katerina Downard
Ministry of Transportation
Environmental Policy Office
777 Bay Street, Suite 700
Toronto, ON M7A 2J8

Re: Greater Golden Horseshoe Transportation Plan – Discussion Paper (ERO #019-3839)

Thank you for the opportunity to comment on the Ministry of Transportation (MTO)'s Greater Golden Horseshoe (GGH) Transportation Plan Discussion Paper ("the Paper"). We understand that the Paper proposes a 30-year vision for mobility designed as a safe, seamless, and accessible transportation system for all Ontarians. It also sets out current and future transportation challenges and illustrates and describes ongoing and conceptual actions to help overcome them, including innovative approaches to policy solutions and new ways to partner, procure and deliver infrastructure and related services. Ultimately, feedback is being sought to inform the development of the forthcoming GGH Transportation Plan ("the Plan"), which is targeted for release later in 2021.

The Toronto and Region Conservation Authority (TRCA) conducts itself in accordance with the objects, powers, roles, and responsibilities set out for conservation authorities (CA) under the *Conservation Authorities Act* and the Ministry of Natural Resources and Forestry Procedures Manual chapter on CA policies and procedures for plan review and permitting activities. TRCA is:

- A public commenting body under the *Planning Act* and *Environmental Assessment Act*;
- An agency delegated the responsibility to represent the provincial interest on natural hazards under Section 3.1 of the Provincial Policy Statement (PPS);
- A regulatory authority under section 28 of the *Conservation Authorities* Act (CA Act);
- A service provider to municipal partners and other public agencies;
- A Source Protection Authority under the *Clean Water Act*;
- A resource management agency; and
- A major landowner in the Greater Toronto Area.

In these roles, and as stated in the Made-in-Ontario Environment Plan, TRCA works in collaboration with municipalities and stakeholders to protect people and property from flooding and other natural hazards, and to conserve natural resources.

Through the application of The Living City Policies (LCP), TRCA promotes natural heritage conservation and landscape connectivity throughout our jurisdiction. TRCA takes a watershed-based approach to our review of transportation infrastructure projects within our Regulated Area through various avenues, including service level agreements, review of master plans and environmental assessments (EAs), as well as through our Permit or Voluntary Project Review (VPR) processes for projects at the detailed design stage. TRCA works with transportation agencies, municipalities and developers in the planning, siting, and alignment of public infrastructure, recognizing the critical role of protecting people, property and infrastructure from natural hazards and avoiding or mitigating impacts to the natural heritage system in our watersheds. In this way, TRCA and its public and private partners take a collaborative and inter-disciplinary approach to ensuring a sustainable interface between transportation systems and the natural system that strives for resilience to climate change. Also integral to this work is TRCA's nature-based recreation network of parks and trails on TRCA-owned or managed lands that provides opportunities for active transportation, forming an important part of the regional transportation network.

General Comments

TRCA generally supports the Paper's long-term vision for mobility across the GGH, particularly as it relates to a more resilient and environmentally sustainable transportation system that will mitigate environmental impacts and adapt and respond to climate change risks. We believe that to optimize transportation infrastructure investments requires an integrated approach of complete community building that employs active transportation, avoids, or mitigates and remediates natural hazards, and conserves and enhances greenspace, thereby improving mobility and reducing transportation-related environmental and human health impacts. To this end, we offer the following comments and **bolded** recommendations for the Ministry's consideration. Please note, in conjunction with these general comments, **the enclosed attachment provides detailed commentary specific to sections of the Paper**.

1. Further Integrate Transportation Planning with Land Use and Environmental Planning:

Certain sections of the Paper are fragmented from the Province's land use planning and environmental frameworks. For example, rapid growth is deemed a key transportation issue and extensive transit and road expansions are identified as capacity and connectivity solutions with vast economic benefits. However, there are other forward-looking policy solutions put forward in related provincial plans that could be coordinated with these actions to improve integration and implementation. For instance, the goals of improving access to jobs, reducing congestion (and carbon emissions), facilitating active transportation and transit-oriented development, and reducing environmental impacts are co-dependent on planning for complete communities with transit-supportive densities and ensuring infrastructure is optimized, while protecting natural systems. **We recommend integrating or cross-referencing policies and objectives of the Plan with other provincial policy goals to ensure transportation system planning, land use planning and transportation investment are coordinated effectively**.

2. Consider Additional Innovative, Sustainable Transportation Solutions:

Further to the above comment, we note that there are other transportation solutions successfully being implemented in comparable urban regions, such as future high-speed rail to connect urban centres, that could be coordinated with the actions identified in the Plan. **We recommend integrating transit hubs with linkages to active transportation in areas outside highly urban areas, and exploring opportunities to improve the state of natural hazards or natural heritage connectivity through new infrastructure projects.**

Further to the above, the Paper provides little emphasis on the need to reduce environmental impacts associated with transportation and land use patterns that favour automobile access. As transportation infrastructure expands and extends, so too does the accompanying built form that is typically over, adjacent, or in relative proximity to it. This can have a multitude of impacts on the natural system (e.g., anthropogenic pressure, habitat loss, pollutants) and the ecosystem benefits provided (e.g., stormwater management, carbon sequestration), which should be considered in relation to other public interests (e.g., economic, social). **We recommend that, where appropriate, Plan policy should support the adaptive reuse and upgrade of existing transportation infrastructure (particularly road/highway networks) prior to expansion, and especially for cyclist, pedestrian and public transit use and stormwater management, and encourage a shift away from auto-centric engineering standards and road/highway expansion as the primary means of alleviating congestion**. This would be in keeping with a priority identified by respondents to MTO's 2020 survey on the GGH Transportation Plan to "make better use of the roads, railways and other infrastructure we already have."

3. Emphasize Protection of the Natural System to Avoid and Mitigate Climate Change Impacts:

A top priority identified by respondents to MTO's 2020 survey on the GGH Transportation Plan is to, "make getting around healthier for me and the planet." To help achieve this important objective, **the Plan should emphasize protection of the natural system as a means of avoiding and mitigating climate change impacts**. This includes designing and constructing the region's transportation system to: avoid natural features and hazards, but where crossings must be located in these areas, ensure they are appropriately sized to convey appropriate storm events (e.g., conservation authority regulatory storm events); allow for natural channel movement and water balance; minimize impacts on side slopes, and include construction impacts related to staging, storage and access requirements in detailed design (i.e., in addition to the infrastructure footprint). These objectives are important to protect people and infrastructure from natural hazards like flooding and erosion, and to preserve the form and long-term function of these features. Components of the natural system like wetlands, woodlands, valleys, and watercourses all contribute to resiliency and climate regulation by filtering air and water pollutants, mitigating for urban heat island effects, and slowing storm and flood waters, while also providing habitat that helps maintain biodiversity.

4. Codify an Ecosystem Compensation Process to Ensure no Net Loss of the Natural Heritage System and Strive (where possible) for Net Gain:

Goal 6 (Future Ready) includes sample actions for minimizing the impact on the natural environment such as supporting the adoption of low and zero carbon modes and green technologies. While these are important, one of the most significant environmental impacts of establishing or expanding transportation corridors is the amount of land removed from the natural system. Where possible, transportation infrastructure should generally be located outside of the natural system, and where crossings are required, their locations should be specifically located to minimize impacts to the natural system. Although new and upgraded transportation systems often cannot avoid impacts to natural heritage, including wildlife corridors and overall landscape connectivity, the preservation of natural areas and features should be examined first. **Given the common necessity of locating transportation infrastructure within or crossing the natural system, we recommend policy that requires ecosystem compensation to achieve, at a minimum, no net loss of natural areas, and where possible, strives for a net gain.** This would contribute to achieving other objectives and co-benefits as well, such as air quality, healthy living and managing climate change risks. TRCA has worked with Metrolinx to develop an "ecological compensation" framework where feature removals within designated natural areas are required to facilitate Metrolinx capital projects. This protocol is based on TRCA's Guideline for Determining Ecosystem Compensation and has been incorporated into the Metrolinx Vegetation Guideline, 2020. We would be pleased to work with the Province to develop a similar protocol.

5. Reference the Importance of Managing the Risk associated with Natural Hazards:

There is minimal reference to natural hazards (e.g., flooding and erosion) throughout the Paper. We recognize that, by nature, certain infrastructure may need to cross hazardous lands and, by virtue of its location and design, can adversely affect risk to life and property associated with natural hazards, particularly in more urban areas. However, the level of risk, and number and severity of emergency responses, can be mitigated by infrastructure siting, alignment, design and construction standards that consider natural hazards. **We suggest that the Plan require that, where possible, new, replaced, upgraded and/or expanded transportation infrastructure be carefully sited and designed to:**

- **avoid, mitigate and remediate risks associated with flooding, erosion or slope instability**
- **protect, rehabilitate and restore existing landforms, features, and functions; and**
- **provide for aquatic, terrestrial and human access**

The Plan should also reference the above direction as part of any proposed coordinated emergency response plan. Please note that, where transportation infrastructure must be located within hazardous lands or hazardous sites, TRCA has experience working with municipalities and other public infrastructure providers to ensure potential emergencies during construction and operation are addressed through techniques such as environmental monitoring, and contingency and emergency management planning.

6. Enable Implementation of Sustainability Initiatives:

TRCA supports proposed initiatives that would improve the sustainability of the region's long-term transportation system, such as building transit stations in highly urban areas, supporting low- and zero-carbon modes, including active transportation, electric and hydrogen powered vehicles, encouraging off-peak delivery, and better connecting walking and cycling paths. We generally support the integration of these sustainability initiatives into the Plan based on feedback from key partners, including conservation authorities. **Should future policies be developed to reflect the proposed sustainability initiatives, we recommend cross-referencing them with actions and associated impacts and/or co-benefits to help ensure policies are more comprehensive and inclusive in nature**. For example, there are opportunities for points of synergy between goods movement and air quality issues or active transportation and fuel options, both of which are increasingly important in urban areas. We suggest referencing the Metrolinx Sustainability Strategy as a starting point in this regard.

7. Promote a Connected/Integrated Active Transportation Network:

We note proposed actions to create a safe, connected and comprehensive active transportation network and improve local and regional cycling linkages by working with municipalities, Indigenous communities and agencies to connect existing and planned cycling routes, infrastructure and amenities with the Province-wide Cycling Network. TRCA has developed a Trail Strategy for the Greater Toronto Region in consultation with our municipal partners to achieve the vision of a complete regional trail network that connects our growing communities to nature, to culture, and to each other. It serves as a framework to protect potential trail alignments for a network from the Oak Ridges Moraine, through the valleys of nine watersheds within TRCA's jurisdiction and along the Lake Ontario shoreline. Further supporting these regional trail alignments, are the local trails which provide connections between the network and the communities they benefit, further connecting residents to nature and to each other, and providing opportunities for community, recreation, active transportation, and healthy living. **TRCA's Trail Strategy for the Greater Toronto Region (and Trail Strategy Data) can help provide the foundation for existing and planned active transportation routes across our jurisdiction, as well as potential strategic points of synergy with broader trail networks and major transportation infrastructure projects and mobility hubs**.

8. Participate in Voluntary Project Review (VPR):

Under the EA Acts (federal and provincial) TRCA is a commenting agency engaged in the review of transportation infrastructure projects. However, where municipalities and private sector proponents are required to obtain TRCA permits under the *Conservation Authorities Act*, Crown agencies are exempt from doing so. In recognizing TRCA's science-based expertise to avoid impacts to natural systems, mitigate risks from flooding and erosion, and identify opportunities for ecosystem restoration and enhancement through the review of detailed designs submitted through the EA review and TRCA permit process, Metrolinx engaged TRCA to develop a VPR process. **Metrolinx has made a commitment for obtaining VPR from TRCA at the detailed design stage for all station expansion and ancillary facilities. It is recommended that MTO commit to TRCA's VPR process for transportation projects in our jurisdiction**.

Thank you once again for the opportunity to provide comments on the GGH Transportation Plan Discussion Paper. Should you have any questions, require clarification on any of the above, or wish to meet to discuss our remarks, please contact the undersigned at 416.661.6600, Ext. 5281 or at laurie.nelson@trca.ca.

Sincerely,

<Original Signed by>

Laurie Nelson, MCIP, RPP
Director, Policy Planning

Encl.
BY E-MAIL
cc:
TRCA: John MacKenzie, Chief Executive Officer
Sameer Dhalla, Director, Development and Engineering Services
Anil Wijesooriya, Director, Restoration and Infrastructure
Beth Williston, Associate Director, Infrastructure Planning and Permits

Greater Golden Horseshoe Transportation Plan: Discussion Paper (ERO#019-3839)

TRCA Comments

Greater Golden Horseshoe Transportation Plan – Discussion Paper	
Section	**TRCA Comments**
1. INTRODUCTION	
Purpose of this discussion paper	• We generally support the commitments to invest in a well-functioning transportation system for the GGH and engage with key partners to ensure shared goals related to the vision are realized. While the need to provide creative solutions to known challenges, new transportation options and better connections is important at a high level, more aspirational and innovative improvements to infrastructure, services and programs could be incorporated. For example, going beyond conventional short-term solutions, e.g., improving commute times through more frequent service and reducing gridlock through capacity expansion, and the conceptual action of “considering new technologies”. We suggest outlining a more sustainable planning vision with detailed mobility solutions based on best practices from other urban regions, such as high-speed rail and more adaptive re-use of existing transportation infrastructure.
The transportation challenge	• The economic impacts of inefficient travel and goods movement and changing demographics associated with rapid growth are emphasized. However, there are other environmental and social challenges integrated with transportation planning which should also be noted. For example, the quantum of land needed to maintain and expand the region’s transportation system (and associated development) that encroaches upon natural features and the resulting carbon emissions that result from increased vehicular travel. We suggest emphasizing the need to address these challenges in an integrated manner.
Process to date	• TRCA is pleased to have been engaged in the previous consultations on the development of the GGH Transportation Plan and would be glad to continue to provide feedback as the Plan is finalized.
2. A VISION FOR MOBILITY IN 2051	
Questions: Does this section contain the right initiatives and concepts? Do you agree with the elements of the vision?	• This section contains many good initiatives and concepts; however, the following actions should also be incorporated through the development of the Plan: o Development of high-speed rail to connect urban corridors across the region. o Transit hubs with linkages outside dense urban centers (in addition to within them).

Greater Golden Horseshoe Transportation Plan – Discussion Paper	
Section	**TRCA Comments**
	○ Adaptive re-use of existing infrastructure (specifically road/highway) prior to expansion, including for cyclist, pedestrian, and stormwater reduction purposes. ○ First-mile/last-mile solutions and for better services to act as viable connections between different modes. ○ Funding to support infrastructure development/ investments, maintenance/state of good repair/life cycle management, and communications to promote use of alternatives should be emphasized. ○ Active transportation modes, designated carpool lots to provide connection hubs, and support for and prioritization of electric vehicles, alternative and renewable fuels, are key to improving community health and reducing transportation related GHG emissions. • The vision identifies a need for "new infrastructure", "better services" and "new policies". We agree with these in principle, but there are other needs which must also be considered, specifically the avoidance and mitigation of natural hazards and natural heritage in infrastructure planning with the aim of reducing environmental and climate change impacts during transportation expansion.
Getting people moving on a connected transit system	• The promotion of walking and cycling (or other forms of active transportation) as a first choice for short trips should be linked to land use planning, i.e., compact, transit supportive and environmentally sustainable communities with proximity to employment, housing, public services, recreational opportunities, etc. Doing so reduces reliance on automobiles, improves access to transit and helps protect lands for other uses, e.g., agricultural, environmental. • In the context of the 2051 vision, moving from "today's radial commuter network" to an "expansive grid" may not be reflective of long-term goals as Union Station and the surrounding downtown core will largely remain the focal point for commuting/connections. We suggest stating something like, "from today's radial commuter network with most connections centered on Union Station, to a more multi-nodal and interconnected expansive grid, so…" Incorporating "multi-modal" along with "multi-nodal" would also incorporate many different modes of transportation, which seems in keeping with vision objectives.
Question: Are these the right initiatives and concepts for the transit system in 2051?	• Explore high-speed rail to better connect the region's urban centres, improve commuting times and reduce reliance on auto-related travel.

Attachment 13: TRCA Submission on ERO#019-3839

Greater Golden Horseshoe Transportation Plan – Discussion Paper	
Section	**TRCA Comments**
Enhancing capacity and performance on congested roads	• Re: "Exploring options to manage passenger travel demand and congestion…", we are pleased to see telecommuting and flexible work hours recognized. Doing so will help reduce vehicular travel and congestion – both of which have environmental benefits. However, reducing the need for travel in general is also a major issue. A multitude of engineering and planning studies maintain that widening highways, while having a positive effect in the short term, do not work in the long term to reduce congestion. Perhaps reconsider the goal to think more in terms of eliminating a need, then reducing it and then minimizing its impact.
Question: Are these the right initiatives and concepts to enhance the road network and address congestion?	• As noted above, highway widening is widely perceived to be an expensive short-term solution to alleviate traffic congestion. Integrated land use planning (e.g., complete communities) and alternate forms of transportation (e.g., public transit, active transportation) can be viable alternatives with sound economic benefits and reduced environmental and agricultural impacts.
Efficiently moving goods across GGH *Question:* Are these the right initiatives and concepts to address future freight needs?	• Goods movement should be addressed in a manner that also addresses other impacts and co-benefits, such as urban air quality, much of which particulates from diesel fuel burning. Improving goods movement while also incorporating alternative fuels could, in turn, improve local air quality and public health.
3. NEAR-TERM ACTIONS	
*Question for each **Goal**:* Are these the right actions to take now? What else can we do to improve these elements of transportation?	• In addition to addressing environmental impacts and climate impacts as part of the Future Ready section, there needs to be near-term actions, such as incorporating a climate lens into procurement of products and services. This could begin to lay the groundwork for reducing embedded carbon in the infrastructure that will be developed. This is another opportunity for leveraging current innovation for longer term gain, as Ontario is positioned economically as a leader in low carbon products and services in construction.
Goal 1: Improve Transit Connectivity	

Greater Golden Horseshoe Transportation Plan – Discussion Paper	
Section	**TRCA Comments**
A. Transit Connectivity B. Transit Integration C. Access to Transit by Active Transportation	• Re: "Establishing a Fare and Service Integration Provincial-Municipal Table…", recreation destinations should be included as key destinations. This has been essential to physical and mental health during the COVID-19 pandemic and can reduce the greenspace dedicated to parking. • Re: "Making it easier to walk or cycle to or from transit …", provide bike storage and repair facilities at transit hubs. • Re: "Developing a best practices guideline document to support updates to the e-bikes framework", please note that this can be a good thing for people with physical limitations because it can allow then to go further than under their own power.
Goal 2: Relieve Congestion	• From a sustainability perspective, public transit and e-services should be included as significant contributors to congestion relief. The co-benefits of better work-life balance that would be created could also be highlighted.
A. Optimize Existing Corridors B. Provide Route Alternatives C. Provide Alternative Ways to Travel D. Reduce the Need for Travel	• Re: "Developing transit-oriented communities at transit stations in strategic locations…", active transportation should be considered an alternative travel choice. This could include cycling on major highways (no additional land base needed, with existing connection to communities). Leveraging major highway projects such as any new or expanding highway should, where appropriate, include active transportation facilities (ideally separated to provide an improved perception of safety and therefore attract more users as a viable alternative to vehicular travel).
Goal 3: Give Users More Choice	
A. Transit Availability B. Comprehensive Active Transportation Network C. Barriers to Transit Access D. Mobility as a Service	• Re. "Improving local and regional cycling linkages..." , TRCA's Trail Strategy for the Greater Toronto Region was developed in consultation with our municipal partners and can provide the foundation for the existing and planned routes, infrastructure, and amenities in the TRCA region. • We suggest improving linkages for trail and active transportation networks to the planned transportation network. There will be stand-alone local and regional cycling linkages but there will be some strategic projects that could be incorporated into planned major road infrastructure projects. TRCA's trail strategy may be useful in identifying where these synergies occur.
Goal 4: Keep Goods Moving	
A. Competitiveness B. Regional Coordination C. Sustainability and Efficiency	• To improve efficiency, all approval agencies (including conservation authorities) should be engaged early (preferably during the RFP process) and often throughout all planning phases to understand and inform all criteria and planning/design requirements.

Greater Golden Horseshoe Transportation Plan – Discussion Paper	
Section	**TRCA Comments**
	• Sustainability and Efficiency could be cross-referenced with being Future Ready, e.g., where there is reference to alternative fuels. Doing so could also help address an air quality and human health co-benefit.
Goal 5: Safe and Inclusive	
A. User Safety B. Emergency Preparedness C. Equality of Opportunity	• Re: "…enhanced safety measures for at-grade road crossings…", TRCA appreciates this being discussed in the Paper. Rail crossings can be a significant barrier to a well-connected active transportation network.
	• The number of and severity of emergency responses can be reduced by siting and planning new or upgraded infrastructure to avoid/address natural hazards, and by designing infrastructure to a higher standard considering a "changing climate" as outlined in the PPS, 2020 and considering flood and erosion hazards, with support from conservation authorities.
Goal 6: Future Ready	
A. Environmental Impact	• The document needs to address the natural environment beyond carbon impacts, including minimizing impacts to sensitive environmental lands. • Environmental impacts should also include embedded carbon in the development of infrastructure. Please note, Infrastructure Canada is currently making a similar request. They are also partnering with the cement industry to develop carbon neutral cement by 2050. This is an area where Ontario already has some leadership and could accelerate this progress through procurement practices and partnership with private sector and industry associations. • The co-benefits of reduced impacts on the environment, climate, air quality and human health should be included.
B. Resiliency	• A stronger commitment to mitigating aspects of climate change while improving transportation systems is needed, including reducing flooding and erosion hazards and intrusions within natural systems. • Overall, increasing resilience to climate change can be linked back to protecting and enhancing the natural system that helps offset GHGs and provides green infrastructure that contributes to mitigation of flooding and erosion. The Plan should tie back to the protection of natural systems through the avoidance and mitigation of impacts and speak to the need to provide compensation for any unavoidable losses. We suggest these links be made when developing the Plan.

Greater Golden Horseshoe Transportation Plan – Discussion Paper	
Section	**TRCA Comments**
C. Emerging Technologies	• The innovation corridor is an excellent idea. TRCA's Partners in Project Green (PPG) program could assist with this initiative through its partnership with the Greater Toronto Airport Authority and its network of businesses. Our Sustainable Technologies Evaluation Program (STEP) could also help with the evaluation of new technologies. • Transportation is a significant issue for urban air quality, especially with articulates. Alternative fuels would help to address air quality and human health as co-benefits. • Low carbon technologies (beyond AVs) should be noted, including electric and hydrogen. Ontario announced its first bio-refinery by the private sector in 2019 and will produce renewable jet fuel and renewable diesel. Although not as clean as electric and hydrogen, they may be good transition fuels that support economic growth.
Goal 7: Muskoka, Haliburton and Connections Beyond the GGH	
4. IMPLEMENTATION & NEXT STEPS	
We are seeking your ideas for ways to achieve the vision, including: - Collaboration, coordination and new ways of working together to align our actions - New and innovative approaches to policy solutions and programs - New ways to partner, procure and deliver infrastructure	• Consider a consolidated planning option when working with multiple approval agencies, where you gather decision makers for all approval agency parties together in a single meeting early into the project. This would provide the opportunity to review the project, evaluate challenges and brainstorm solutions/mitigations. In doing so, all parties can see what all approval agencies' requirements are and come to a consensus solution that all parties can agree on or negotiate with. Such meetings held at regular intervals would assist with working through multi-agency issues and approvals to avoid delays.
Question: Are the goals and near-term priorities and actions the right areas of focus?	• Please see general comments.
Question: What else should be done in the near-term?	• Invest in state of good repair of existing infrastructure so connectivity and functionality are not lost from the existing network.
Question: Are there implementation considerations as we develop the GGH Transportation Plan and turn the 2051 vision into reality?	• Please see general comments.

Toronto and Region Conservation Authority

March 1, 2021

VIA EMAIL (ec.water-eau.ec@canada.ca)

Environment and Climate Change Canada
4905 Dufferin Street, 2S423
Toronto, ON
M3H 5T4

Re: Toward the Creation of a Canada Water Agency, Discussion Paper

Thank you for the opportunity to comment on Environment and Climate Change Canada's "Toward the Creation of a Canada Water Agency" Discussion Paper.

The Toronto and Region Conservation Authority (TRCA) is one of 36 conservation authorities in Ontario. Conservation authorities are watershed-based, natural resource management agencies created to safeguard and enhance the health and well-being of communities through the protection and restoration of the natural environment. TRCA's jurisdiction represents a diversity of communities and landscapes across nine watersheds, 65 kilometres of Lake Ontario shoreline, and an area that includes a population of almost 5 million. TRCA's 28-member Board of Directors is largely comprised of elected officials including Mayors and Regional Councillors from throughout TRCA's jurisdiction. TRCA staff are multi-disciplinary, applying watershed-based science at multiple scales for multiple benefit, collaborating with a diversity of public and private partners to achieve shared objectives on private and public lands and waters.

TRCA conducts itself in accordance with the objects, powers, roles and responsibilities set out for conservation authorities (CA) under the *Conservation Authorities Act* and the provincial Procedural Manual chapter on CA policies and procedures for plan review and permitting activities. TRCA's roles are:

- A public commenting body under the *Planning Act* and *Environmental Assessment Act*;
- An agency delegated the responsibility to represent the provincial interest on natural hazards under Section 3.1 of the Provincial Policy Statement;
- A regulatory authority under Section 28 of the *Conservation Authorities Act*;
- A service provider to municipal partners and other public agencies;
- A Source Protection Authority under the *Clean Water Act*;
- A resource management agency; and
- A major landowner in the Greater Toronto Area.

In these roles, and as stated in “A Made-In-Ontario Environment Plan,” TRCA works in collaboration with municipalities and stakeholders to protect people and property from flooding and other natural hazards, and to conserve natural resources.

Canada-Ontario Great Lakes Water Quality Agreement

As a related initiative, it is important to note that in 2019, TRCA commented on the Government of Ontario’s proposal to update the Canada-Ontario Great Lakes Water Quality Agreement (COA) to recognize the need to strengthen efforts to address new and continuing threats to Great Lakes water quality and ecosystem health, including aquatic invasive species, excessive nutrients, harmful pollutants, discharges from vessels, climate change and the loss of habitats and species. TRCA supported the proposed update to the COA and appreciated its premise that Great Lakes water quality and ecosystem health cannot be achieved by addressing individual threats in isolation, but rather depends upon the application of an ecosystem approach that addresses individually and cumulatively all sources of stress to the Great Lakes. There is a strong alignment with conservation authorities’ (CAs) ecosystem approach and watershed-based work that serves to mitigate for the impacts of urbanization and climate change on the Great Lakes and improves ecosystem health.

The COA supports the Toronto and Region Remedial Action Plan (RAP). TRCA administers the RAP for the Toronto Area of Concern (AOC) as part of a 5-year (2015-2020), $2.5 million agreement with Environment and Climate Change Canada and the Ministry of Environment, Conservation and Parks (matching funding). In addition to habitat restoration work, through development and infrastructure planning processes, TRCA staff work with municipalities and proponents to ensure restoration is directed toward strategic areas to address RAP priorities in the Toronto AOC.

Great Lakes Water Quality Monitoring

On a collective basis, CAs and their partners’ environmental protection and management of rivers, wetlands and headwaters provide downstream benefits to the Great Lakes, including those for water quality, habitat and recreation. As local watershed and partnership agencies, CAs are well-positioned to play a key role in many of the actions identified in the COA. This is particularly the case for the Greater Golden Horseshoe CAs with Great Lakes shorelines, where the impacts of urbanization and the compounding effects of climate change are acutely felt.

TRCA work on the Great Lakes includes:

- Monitoring nearshore and coastal marsh water quality in Ajax –Pickering nearshore area with support from York and Durham Regions and MECP and ECCC.
- TRCA collaborated in water quality studies looking at eutrophication issues in the Toronto Harbour.
- TRCA assists the City of Toronto with wet weather flow studies (tributary & watershed monitoring).
- TRCA helping MECP and ECCC with monitoring of nuisance algae and lakebed biota in Lake Ontario.

- Sustainable Technologies Evaluation Program (STEP) program offers significant advancements in LID and stormwater technology.
- TRCA has a Rural Clean Water program and Restoration and Stewardship programs that address sources of nutrients.
- Regional Watershed Monitoring Network and Watershed Report Cards document current nutrient conditions and trends within the TRCA.
- TRCA provides plan input and review services related to development planning applications and infrastructure undertakings in TRCA regulated areas. In areas where natural hazards, natural heritage or water resources may be affected by these works, TRCA applies the mitigation hierarchy and where avoidance is not possible, requires that the proponent provide comprehensive mitigation strategies and where appropriate, compensation/off-setting plans.

Canada Water Agency Proposal

We understand that in 2019, the Government of Canada committed to establishing a Canada Water Agency (CWA) to “work together with the provinces, territories, Indigenous communities, local authorities, scientists and others to find the best ways to keep our water safe, clean and well-managed.” In the current consultation, the Discussion Paper, “Toward the Creation of a Canada Water Agency,” presents key issues for consideration in the Government’s approach to creating the agency. Broad input from provinces, territories, Indigenous peoples, stakeholders and the public, is being sought. The results of this engagement process will inform the Government’s next steps in implementing the commitment to create a CWA. Further, we understand that the Government is not embarking on legislative or regulatory changes through this Discussion Paper.

The Discussion Paper states that identifying freshwater management objectives for the federal government, while recognizing provincial and territorial jurisdiction, is critical in designing the CWA. The Government of Canada has previously stated its objective to ensure First Nations have access to safe, clean drinking water and is working with First Nations communities to improve water infrastructure on reserves, end long-term drinking water advisories on public systems on reserves, and prevent short-term advisories from becoming long term. The Paper proposes the following further objectives to enhance freshwater management:

- Federal policies promote effective management and protection of freshwater resources and ecosystems in Canada for 21st century challenges and beyond—including adapting to climate change.
- Canada has a state-of-the-art prediction system for floods and droughts that informs climate change adaptation and disaster risk reduction. Indigenous peoples play an increased role in the management of Canada’s fresh water.
- Canada is a leader in sustainable agricultural water management.

- Canada's economic sectors have the fresh water they need to grow sustainably, and the tools they need to improve freshwater management and use.
- Canada has and applies cutting edge science to tackle the freshwater challenges of the next century, including climate change.
- Data and information are available to support informed freshwater decision making at all levels.
- Collaborative arrangements are in place and support effective management of domestic and Canada-U.S. transboundary fresh waters.
- Canada is a global leader in freshwater technology, innovation, and infrastructure.
- Canadians are actively engaged in managing and protecting fresh water.

TRCA Comments

TRCA is in receipt of comments provided by Conservation Ontario in response to the CWA Survey on the public consultation website. TRCA supports Conservation Ontario's comments and wishes to provide our own on selected areas of the Discussion Paper as outlined in the table below, based on TRCA's local partnerships and programs, and experience and expertise specific to our watersheds.

Discussion Paper: Toward the Creation of a Canada Water Agency	
Section	**TRCA Comments**
Introduction	• TRCA appreciates the statement that the CWA, "will work collaboratively and respect the jurisdictions of provincial, territorial, and Indigenous governments by building on successful existing mechanisms for cooperation." As a partner and collaborator for watershed health with all three levels of government on public and private initiatives, TRCA is well positioned to assist in providing guidance on how to build on existing mechanisms for meeting shared objectives, while avoiding duplication and finding synergies and efficiencies.
3.1 Freshwater objectives a. What are your thoughts on the above objectives? b. Which objectives are a priority for you? c. Are any objectives missing?	• TRCA supports the creation of a CWA to build on the success and address the challenges of existing mechanisms to meet the stated objectives. • We recommend prioritization of the objectives based on input from the national and regional freshwater forums. Given the range of issues and objectives presented and the diversity of landscapes, communities and their experiences across the country, it may be necessary to prioritize and phase the action plan in setting out resources and timelines to accomplish the objectives.
3.2 Freshwater policy, coordination and multilateral engagement	• The federal government has done extensive work along the Oak Ridges Moraine over the past 20 years. Great partnerships were established with the Ontario Geological Survey, conservation

a. What are your thoughts on the current level of federal engagement on freshwater issues with others in Canada? How can the federal government support engagement? b. How should federal, provincial, territorial, municipal, and Indigenous governments work together to coordinate efforts and cooperatively address local and regional freshwater issues? c. How should the federal government support freshwater-related international activities?	authorities and municipalities. This work has diminished in recent years and should be re-energized. The government should provide guidance and financial support to ensure that work is coordinated and optimized and that a robust framework is in place to share data, knowledge, and wisdom with respect to the geology and hydrogeology of Canada. • In addition, the government should sponsor international forums and leverage the work of groups such as the International Association of Hydrogeologists and the Canadian Water Resources Association. They should support attendance by groups with stories to be told but lacking in the financial resources to be at the table.
3.3 Freshwater prediction to inform climate change adaptation and disaster risk reduction a. What scale and geographic precision of modelling output is needed to support your decision-making and how do you see this evolving over the next decade? b. What are your needs for water quantity prediction products, services, and applications? c. Which of your needs are or are not being met now? How do you see your needs evolving over the next 10 years?	• It would be helpful if the federal government were to provide the overarching directions or standards that should be met by each jurisdiction with regard to ecosystem protection, flood management, water quality, etc. and then providing the funding mechanisms to support local authorities in achieving those standards, e.g., an update to “How Much Habitat is Enough?” is needed, especially with respect to urban area targets. The amount of natural cover and impervious surface in TRCA watersheds is directly tied to the health of its freshwater waterbodies and hydrologic systems. • An outstanding need on the research side is to downscale future climate data for continuous modelling to support hazard risk management, including erosion risks. For this, sub-daily future climate data is needed and not just daily as it is insufficient. As the science is not yet able to facilitate this, the federal government’s assistance is needed in terms of research grants and/or innovation support. • Conservation Authorities work at the quaternary watershed scale and below. We therefore need a high degree of precision in our models. The federal government could support this work through the funding of supercomputing centres, such as the one currently running in the GTA. • Moving forward, large scale, high precision models are needed that integrate the local knowledge of conservation authorities’ watershed models with the continental scale climate models. Our

	integration of climate models with the existing hydrologic and hydrogeologic models is in its infancy and will need to significantly improve in the years ahead. Advanced computing systems and provincial-scale databases will be needed to support the high resolution and precision required to inform land use and water policy decisions. • Currently, we have a reasonable understanding of our local conditions, but there are issues with respect to edge-matching and consistency of approach across conservation authority boundaries. Over the next five to ten years, the individual models (over 70 major models and counting that touch the TRCA jurisdiction alone) need to be tested and linked to provide seamless model products.
3.4 Indigenous peoples and freshwater management a. From the perspective of Indigenous peoples, what concerns, gaps or opportunities related to fresh water should be taken into consideration when establishing the mandate of the CWA? b. What are some positive examples of First Nations, Métis, and Inuit participation in freshwater governance and decision-making? How might the CWA present an opportunity for better freshwater management informed by these examples?	• While TRCA is not a crown-agency and therefore does not have the Duty to Consult, it does undertake the procedural aspects of Indigenous consultation when requested by its crown-agency partners and in cooperation with partner municipalities. In addition, TRCA's owned and managed lands are typically water-based so that the potential for indigenous interests is high. • TRCA's jurisdiction contains many overlapping Traditional territories and Treaty areas relating to Anishinaabe, Haudenosaunee, Huron-Wendat and Métis nations. TRCA lands contain hundreds of known ancestral archaeological sites as well as high potential for many hundreds more. TRCA's in-house licensed archaeologists regularly communicate two-way information with the modern descendant communities of the people who occupied these past site locations, particularly when there is the need to investigate a site during an archaeological assessment. • TRCA has Engagement Guidelines to obtain guidance on stewardship and management decisions within the archaeological assessment process and other TRCA land management processes. The Guidelines outline and provide guidance on TRCA's commitment to growing our relationships with Anishinaabe, Huron-Wendat, Haudenosaunee and Métis communities, whether that be relatively informal partnerships in various initiatives or formal engagement for TRCA projects subject to legislation requiring engagement. TRCA's overall aim is to develop a positive relationship with communities whose interests may be impacted by TRCA projects, through a process of meaningful, mutually respectful engagement.

	• During the past 35 years, various partnerships have evolved between TRCA Archaeology and a variety of agencies and school boards for the purposes of site protection and public education, including the Ontario Ministry of Tourism, Culture and Sport, Ontario Heritage Trust, school boards, the Royal Ontario Museum, Ontario Archaeological Society and York University.
3.5 Agriculture and fresh water a. How should Canada support the agriculture sector to sustainably manage freshwater resources needed for production and to enhance resilience? b. What new or improved tools or science-related information would help the agriculture sector to enhance water management?	• It would be helpful if the CWA could support compensating farmers for implementing best management practices on their lands that help protect and restore natural features and/or use water more efficiently. Funds for this kind of work are currently relatively limited but could have a substantial impact downstream and on the quality of Lake Ontario. • The agricultural sector has a strong connection to the land and a vested interest in the sustainable use of our hydrologic resources. In this regard, on-line guidance tools, including assistance with multi-sourcing of irrigation water, aquifer mapping, and real-time irrigation optimization tools may be welcomed. For example, our overall understanding of evapotranspiration rates and soil moisture remains limited, but funding of the complex monitoring systems has ceased, at least in Ontario. This is despite the fact that evapotranspiration comprises 60-70% of the hydrologic water budget in Canada. • This work should be restarted and expanded, with the data and analysis fully available to the public. Support for long term partnerships with universities would also be helpful to ensure that monitoring is geographically extensive and covers a wide range of agricultural activities.
3.6 Economic sectors and fresh water a. What sectors do you believe will face the greatest freshwater challenges nationally, and in your region in the next 5, 10, and 20 years? What support is needed to assist sectors in addressing these challenges in terms of technology, information, and other approaches for sustainable freshwater management? b. What are some positive examples of freshwater challenges addressed in sector-specific strategies	• In TRCA's jurisdiction, the issue has been too much water, and this is expected to continue. We have experienced record high water levels in the Great Lakes over the past 5 years. At the same time, Ontario has undergone significant drought events over the past 20 years. Perhaps investment is needed in water storage for use in times of drought; increased water stress is one prediction of a future climate but will not be the main concern based on current science. • Better understanding is needed of long-term trends and influences, regional aquifer systems and the annual water budgets of the Great Lakes, so that governments can more accurately assign water use permits that match the available supplies. • Canada should be a leader in innovative water treatment technologies that make better use of the additional stormwater generated by urbanization, thereby managing stormwater as a resource rather than a liability.

and what can we learn from them?	• Better understanding of the requirements of the growing aquaculture industry is needed to ensure that freshwater availability does not limit their success. One positive example is a successful stormwater treatment at a GTA golf course that produces high-quality irrigation water from a waste product that had previously impacted the natural hydrologic system with excess nutrients.
3.7 Freshwater science a. What are the priority knowledge and research gaps to be filled to achieve effective freshwater management over the next 10 years? b. How well is freshwater science coordinated today? If further coordination is needed, how might that be accomplished?	• TRCA strongly supports the idea of collaboration among the provinces, territories, and others to develop a national freshwater science agenda that would galvanize efforts around key research priorities, improve science integration and communication across governments, academics, and others, and ensure the science is well linked with policy and program needs, including climate change adaptation. • Responding to unique regional water management challenges by supporting regional centres of expertise is another welcome idea presented in the Discussion Paper that would bring expertise together to focus on issue-specific freshwater science. For example, more study is needed on how future climate will affect water resources. TRCA is starting to tackle these issues through watershed planning. Regional forums for discussing these priorities as a Community of Practice would be a helpful role for the CWA to take on. • In terms of water quality, we need an improved understanding of the nature, extent, and impacts of PFAS, endocrine disruptors, and other emerging contaminants in the hydrologic system. Currently, our laboratory testing is limited and expensive for these chemicals, which results in limited testing. • In terms of water quantity, we need a more comprehensive understanding of the availability of both groundwater and surface water, and the cumulative impacts of water use and wastewater disposal. We need official endorsement and support of the cross-jurisdictional work done by hydrologic and hydrogeologic practitioners across the country. More opportunities are necessary for these professionals to interact with each other and the academic community to ensure that ongoing research addresses issues that are identified by those who make use of freshwater resources and those that regulate such uses. We need to encourage, support and fund professionals across this nation to share their data, knowledge and wisdom early and often.
3.8 Freshwater data a. What are your experiences with freshwater	• The Discussion Paper raises the possibility of a Freshwater Data Discovery Strategy that allows users to discover vital freshwater data and bring datasets together based on agreed themes. In April

data? What worked well and what areas have the most room for improvement? Are there good models to learn from? b. What advances in data analytics present opportunities for freshwater management and decision-making? What can the Government of Canada do to capitalize on these opportunities? c. What are examples of where compatibility and interoperability of data across orders of government and with non-government organizations has been achieved? What can we learn from these examples?	2021, TRCA will be launching a Watershed and Ecosystems Reporting Hub, which is an example of how a similar platform is being developed on a regional and watershed scale. • In TRCA's experience, an excellent example of data management is the Oak Ridges Moraine Groundwater Program (ORMGP). This diverse team of professionals has developed one of the most comprehensive regional freshwater datasets and regional assessment of freshwater resources, largely with funding from regional government sources, and limited investment by both the provincial and federal governments. • The ORMGP model could be expanded to provide timely access to hydrologic data across the country, but adoption of this approach would require financial investment to put the appropriate staff and resources in place to ensure the resultant datasets are robust, reliable, and available to the public. • The advancements of shared supercomputer platforms have the potential to allow for high-resolution modelling at scales never before considered. The underlying comprehensive, regional, and national datasets are needed to provide the foundation for this modelling in the future.
3.10 Freshwater technology, innovation, and infrastructure a. What are your thoughts on the technology and infrastructure priority areas identified above? Should others be considered? b. What are the most important freshwater infrastructure priorities for your community, including those needed to adapt to a changing climate? c. What models should the Government of Canada consider to enhance coordination and collaboration on freshwater technology, innovation and infrastructure?	• TRCA strongly supports all of the technology and infrastructure priority areas identified. In addition to the Oak Ridges Moraine Groundwater Program already mentioned, another excellent example of multi-agency coordination is the ongoing Federal-Provincial-Conservation Authority workshop/open house on the Regional Hydrogeology of Southern Ontario.
3.11 Engaging Canadians in managing and protecting fresh water a) What specific tools and approaches will be most effective in advancing high-	• Funding to support training, equipment and coordination of citizen science groups to collect, store, and roll-up monitoring data to the regional centre scale (or beyond) would be helpful; training should

quality citizen and community science and data for freshwater decision-making, and in enabling involvement by all groups?	ensure rigorous quality assurance/quality control to ensure that the right data are attributed to the correct location(s).
3.12 Overarching discussion questions a. What are your views on the possible opportunities to enhance freshwater management identified in sections 3.2 to 3.11? Which should be the highest priority? What is missing? b. Which of these possible opportunities should be priority roles for a CWA?	• The key opportunities in the Paper centre around the collection, storage, and dissemination of extensive, reliable freshwater quality and quantity data. Once that has been accomplished, these data can be the foundation of ongoing resource assessments and implementation of mitigative strategies to ensure the long-term sustainability of our vital freshwater resources. Section 3.10 does a good job of outlining the priorities.
4.0 Governance considerations for a Canada Water Agency a. What are examples or best practices from other jurisdictions or other governance models the Government of Canada should consider in creating a CWA? b. What are your views on the considerations presented? What should be the highest priority? What is missing?	• The Province of Ontario's Provincial Policy Statement requires land use planning authorities to protect, improve or restore the quality and quantity of water by using the watershed as the ecologically meaningful scale for integrated and long-term planning, noting that it can be a foundation for considering cumulative impacts of development. The watershed-based approach should be the foundation of the CWA. As conservation authorities are unique to Ontario, other provinces currently do not benefit from this nature-based, local needs, partnership model. The CWA could provide direction to provinces and regions to adopt such a model through legislation and partnerships across municipal/regional jurisdictions with shared watersheds.

Thank you once again for the opportunity to provide comments on the Discussion Paper on the creation of a Canada Water Agency. Should you have any questions, require clarification on any of the above, or wish to meet to discuss our remarks, please contact the undersigned at 416.661.6600, Ext. 5281 or at laurie.nelson@trca.ca.

Sincerely,

- Original signed by -

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cc:
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